THE CALENDAR BELOW lists all of the meetings which have been approved by the Council up to the date this issue of the Notices was sent to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have yet been assigned.

ABSTRACTS SHOULD BE SUBMITTED ON SPECIAL FORMS which are available in most departments of mathematics; forms can also be obtained by writing to the headquarters of the Society. Abstracts to be presented at the meeting in person must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline for the meeting.

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*Deadline for abstracts NOT presented at a meeting (by title) October 1978 issue: AUGUST 21
November 1978 issue: SEPTEMBER 12

OTHER EVENTS

August 15—23, 1978
International Congress of Mathematicians
Helsinki, Finland

March 27—30, 1979
Symposium on the Geometry of the Laplace Operators
University of Hawaii, Honolulu, Hawaii

SUBSCRIPTION INFORMATION: Notices of the American Mathematical Society is published eight times a year (January, February, April, June, August, October, November, and December). Subscription prices for Volume 25 (1978) are $19.00 list, $8.50 member. The subscription price for members is included in the annual dues. Subscriptions and orders for AMS publications should be addressed to the American Mathematical Society, P. O. Box 1571, Annex Station, Providence, R. I. 02901. All orders must be accompanied by payment.

OTHER CORRESPONDENCE with the Society should be sent to the Society at P. O. Box 6248, Providence, R. I. 02940. Please affix one of the peel-off labels from copies of the Notices to any correspondence with the Society.

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The eighty-second summer meeting of the American Mathematical Society will be held at Brown University, Providence, Rhode Island from Wednesday, August 9, through Saturday, August 12. All sessions will take place on the campus of the university.

No Colloquium Lectures are scheduled at this meeting.

There will be two special lectures concerned with mathematical discovery. HASSLER WHITNEY of the Institute for Advanced Study will give a lecture on "Fostering and hindering creativity in mathematics" at 10:00 a.m. on Thursday, and HANS J. ZASSENHAUS of Ohio State University will speak on "On the 4 group theorems" at 10:00 a.m. on Friday.

By invitation of the Society's Program Committee, there will be eight invited one-hour addresses, as follows: 1:00 p.m., Wednesday, DONALD J. BROWN, Cowles Foundation for Research in Economics, Yale University, "Myopic economic agents"; 2:15 p.m., Wednesday, RAOUl H. BOTT, Harvard University, "Recent developments in Yang-Mills theory"; 11:00 a.m. Thursday, ANIL NERODE, Cornell University, "The limits of effectivity in classical mathematics"; 11:00 a.m. Friday, JOHN W. MORGAN, Columbia University, "Hodge theory for the algebraic topology of nonsingular varieties"; 1:00 p.m. Friday, JAMES G. ARTHUR, Duke University, "Automorphic forms and the trace formula"; 2:15 p.m. Friday, BORIS MOISHEZON, Columbia University, "Global problems in the singularities theory"; 11:00 a.m. Saturday, SPENCER BLOCH, University of Chicago, "On the geometry of algebraic cycles"; and 1:00 p.m. Saturday, JAMES V. RALSTON, University of California, Los Angeles, "The scattering of sound waves."

Also by invitation of the Program Committee, there will be twenty-two special sessions of selected twenty-minute papers, five of which are directly related to the invited hour addresses. The titles of these special sessions, the names of the organizers, and the times of their first meetings are as follows: Algebraic cycles, SPENCER BLOCH, 8:30 a.m. Saturday; Yang-Mills theory, RAOUl H. BOTT, 3:30 p.m. Wednesday; Mathematical economics, DONALD J. BROWN, 3:30 p.m. Wednesday; Algebraic topology of smooth algebraic varieties, CHARLES HERBERT CLEMENS, 8:30 a.m. Thursday; and Problems in logic arising from mathematics, ANIL NERODE, 8:30 a.m. Thursday.

The titles of the remaining special sessions, the names of the mathematicians arranging them, and the times of their first meetings are as follows: Some aspects of the biology and mathematics of neural modeling, JAMES ANDERSON and ERKKI OJA, 1:00 p.m. Friday; Functional differential equations, H. THOMAS BANKS, 8:30 a.m. Friday; Partial differential equations, RICHARD W. BEALS, 8:30 a.m. Saturday; Combinatorial aspects of mathematical programming, LOUIS J. BILLERA, 8:30 a.m. Friday; Geometric methods in control theory, C. BYRNES, 3:30 p.m. Wednesday; Operator theory and functional analysis, IVAN N. ERDELYI, 2:30 p.m. Wednesday; Several complex variables, JOHN ERIK FORNÆSS, 3:30 p.m. Wednesday; Galois theory, MURRAY GERSTENHABER, 8:30 a.m. Thursday; Number theory, LARRY J. GOLDSTEIN, 8:30 a.m. Saturday; The identity problem, M. GUTTIEREZ, 8:30 a.m. Saturday; Energy model algorithms and related mathematical research, CAULTON L. IRWIN, 2:10 p.m. Saturday; History of mathematics, M. MAHONEY, 3:30 p.m. Wednesday; Approximation theory, PAUL G. NEVAI, 8:30 a.m. Saturday; Interacting particle systems, LAURIE J. SNELL, 8:30 a.m. Thursday; Combinatorics, ALAN P. SPRAGUE, 8:30 a.m. Thursday; and Conceptual analysis in rational thermomechanics, CLIFFORD TRUESDELL, 3:30 p.m. Wednesday.

There will be sessions for contributed ten-minute papers on Wednesday afternoon, Thursday morning, Friday afternoon, Saturday morning, and Saturday afternoon. No provision will be made for late papers. Abstracts should have been received in Providence prior to the deadline of May 30.

Overhead projectors, screens, and blackboards will be in each room used for a special session or contributed paper session. Presenters of ten- or twenty-minute papers are urged to use the overhead projector rather than the blackboard for their presentation in order to obtain maximum visibility by all members of the audience.

COUNCIL AND BUSINESS MEETING

The Council of the Society will not meet because of the closeness in time of the Society meeting to the International Congress of Mathematicians. The Business Meeting of the Society will take place at 4:00 p.m. on Friday, August 11. The secretary notes the following resolution of the Council: "Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society."

In further explanation, it is noted that "each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society."

For additional information concerning the Business Meeting refer to the box at the top of page 272.
Introduction to Systems and Control Theory for Mathematicians
August 6–7, 1978

The American Mathematical Society will present a one and one-half day short course entitled "Introduction to systems and control theory for mathematicians" preceding the 82nd summer meeting of the Society on Sunday and Monday, August 6 and 7, in room 166 of Barus-Holley Hall on the campus of Brown University in Providence, Rhode Island. The course will give a concentrated introduction to several aspects of theory and applications. It is intended primarily for mathematicians who are not specialists in this area of applied mathematics. Topics will include an introduction to control concepts, controllability questions for linear and nonlinear systems, numerical methods, and applications to flight trajectory optimization and to a biological control problem.

The program is under the direction of Wendell H. Fleming of Brown University. The short course was recommended by the Society's Committee on Employment and Educational Policy, whose members are Lida K. Barrett, Alan J. Goldman, Arthur P. Mattuck, Hugo Rossi, Martha K. Smith, and Robert J. Thompson.

The program will consist of six seventy-five minute lectures as follows: Wendell H. Fleming will speak on "Optimal control: An introduction"; W. M. Wonham (Department of Electrical Engineering, University of Toronto) will speak on "Linear multivariable control. Geometric formulation"; H. T. Banks (Division of Applied Mathematics, Brown University) will speak on "Control problems in biological sciences"; Roger Brockett (Division of Engineering and Applied Physics, Harvard University) will speak on "Nonlinear systems and differential geometry"; Henry J. Kelley (Analytical Mechanics Associates, Inc.) will speak on "Trajectory optimization"; and Alan J. Laub (Electronic Systems Laboratory, Massachusetts Institute of Technology) will speak on "Linear multivariable control. Numerical considerations."

In addition, a half-hour informal panel discussion will be held at the end of the course to consider questions from the audience, and to put the course in perspective. Joseph P. LaSalle (Division of Applied Mathematics, Brown University) will be the moderator.

Pi Mu Epsilon will hold its summer meeting on Wednesday and Thursday, August 9–10. The J. Sutherland Frame Lecture will be presented at 8:30 p.m. on Wednesday by Herbert E. Robbins of Columbia University. The title of his lecture is "The statistics of incidents and accidents."

The Association for Women in Mathematics will sponsor a panel discussion on "Women mathematicians before 1950" at 4:00 p.m. on Wednesday, August 9. Patricia C. Kenschaft will serve as moderator. Panel members are Dorothy Bernstein, M. Gweneth Humphreys, Anne F. O'Neill, and Mina Rees.

**OTHER ORGANIZATIONS**

The Mathematical Association of America (MAA) will hold its summer meeting on August 8–10, Tuesday–Thursday, in conjunction with this meeting of the Society. The Business Meeting of the Association will take place at 10:00 a.m. on Wednesday, August 9, at which the Carl B. Allendoerfer, Lester R. Ford, and George Pólya Awards will be presented. A more detailed listing of the program of the Association appears in the Timetable, beginning on page 278 of these Notices.

Also on Wednesday, there will be a dinner at 6:30 p.m. in the Ballroom of the Marriott Inn for those who have been members of the Association for thirty years or more. The dinner will be followed by a short program, with G. Baley Price as master of ceremonies and MAA President Henry L. Alder, Past President Henry O. Pollak, and Nura D. Turner as speakers. Similar dinners were held at the August meetings in 1976 and 1977, and proved to be pleasant occasions. Thirty-year members of the Association who have reserved tickets for this dinner may purchase them at the registration desk, and should do so prior to 4:30 p.m. on Tuesday. Others who have been MAA members for thirty years or more and would like to attend this dinner may also purchase tickets at the desk until 4:30 p.m. on Tuesday. Tickets for the dinner are $10 per person, and spouses are invited. The ticket price includes sales tax and gratuity.

An informal version of the Employment Register will be operated on a limited basis during the summer meeting. No interviews will be scheduled by the staff. Instead facilities will be provided for applicants and employers to display résumés and job listings. Message boxes will be set up for individuals to leave messages for one another requesting interviews.

The Register will be located in Room 136 Barus-Holley Building (H on the map on page 274), and will be open from 8:30 a.m. to 4:30 p.m. daily, Wednesday through Friday, August 9–11.

Applicants should recognize that the Mathematical Sciences Employment Register cannot...
Committee on the Agenda for Business Meetings

The Society has a Committee on the Agenda for Business Meetings. The purpose is to make Business Meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasi-political" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to

(a) doing nothing;
(b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting;
(c) recommending and planning a format for debate to suggest to a Business Meeting;
(d) recommending referral to a committee;
(e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a Business Meeting to refer it rather than to act on it without benefit of the advice of the committee.

The committee consists of Barbara L. Osofsky, David A. Sanchez, Michael Taylor, and Guido L. Weiss, with the secretary as chairman.

In order that a motion for the Business Meeting of August 11, 1978, receive the service to be offered by the committee in the most effective manner, it should have been in the hands of the secretary by July 7, 1978.

Everett Pitcher, Secretary

EXHIBITS AND BOOK SALE

The book and educational media exhibits will be displayed in the lobby of the Barus-Holley Building (H on the map on p. 274) at the following times: Tuesday, August 8, 1:00 p.m. to 5:00 p.m.; Wednesday and Thursday, August 9–10, 8:30 a.m. to 4:30 p.m. All participants are encouraged to visit the exhibits some time during the meeting.

Books published by the Society will be sold at prices somewhat below the usual mail order prices. The book sale will be located in the lobby of Barus-Holley, and will be open at the following times: Tuesday, August 8, 8:00 a.m. to 4:30 p.m.; Wednesday through Friday, August 9–11, 8:30 a.m. to 4:30 p.m.

MEETING REGISTRATION

Participants who wished to preregister for the meeting should have done so prior to the deadline of July 14.

Meeting preregistration and registration fees partially cover expenses of holding the meetings. The preregistration fee does not represent an advance deposit for lodgings.

Please note that separate fees are required for the Short Course and the Joint Mathematics Meetings. These fees are as follows:

<table>
<thead>
<tr>
<th>Introduction to Systems and Control Theory for Mathematicians</th>
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<tbody>
<tr>
<td>Short Course</td>
</tr>
<tr>
<td>Student/unemployed</td>
</tr>
<tr>
<td>All other participants</td>
</tr>
<tr>
<td>One-day fee for second day only</td>
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Joint Mathematics Meetings

<table>
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<td>Members of AMS, MAA and IME</td>
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<tr>
<td>Nonmembers</td>
</tr>
<tr>
<td>Student/unemployed</td>
</tr>
</tbody>
</table>

There will be no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

Students are considered to be only those currently working toward a degree who do not receive compensation totaling more than $7,000 from employment, fellowships, and scholarships.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned or retired from their latest position.

A fifty percent refund of the preregistration fee will be made for all cancellations received in Providence no later than August 4. There will be no refunds granted for cancellations received after that date, or to persons who do not attend the meetings.

Registration for the Short Course only will begin on Sunday, August 6, at 11:00 a.m., outside Room 166 in the Barus-Holley Building (H on the map on page 274). Participants who are not attending the Short Course are advised that no Joint Mathematics Meetings information or registration material will be available prior to the time listed below for the Joint Mathematics Meetings registration.

The Joint Mathematics Meetings registration desk will be located in the lobby of the Barus-Holley Building. The desk will be open during the hours listed on the following page.
Introduction to Systems and Control Theory
for Mathematicians

Short Course Registration
Outside Room 166, Barus-Holley Building

Sunday, August 6 11:00 a.m. - 3:30 p.m.
Monday, August 7 8:00 a.m. - 2:00 p.m.

Joint Mathematics Meetings Registration
Barus-Holley Building Lobby

Monday, August 7 2:00 p.m. - 8:00 p.m.
Tuesday, August 8 8:00 a.m. - 4:30 p.m.
Wednesday, August 9 through Friday, August 11 8:30 a.m. - 4:30 p.m.
Saturday, August 12 8:30 a.m. - 1:30 p.m.

RESIDENCE HALL HOUSING

Participants desiring to obtain confirmed reservations for residence hall accommodations should have preregistered prior to the deadline of July 14. Rooms may be available for those who did not preregister, but this cannot be guaranteed. It will not be possible for participants to occupy rooms prior to Saturday, August 5, or after noon on Sunday, August 13. If housing requests are received for dates before August 5 or after August 12, they will be honored for the period August 5-12 only. Residence hall reservations do not require a deposit in advance; however, full payment for rooms at the residence halls must be made at check-in time. Cash, personal or travelers' checks will be accepted; credit cards will not be honored. A $2 room key deposit will be collected at check-in time, which is refundable upon return of the key. Parking tickets may also be purchased at check-in time (see section titled PARKING). Room keys open the main entrance to the residence hall, as well as the individual room.

Brown University is providing two residence areas for the Joint Mathematics Meetings and AMS Short Course. Both complexes are conveniently located to the dining hall and session rooms on campus. The West Quadrangle (see A on the map on page 274) is a grouping of six buildings one block west of the dining hall, and will be used primarily for couples and families requiring double rooms. The Graduate Center (see B on the map on page 274) is one block south of the dining hall. All rooms in the Center are singles. Neither of these residence halls is air-conditioned.

The room rates quoted below include breakfast at the Sharpe Refectory (see C on the map on page 274), the following morning for those in residence starting Monday night, August 7, and through Saturday night, August 12. For those in residence before August 7, the room rates are $11 single and $7.50 double per person. For information on meals at Brown see the section titled FOOD SERVICES.

ROOM RATES PER PERSON PER NIGHT
SINGLE $12.85
DOUBLE 9.35

There will be no charge for infants occupying a crib provided by parents. (See section titled CRIB RENTAL.) Cots are available for children 10 years of age or under. Use of these cots is limited to one cot per double room, and at least one parent or adult must occupy one of the beds in the room where a child 10 or under sleeps. The charge for the cot, including breakfast, is $3.25 per night. The charge for a cot before August 7 (without breakfast) is $2.

Any child over 10 years of age must occupy a bed, and will be charged the same rate as an adult. Children under 10 may, of course, occupy a bed, provided the adult room rate is paid.

Participants with confirmations for rooms in the West Quadrangle and those participants who do not request residence hall housing in advance, but will require accommodations (if available) arriving on August 5 and 6 must check in at the University Housing Office in Wayland House (see D on the map on page 274), which is open twenty-four hours. Participants with confirmations for rooms in the Graduate Center arriving on August 5 and 6 must check in at the desk in the lobby of the Center from 10:00 a.m. to midnight. Participants are advised to have their taxi or limousine let them off at the Charles Field Street entrance at the ramp. Between the hours of 12:01 a.m. to 10:00 a.m., these participants should check in at Wayland House.

All participants arriving during the period August 7-12 must check in at the housing desk in Arnold Lounge of the West Quadrangle between the hours of 8:00 a.m. to midnight, or at the desk in the lobby of the Graduate Center between the hours of 8:30 a.m. and 11:00 p.m. according to their housing assignments. Participants arriving without confirmed reservations during this period, or participants with confirmations arriving during the times the residence hall desks are not open should check in at Wayland House.

All double rooms in the West Quadrangle contain two single beds. Double beds are not available. Participants will share several large, communal bathrooms on each floor. The room/cot charge includes one complete set of towels (no face cloths), soap, bed linen, blanket, and pillow, for the entire length of stay. Daily maid service will be provided, including making of beds, tidying up, and emptying of wastebaskets. Each room contains, in addition to the two single beds, dressers, desks and student chairs, lounge chairs, lamps, ashtrays and drinking glasses. West Quadrangle contains several kitchenettes, each with sink, stove, dining table and chairs (no refrigerator). Participants planning to use the kitchen facilities should bring their own cooking and eating utensils. Laundry centers are located to the rear of Bronson and Jameson Houses in the West Quadrangle; coin-operated washers and dryers cost $0.25 each. Ironing boards are in the room; irons are available from the University Housing Office in Wayland House. Participants must provide their own soap or detergent. There are several lounges and reading rooms, some of which are equipped with ping-pong tables, pool tables, and television sets.
All rooms in the Graduate Center contain one single bed, dresser, desk and student chair, lounge chair, lamp, ashtray, and drinking glass. There are kitchennettes on the second and fifth floors; again, participants should bring their own utensils. The same type of linen and maid service will be provided as in the West Quadrangle. There are coin-operated washers and dryers in the basement, as well as ironing boards. Irons are available at the desk in the lobby; however, participants must supply their own laundry materials. There is an air-conditioned central lounge in the Center with a television set, ping-pong tables, and pool table.

There are no telephones in the residence hall rooms. There are pay phones in the main lobby of the Graduate Center and in the University Housing Office. There are outside phones near both residence halls for emergency use; one need only pick up the telephone in order to be connected with the Security Office. Participants are advised that it will be extremely difficult to get telephone messages to them from family or friends not at the meeting during hours the message center at the Joint Mathematics Meetings registration desk is not open. In case of extreme emergency, the campus police at 401-863-2556 will attempt to locate participants staying in the residence halls.

Pets are not allowed in the residence halls. There are no restrictions on the use of alcoholic beverages on campus. Each participant will be given a list of regulations pertaining to the residence halls at time of check-in.

**FOOD SERVICES**

Included in the room charge (August 7–12) is a full-course breakfast (unlimited seconds), which will be served in the Sharpe Refectory from 7:00 a.m. to 9:00 a.m., starting Tuesday, August 8, through Sunday, August 13. Meal tickets will be issued when you receive your room key. For those on campus August 7, breakfast may be purchased on a cash basis for $2.25 (children ten years of age and under half-price). The Refectory will not be open August 5 and 6.

Luncheon, served from 11:15 a.m. to 1:45 p.m., and dinner, served from 5:00 p.m. to 6:30 p.m., will be available in the Sharpe Refectory at $2.75 and $4, respectively. Children ten and under will be charged half-price. These set-price meals feature buffet-style dining (unlimited seconds) so popular with Brown’s summer residents. Diners are encouraged to select from a wide variety of entrees, visit the several salad bars, choose from fresh fruit and extensive beverage offerings, and enjoy serve-yourself soft ice cream cones.

There are vending areas in both West Quadrangle and the Graduate Center, where machines offer a variety of soft drinks, coffee, snacks, candy, pastry, cigarettes, milk, and ice cream. The vending areas are open twenty-four hours a day, seven days a week.

Participants will be furnished with a list of other university food services and restaurants in the area with their registration packets. There are many restaurants within easy walking distance of the campus.

**HOTELS**

A block of rooms has been set aside for use by participants at the Marriott Inn. Participants should have made their own reservations early directly with the Marriott or other hotels listed below, and should identify themselves as participants in either the Short Course or Joint Mathematics Meetings.

The following codes apply: FP—Free Parking; SP—Swimming Pool; AC—Air Conditioned; TV—Television; CL—Cocktail Lounge; RT—Restaurant. The age limit for children under which there is no charge, providing a cot is not required and they are in the same room as a parent, is shown in parentheses on the same line as the charge for an extra person in the room. In all cases "single" refers to one person in one bed; "double" refers to two persons in one bed; and "twin" refers to two persons in two beds. A rollaway cot for an extra person can be added to double or twin rooms only. Participants will be advised of deposit requirements by the hotels at time of confirmation. The actual mileage and approximate walking times from the hotel to the meeting registration desk on campus are given in the parentheses after the name of the hotel. All rates quoted are subject to the 6 percent Rhode Island Sales Tax.

**MARRIOTT INN**

(1.3 miles, 30-minute walk)
Charles and Orms Streets 02904
Telephone: 401-272-2400 or 800-228-9290
Single $37 Double or Twin $42
Extra person in room $6 (18 years)
Code: FP, SP, AC, TV, CL, RT

**CRANSTON HILTON INN**

(4.1 miles, 1 1/2-hour walk)
1150 Narragansett Boulevard, Cranston 02905
Telephone: 401-467-8800
Single $25–32 Double or Twin $32–39
Extra person in room $7 (16 years)
Code: FP, SP, AC, TV, CL, RT

**HOLIDAY INN**

(1.5 miles, 36-minute walk)
21 Atwells Avenue 02903
Telephone: 401-831-3900
Single $25.50 Double or Twin $31
Extra person in room $4 (18 years)
Code: FP, SP, AC, TV, CL, RT

**HOWARD JOHNSON’S MOTOR LODGE**

(4.5 miles, 1 3/4-hour walk)
2 George Street, Pawtucket 02860
Telephone: 401-723-6700
Single $21 Double $26 Twin $28
Extra person in room $4 (18 years)
Code: FP, SP, AC, TV, CL, RT

**HOWARD JOHNSON’S MOTOR LODGE**

(6.4 miles, 2 1/2-hour walk)
20 Jefferson Boulevard, Warwick 02888
Telephone: 401-467-9800
Single $25 Double $29 Twin $36
Extra person in room $5 (18 years)
Code: FP, SP, AC, TV, CL, RT
Rhode Island has eleven state-owned camping areas, ten of which are open to meeting participants. Generally speaking, there is a two-week limitation on permits, and rates vary from no charge to $3 per person per night. Interested participants should have written for more information to the Division of Parks and Recreation, Department of Environmental Management, 83 Park Street, Providence, Rhode Island 02903 (telephone 401-277-2632).

ATHLETIC FACILITIES

The Aldrich Dexter Athletic Building adjacent to Meehan Auditorium on George Street has agreed to allow participants and families to use its facilities at faculty rates, provided a meeting badge is presented. The swimming pool is open to adults (15 years of age and over) from 11:30 a.m. to 1:00 p.m., from 4:00 p.m. to 5:00 p.m., and from 9:30 p.m. to 11:00 p.m. Monday through Friday, and from 3:30 p.m. to 5:30 p.m. Saturday and Sunday. Families with children under 15 years of age may use the pool from 1:00 p.m. to 4:00 p.m. and from 7:30 p.m. to 9:30 p.m. Monday through Friday, and from 12:30 p.m. to 3:30 p.m. and 7:30 p.m. to 9:30 p.m. Saturday and Sunday. The charge is $1 per person; swimmers must furnish their own suits and towels.

The tennis courts will be available to participants presenting meeting badges at the rate of $2 per hour per person, on a first-come, first-served basis. Participants should bring their own equipment.

BOOKSTORES

The Brown University Bookstore, located at 244 Thayer Street, is open from 9:00 a.m. to 6:00 p.m., Monday through Saturday. The College Hill Book Store at 252 Thayer Street is open from 9:00 a.m. to 11:00 p.m., Monday through Sunday.

CHILD CARE

The Brown University Fox Point Day Care Center at 150 Hope Street, Providence, Rhode Island 02906 (see map on page 274), will accept children from two-and-one-half years of age up to ten years of age. The Center is open from 7:30 a.m. to 5:15 p.m., Monday through Friday, and the daily rate is approximately $6, including lunch. Participants wishing to take advantage of the services offered by the Center should have written to Beatrice Blackwell, Director, in advance of the meeting in order to make reservations for the child or children. The Center is bilingual (Portuguese) and bicultural.

Swimming and day trips are some of the activities planned.

A list of babysitters will also be available at the Local Information Desk at the meeting.

CRIB RENTAL

Participants wishing to rent cribs should have written no later than June 15, 1978, in order to ensure their crib reservation.

ENTERTAINMENT

On Thursday evening, August 10, there will be an authentic New England Clambake on the grounds of Francis Farm in Rehoboth, Massachusetts, twenty minutes from Providence. Round-trip bus transportation will be available to ticket-holders; the cost will be included in the price of the ticket. Buses will leave starting at 6:00 p.m. from in front of St. Stephen's Church on George Street. Chowder and clamcakes will be served while the bake is steaming in a pit lined with seaweed. When the bake is served, there will be all one can eat of steamed clams with drawn butter, fish, white and sweet potatoes, onions, sweet corn, sausage, and brown bread, topped off with coffee, soft drinks, and watermelon. No alcoholic beverages will be served. Firm prices are not yet available, but it is anticipated that the cost of an adult ticket, including bus transportation, will be about $10.50, and that a ticket for a child between six and twelve years of age will be half-price. There is no charge for children under six. The cost of an adult ticket without bus transportation will be approximately $9. Although lobster has traditionally been included in clambakes, the price of this particular seafood has become so high it is being offered as an option only. Adults wishing to have half a lobster included in their bake should anticipate adding approximately $2.50 to the prices quoted above. The same amount would have to be added to the price of children's tickets as well. Lobster will not be served to children under six for whom there is no charge. Participants are urged to purchase their tickets at the Joint Mathematics Meetings registration desk as soon as they arrive in order to be assured of participating. Ticket sales will be cut off at 4:30 p.m. on Wednesday, August 9.

On Friday evening, August 11, there will be a concert by several mathematicians and their spouses. The program will include clarinet quintets of Mozart and Brahms and the cello quintet of Schubert, and is under the direction of Reese T. Prosser of Dartmouth College.

The headquarters office of the Society is located in Providence at 201 Charles Street, directly across from the Marriott Inn. Participants are encouraged to visit the headquarters at 9:00 a.m., or at 2:00 p.m., Tuesday through Thursday, when tour guides will be available to explain the function of various departments and provide information on the Society's operation. Light refreshments will be served at the conclusion of each tour, which should take no longer than an hour.

Rhode Island has many attractions which we hope our participants will find time to visit.
The city of Newport has its famous Bellevue Avenue mansions, Touro Synagogue established in 1763 (the oldest in America), and the beauty of its harbor and shore line. There are several excellent salt water beaches in the state, and salt water fishing is one of the most popular tourist pastimes. Walking tours of famous Providence homes in the university area, such as the John Brown House and Stephen Hopkins House, are available. Providence is within easy driving distance of Mystic Seaport and the Old Sturbridge Village, where life is depicted as it was in the eighteenth and nineteenth centuries. Further information and details on tours, bus travel, and accessibility of these and other attractions will be available at the Local Information Section of the Joint Mathematics Meetings registration desk.

LIBRARIES

The John D. Rockefeller, Jr., Library, the main campus library (J on the map on page 274) is open 8:30 a.m. to 9:00 p.m. Monday through Friday. The Sciences Library, which contains the mathematics library (K on the map) is open the same hours weekdays, and 8:30 a.m. to 4:30 p.m. Saturday and Sunday. The John Hay Library (L on the map) contains historical collections of interest particularly to Lincoln scholars, and the John Carter Brown Library (M on the map) houses a nationally famous collection of early Americana. Both of these libraries are open from 8:30 a.m. to 4:30 p.m. Monday through Friday.

MAIL AND TELEPHONE MESSAGES

All mail and telegrams for persons attending the meetings should be addressed to the participant in care of Joint Mathematics Meetings, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940. Mail and telegrams so addressed may be picked up at the Joint Meetings Registration Desk located in the lobby of the Barus-Holley Building during the hours that desk is open.

A telephone message center will be located in the same area to receive incoming calls for participants during the hours the desk is open. Messages will be written down, and the name of the participant for whom a message has been received will be posted on a blackboard until the message is picked up at the message center. The telephone number of the center is 401-863-2413. The center will be open during the hours for Joint Mathematics Meetings registration.

MEDICAL SERVICES

Brown University’s infirmary which provides free outpatient minor emergency care is located in Andrews House (E on the map on page 274), and is open from 8:00 a.m. to 4:00 p.m., weekdays. There is a charge for any medications required. The emergency room at Miriam Hospital, 164 Summit Avenue, is open twenty-four hours, seven days, and offers all emergency medical services except psychiatric and obstetric. Participants with emergency dental problems may call Dr. Mitchell Sack at 722-3757. Dr. Sack’s office is at 32 Goff Avenue in Pawtucket, and is open Monday through Saturday from 9:00 a.m. to 4:00 p.m., with the exception of Wednesday when the office closes at 1:00 p.m.

PARKING

Brown University has set aside two parking lots on campus for use by participants. The Power Street Lot (F on the map on page 274) may be used by the participants living in the residence halls. There is no charge for parking in this lot during daylight hours; the fee for overnight parking is $0.50. Parking tickets for overnight may be purchased when participants check in at the residence halls and receive their room assignments.

The lot at Meehan Auditorium may be used without charge by any participant during daylight hours. There is no provision for overnight parking at Meehan.

TRAVEL AND LOCAL INFORMATION

Providence operates on Eastern Daylight Time during the summer. The city is served by Theodore Francis Greene Airport, in Warwick, Rhode Island, which is an approximate fifteen-minute drive from the city via I-95. Rush hour traffic may extend this up to thirty minutes. A transportation desk will be set up in the airport lobby to provide information on limousine and taxi service for participants. The charge for the limousine will be $4.50 per person, for service to the Marriott Inn, West Quadrangle, or the Graduate Center. Taxicabs are on meters, and the average charge is $12. Cabs will take up to four occupants going to the same destination; there is no additional charge for more than one passenger. Participants were asked to provide flight information requested on the Preregistration and Housing Form in order to assist the limousine and taxi company in providing adequate service. In addition, participants requiring taxi or limousine service upon leaving the meeting are asked to sign up at the Local Information Section of the Joint Mathematics Meetings registration desk.

If you plan to drive from the airport to the university, follow the signs after leaving the airport directing one to "I-95 North." Once on the interstate, continue north until you near the center of Providence, and take the exit marked "I-195 East." Once on I-195, take the first exit marked "Downtown," and proceed along the Providence River past the Court House, turning right up the hill on College Street to Prospect Street. Turn right on Prospect Street, then left on George Street. Participants wishing to check in at the West Quadrangle should continue on George Street turning right on Brown Street. Participants wishing to check in at the Graduate Center should continue on George Street, turning right on Brown Street, and left on Charles Field Street. The ramp entrance to the Graduate Center is on Charles Field Street. The University Housing Office in Wayland House, for those checking in after hours, is located at the corner of George and Brown Streets.

If you plan to drive from the airport to the Marriott Inn, take the exit from I-95 north
marked "State Offices," turning left upon exiting onto Orms Street; the Marriott entrance is then only a short distance away on the left.

Participants traveling to the meeting by auto from points south on I-95 (which runs from Florida to Maine) should follow the same directions once reaching the city of Providence. Participants driving to Providence from the north on I-95 would, of course, take the same exits from the opposite direction in order to reach the campus. To reach the Marriott Inn, take Exit 23 (marked "Charles Street" at first sign, and "State Offices" at next sign). Take first available left to go under Route I-95. The Marriott is a short distance away on the right.

Amtrak has regular train service from New York City and Washington, D.C. Union Station is in the center of Providence, and is only a few minutes from the campus by taxi.

The Bonanza Bus terminal is also a short taxi ride from campus, and has frequent express service from New York City and from Logan Airport in Boston.

--- TIMETABLE ---
(Eastern Daylight Time)

<table>
<thead>
<tr>
<th>B-H = Barus-Holley Building</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMERICAN MATHEMATICAL SOCIETY SHORT COURSE SERIES</strong></td>
</tr>
<tr>
<td><strong>SUNDAY, August 6</strong></td>
</tr>
<tr>
<td>11:00 a.m. - 3:30 p.m.</td>
</tr>
<tr>
<td>Introductory remarks</td>
</tr>
<tr>
<td>1:30 p.m.</td>
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<tr>
<td>Wendell H. Fleming</td>
</tr>
<tr>
<td>1:45 p.m. - 3:00 p.m.</td>
</tr>
<tr>
<td>W. M. Wonham</td>
</tr>
<tr>
<td>3:30 p.m. - 4:45 p.m.</td>
</tr>
<tr>
<td>H. T. Banks</td>
</tr>
<tr>
<td>MONDAY, August 7</td>
</tr>
<tr>
<td>8:00 a.m. - 2:00 p.m.</td>
</tr>
<tr>
<td>Registration (Short Course Only)</td>
</tr>
<tr>
<td>ROOM 166, B-H</td>
</tr>
<tr>
<td>9:00 a.m. - 10:15 a.m.</td>
</tr>
<tr>
<td>H. T. Banks</td>
</tr>
<tr>
<td>10:45 a.m. - noon</td>
</tr>
<tr>
<td>Roger Brockett</td>
</tr>
<tr>
<td>1:30 p.m. - 2:45 p.m.</td>
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<tr>
<td>Henry J. Kelley</td>
</tr>
<tr>
<td>3:05 p.m. - 4:20 p.m.</td>
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<tr>
<td>Alan J. Laub</td>
</tr>
<tr>
<td>4:30 p.m. - 5:00 p.m.</td>
</tr>
<tr>
<td>Joseph P. LaSalle (moderator)</td>
</tr>
<tr>
<td><strong>JOINT MATHEMATICS MEETINGS</strong></td>
</tr>
<tr>
<td><strong>MONDAY, August 7</strong></td>
</tr>
<tr>
<td>American Mathematical Society</td>
</tr>
<tr>
<td>9:00 a.m. - 4:00 p.m.</td>
</tr>
<tr>
<td>Ballroom, Marriott</td>
</tr>
<tr>
<td>2:00 p.m. - 8:00 p.m.</td>
</tr>
</tbody>
</table>

--- WEATHER ---

The normal daytime high temperature in Providence during August is 79°F. Normal nighttime low is 61°F. The record high and low temperatures are 104°F and 40°F, respectively. Rainfall in August averages 3.72", although the record maximum is 7.32". Humidity ranges from an early morning high of 82 percent to an early evening low of 54 percent. Light sweaters and jackets are advisable for the occasional cool evening.

--- LOCAL ARRANGEMENTS COMMITTEE ---

# TIMETABLE

<table>
<thead>
<tr>
<th>TUESDAY, August 8</th>
<th>American Mathematical Society</th>
<th>Other Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. - 4:30 p.m.</td>
<td>REGISTRATION - Inner Lobby, B-H</td>
<td>Meehan Auditorium</td>
</tr>
<tr>
<td>9:00 a.m. - 9:10 a.m.</td>
<td>WELCOME ADDRESS</td>
<td>THE EARLE RAYMOND HEDRICK LECTURES</td>
</tr>
<tr>
<td>9:10 a.m. - 10:00 a.m.</td>
<td>THE EARLE RAYMOND HEDRICK LECTURES</td>
<td>Winning ways: Lectures on combinatorial games. Lecture I: What is a game?</td>
</tr>
<tr>
<td>10:10 a.m. - 11:00 a.m.</td>
<td>INVITED ADDRESS</td>
<td>Nonstandard calculus: The wave of the future?</td>
</tr>
<tr>
<td>11:10 a.m. - noon</td>
<td>INVITED ADDRESS</td>
<td>250 years of the gamma function</td>
</tr>
<tr>
<td>11:10 a.m. - noon</td>
<td>INVITED ADDRESS</td>
<td>College IV: One college's experience with a self-paced curriculum</td>
</tr>
<tr>
<td>1:00 p.m. - 5:00 p.m.</td>
<td>EXHIBITS - Main Lobby, B-H</td>
<td>THE EARLE RAYMOND HEDRICK LECTURES</td>
</tr>
<tr>
<td>1:30 p.m. - 2:20 p.m.</td>
<td>MAA - INVITED ADDRESS</td>
<td>Winning ways: Lectures on combinatorial games. Lecture II: Impartial games</td>
</tr>
<tr>
<td>2:30 p.m. - 3:20 p.m.</td>
<td>MAA - INVITED ADDRESS</td>
<td>Interacting galaxies</td>
</tr>
<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>MAA - PANEL DISCUSSION: Bayesian vs. non-Bayesian statistics</td>
<td>Lawrence Brown</td>
</tr>
<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>MAA - INVITED ADDRESS</td>
<td>I. R. Savage (moderator)</td>
</tr>
<tr>
<td>7:00 p.m. - 9:00 p.m.</td>
<td>Pi Mu Epsilon - Reception</td>
<td>Central Lounge, Graduate Center</td>
</tr>
<tr>
<td>7:00 p.m. - 9:45 p.m.</td>
<td>MAA - FILM PROGRAM</td>
<td>Unless otherwise noted, all films are in color</td>
</tr>
<tr>
<td>7:00 p.m.</td>
<td>Adventures in perception (Maurits Escher)</td>
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<tr>
<td>7:25 p.m.</td>
<td>Area under a curve (Rickart) - a film of the MAA Calculus Film Project</td>
<td></td>
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<tr>
<td>7:41 p.m.</td>
<td>Conic sections: A BBC broadcast as part of the Open University Foundation course in mathematics</td>
<td></td>
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<tr>
<td>8:07 p.m.</td>
<td>The Gauss-Bonnet theorem (Allendoerfer)</td>
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<tr>
<td>8:34 p.m.</td>
<td>The seven bridges of Königsberg (Cornwell)</td>
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<tr>
<td>8:40 p.m.</td>
<td>Space filling curves (Max) - a film of the Topology Film Project</td>
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<tr>
<td>9:10 p.m.</td>
<td>Geometric introduction to partial derivatives (Myers)</td>
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<tr>
<td>9:24 p.m.</td>
<td>Shapes of the future: Some unsolved problems in geometry-three dimension, Part II (Klee)</td>
<td></td>
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<tr>
<td>7:00 p.m. - 10:00 p.m.</td>
<td>MAA - SECTION OFFICERS</td>
<td>Ballroom, Marriott</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>REGISTRATION - Inner Lobby, B-H</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>EXHIBITS - Main Lobby, B-H</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>EMPLOYMENT REGISTER - Room 136, B-H</td>
<td></td>
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<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td>Meehan Auditorium</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td>MAA - THE EARLE RAYMOND HEDRICK LECTURES: Winning Ways: Lectures on combinatorial games. Lecture III: Three new theories for partisan games (Richard K. Guy)</td>
<td></td>
</tr>
<tr>
<td>10:00 a.m. - 10:50 a.m.</td>
<td>MAA - BUSINESS MEETING</td>
<td></td>
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<tr>
<td>11:00 a.m. - 11:50 a.m.</td>
<td>MAA - INVITED ADDRESS</td>
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<tr>
<td>11:00 a.m. - 11:50 a.m.</td>
<td>Regions admitting quadrature formulas (Philip J. Davis)</td>
<td></td>
</tr>
<tr>
<td>noon - 1:00 p.m.</td>
<td>MAA - INVITED ADDRESS</td>
<td></td>
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<tr>
<td>noon - 1:00 p.m.</td>
<td>What a difference a dimension makes (Frank R. Buianouckas)</td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>ILME - Council Luncheon</td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>Delta Phi Room, Sharpe Refectory</td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>Association for Women in Mathematics</td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>COUNCIL - Open Meeting</td>
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<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>Room 304, Wilson Hall</td>
<td></td>
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<tr>
<td>2:15 p.m. - 3:15 p.m.</td>
<td>SPECIAL SESSION</td>
<td></td>
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<tr>
<td>2:30 p.m. - 5:20 p.m.</td>
<td>Operator theory and functional analysis I</td>
<td></td>
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<tr>
<td>3:00 p.m. - 5:30 p.m.</td>
<td>Room 110 List Hall</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>SPECIAL SESSION</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Meehan Auditorium</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>MAA - INVITED ADDRESS</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Recent developments in Yang-Mills theory (Raoul H. Bott, Meehan Auditorium)</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>SPECIAL SESSION</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>DIFFERENTIAL AND INTEGRAL EQUATIONS I</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 185, B-H</td>
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<td>3:30 p.m. - 4:20 p.m.</td>
<td>GEOMETRIC METHODS IN CONTROL THEORY I</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 168, B-H</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>CONCEPTUAL ANALYSIS IN RATIONAL THERMOMECHANICS I</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 166, B-H</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>HISTORY OF MATHEMATICS</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Carmichael Auditorium</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>SESSIONS FOR CONTRIBUTED PAPERS</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Differential and integral equations I</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 185, B-H</td>
<td></td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>GEOMETRY</td>
<td></td>
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<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 301, Wilson Hall</td>
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<td>3:30 p.m. - 4:20 p.m.</td>
<td>COMBINATORICS</td>
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<td>3:30 p.m. - 4:20 p.m.</td>
<td>Room 101, Wilson Hall</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>AWM - PANEL DISCUSSION: Women mathematicians before 1950</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>Dorothy Bernstein</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>M. Gweneth Humphreys</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>Patricia C. Kenschaft (moderator)</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>Anne F. O'Neill</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>Mina Rees</td>
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<tr>
<td>4:00 p.m. - 5:30 p.m.</td>
<td>Meehan Auditorium</td>
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<tr>
<td>Time</td>
<td>American Mathematical Society</td>
<td>Other Organizations</td>
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<tr>
<td>6:00 p.m. - 7:30 p.m.</td>
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<td>IIME - Banquet</td>
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<td></td>
<td>Canal Room, Marriott</td>
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<tr>
<td>6:30 p.m. - 10:00 p.m.</td>
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<td>MAA - Banquet for 30 year members</td>
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<td></td>
<td>Ballroom, Marriott</td>
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<tr>
<td>7:00 p.m. - 10:00 p.m.</td>
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<td>MAA - Committee on Two-Year Colleges</td>
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<td>INFORMAL MEETING</td>
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<td>Room 304, Wilson Hall</td>
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<td>7:00 p.m. - 8:30 p.m.</td>
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<td>MAA - FILM PROGRAM</td>
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<tr>
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<td>Illustrated lecture on interactive</td>
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<td>computer graphics in mathematical</td>
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<td>research</td>
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<td>8:30 p.m. - 9:30 p.m.</td>
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<td>IIME - J. SUTHERLAND FRAME LECTURE</td>
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<td>The statistics of incidents and</td>
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<td>accidents</td>
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<td></td>
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<td>Herbert E. Robbins, Room 168, B-H</td>
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**THURSDAY, August 10**

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<thead>
<tr>
<th>Time</th>
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<tr>
<td>7:30 a.m. - 8:30 a.m.</td>
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<td>IIME - Dutch Treat Breakfast</td>
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<td>Delta Phi Room, Sharpe Refectory</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>REGISTRATION</td>
<td>Inner Lobby, B-H</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>EXHIBITS</td>
<td>Main Lobby, B-H</td>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>EMPLOYMENT REGISTER</td>
<td>Room 136, B-H</td>
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<td>SPECIAL SESSIONS</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Interacting particle systems I</td>
<td>Room 302, Wilson Hall</td>
</tr>
<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Several complex variables II</td>
<td>Room 145, B-H</td>
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<td>SPECIAL SESSIONS</td>
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<tr>
<td>8:30 a.m. - 10:20 a.m.</td>
<td>Mathematical economics II</td>
<td>Room 141, B-H</td>
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<tr>
<td>8:30 a.m. - 11:20 a.m.</td>
<td>Combinatorics</td>
<td>Carmichael Auditorium</td>
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<tr>
<td>8:30 a.m. - 10:50 a.m.</td>
<td>Galois theory</td>
<td>Metcalf Auditorium</td>
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<td>8:30 a.m. - 10:50 a.m.</td>
<td>Operator theory and functional analysis II</td>
<td>Room 110, List Hall</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Conceptual analysis in rational thermomechanics II</td>
<td>Room 166, B-H</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Algebraic topology of smooth algebraic varieties I</td>
<td>Room 102, Wilson Hall</td>
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<tr>
<td>8:30 a.m. - 10:50 a.m.</td>
<td>Problems in logic arising from mathematics I</td>
<td>Room 120, List Hall</td>
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<tr>
<td>8:30 a.m. - 9:20 a.m.</td>
<td>Geometric methods in control theory II</td>
<td>Room 168, B-H</td>
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<td>SECTIONS FOR CONTRIBUTED PAPERS</td>
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<tr>
<td>8:30 a.m. - 10:10 a.m.</td>
<td>Applied mathematics</td>
<td>Room 301, Wilson Hall</td>
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<tr>
<td>8:30 a.m. - 9:25 a.m.</td>
<td>Differential and integral equations II</td>
<td>Room 158, B-H</td>
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<tr>
<td>10:00 a.m. - 11:00 a.m.</td>
<td>SPECIAL LECTURE</td>
<td>Fostering and hindering creativity in mathematics</td>
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<td>INVITED ADDRESS</td>
<td>Herbert Whitney, Meehan Auditorium</td>
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<tr>
<td>11:00 a.m. - noon</td>
<td></td>
<td>The limits of effectivity in classical mathematics</td>
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<td>Anil Nerode, Meehan Auditorium</td>
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<tr>
<td>1:30 p.m. - 2:20 p.m.</td>
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<td>MAA - INVITED ADDRESS</td>
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<td>The three crises in mathematics: Logicism, intuitionism, and formalism</td>
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<td>Ernst Snapper, Meehan Auditorium</td>
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<tr>
<td>THURSDAY, August 11</td>
<td>American Mathematical Society</td>
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<tr>
<td>2:30 p.m. - 3:20 p.m.</td>
<td>MAA - PANEL DISCUSSION: CUPM's proposed general mathematical sciences program&lt;br&gt;Richard A. Alo&lt;br&gt;William F. Lucas&lt;br&gt;Alan C. Tucker (moderator)&lt;br&gt;Meehan Auditorium</td>
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<tr>
<td>2:30 p.m. - 3:20 p.m.</td>
<td>MAA - INVITED ADDRESS&lt;br&gt;Using computers in the Junior College mathematics curriculum&lt;br&gt;Michael J. Flynn, Room 166, B-H</td>
<td></td>
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<tr>
<td>3:00 p.m. - 5:30 p.m.</td>
<td>IIME - Contributed Paper Session&lt;br&gt;Room 309, Wilson Hall</td>
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<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>MAA - INVITED ADDRESS&lt;br&gt;Error correcting codes and secret codes&lt;br&gt;Neil J. A. Sloane, Meehan Auditorium</td>
<td></td>
</tr>
<tr>
<td>3:30 p.m. - 4:20 p.m.</td>
<td>MAA - INVITED ADDRESS&lt;br&gt;Humor in mathematics&lt;br&gt;Robert Burghardt, Room 166, B-H</td>
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<td>6:00 p.m.</td>
<td>CLAMBAKE - Francis Farm</td>
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<th>FRIDAY, August 11</th>
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<tr>
<td>8:30 a.m. - 4:30 p.m.</td>
<td>SPECIAL SESSIONS</td>
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<td>8:30 a.m. - 4:30 p.m.</td>
<td>EMPLOYMENT REGISTER - Room 136, B-H</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Combinatorial aspects of mathematical programming I&lt;br&gt;Room 168, B-H</td>
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<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Functional differential equations I&lt;br&gt;Room 166, B-H</td>
</tr>
<tr>
<td>8:30 a.m. - 9:50 a.m.</td>
<td>Interacting particle systems II&lt;br&gt;Room 302, Wilson Hall</td>
</tr>
<tr>
<td>8:30 a.m. - 10:20 a.m.</td>
<td>Problems in logic arising from mathematics II&lt;br&gt;Room 120, List Hall</td>
</tr>
<tr>
<td>10:00 a.m. - 11:00 a.m.</td>
<td>SPECIAL LECTURE&lt;br&gt;On the 4 group theorem&lt;br&gt;Hans J. Zassenhaus</td>
</tr>
<tr>
<td>11:00 a.m. - noon</td>
<td>INVITED ADDRESS&lt;br&gt;Hodge theory for the algebraic topology of nonsingular varieties&lt;br&gt;John W. Morgan</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>INVITED ADDRESS&lt;br&gt;Automorphic forms and the trace formula&lt;br&gt;James G. Arthur</td>
</tr>
<tr>
<td>1:00 p.m. - 2:50 p.m.</td>
<td>SPECIAL SESSIONS</td>
</tr>
<tr>
<td>1:00 p.m. - 2:50 p.m.</td>
<td>Problems in logic arising from mathematics III&lt;br&gt;Room 120, List Hall</td>
</tr>
<tr>
<td>1:00 p.m. - 3:20 p.m.</td>
<td>Functional differential equations II&lt;br&gt;Room 166, B-H</td>
</tr>
<tr>
<td>1:00 p.m. - 3:20 p.m.</td>
<td>Combinatorial aspects of mathematical programming II&lt;br&gt;Room 168, B-H</td>
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<tr>
<td>1:00 p.m. - 2:20 p.m.</td>
<td>Some aspects of the biology and mathematics of neural modeling&lt;br&gt;Room 110, List Hall</td>
</tr>
<tr>
<td>1:00 p.m. - 1:50 p.m.</td>
<td>Algebraic topology of smooth algebraic varieties II&lt;br&gt;Room 102, Wilson Hall</td>
</tr>
<tr>
<td>1:00 p.m. - 2:55 p.m.</td>
<td>GENERAL SESSION&lt;br&gt;Analysis I&lt;br&gt;Room 302, Wilson Hall</td>
</tr>
<tr>
<td>1:00 p.m. - 3:25 p.m.</td>
<td>SESSIONS FOR CONTRIBUTED PAPERS&lt;br&gt;Algebra&lt;br&gt;Room 101, Wilson Hall</td>
</tr>
<tr>
<td>1:00 p.m. - 3:10 p.m.</td>
<td>Topology&lt;br&gt;Room 301, Wilson Hall</td>
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## TIMETABLE

**FRIDAY, August 11**

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<tr>
<th>Time</th>
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</table>
| 2:15 p.m. - 3:15 p.m. | **INVITED ADDRESS** Global problems in the singularities theory  
  Boris Moishezon |
| 4:00 p.m. - 5:00 p.m. | **BUSINESS MEETING**  
  David Tartakoff - violin  
  Robin Each - violin  
  Nancy Prosser - viola  
  Reese Prosser - cello  
  Joan Each - cello  
  William Lipscomb - clarinet |
| 8:30 p.m. - 10:30 p.m. | **CONCERT - Sayles Hall** |

**SATURDAY, August 12**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</thead>
</table>
| 8:30 a.m. - 1:30 p.m. | **SPECIAL SESSIONS**  
  Algebraic topology of smooth algebraic varieties III  
  Room 301, Wilson Hall  
  Approximation theory I  
  Room 168, B-H  
  The identity problem I  
  Room 102, Wilson Hall  
  Partial differential equations I  
  Room 120, List Hall  
  Number theory  
  Room 110, List Hall  
  Algebraic cycles  
  Room 168, B-H  
  SESSIONS FOR CONTRIBUTED PAPERS |
| 8:30 a.m. - 9:10 a.m. | **Algebraic geometry**  
  Room 101, Wilson Hall |
| 8:30 a.m. - 9:55 a.m. | **General session I**  
  Room 309, Wilson Hall  
  GENERAL SESSION |
| 8:30 a.m. - 10:55 a.m. | **Analysis II**  
  Room 302, Wilson Hall  
  INVITED ADDRESS  
  On the geometry of algebraic cycles  
  Spencer Bloch  
  INVITED ADDRESS  
  The scattering of sound waves  
  James V. Ralston  
  SPECIAL SESSIONS  
  Partial differential equations II  
  Room 120, List Hall  
  Energy model algorithms and related mathematical research  
  Room 302, Wilson Hall  
  Approximation theory II  
  Room 168, B-H  
  The identity problem II  
  Room 102, Wilson Hall  
  SESSIONS FOR CONTRIBUTED PAPERS  
  Number theory  
  Room 110, List Hall  
  General session II  
  Room 309, Wilson Hall |

**PRESENTATION SITES**

- **Meehan Auditorium**
- **Sayles Hall**
- **Wilson Hall**
- **List Hall**

**REGISTRATION**

- Inner Lobby, B-H
Program of the Sessions

The time limit for each contributed paper in the general sessions is ten minutes. In the special sessions the time varies from session to session and within sessions. To maintain the schedule, the time limits will be strictly enforced.

WEDNESDAY, 1:00 P.M.

Invited Address, Meehan Auditorium
(1) Myopic economic agents. Professor DONALD J. BROWN, Cowles Foundation for Research in Economics, Yale University (758-90-1)

WEDNESDAY, 2:15 P.M.

Invited Address, Meehan Auditorium
(2) Recent developments in the Yang-Mills theory. Professor RAOUl H. BOTT, Harvard University (758-81-2)

WEDNESDAY, 2:30 P.M.

Special Session on Operator Theory and Functional Analysis I, 110 List Hall
2:30- 2:50 (3) Some new theorems in operator theory. Professor CARL M. PEARCY, University of Michigan (758-47-2)

3:00- 3:20 (4) Invariant subspaces of operators having nearly disconnected spectra. Preliminary report. Professor C. R. PUTNAM, Purdue University (758-47-6)

3:30- 3:50 (5) On the generalized Calkin algebra. Professors J. J. BUONI* and A. KLEIN, Youngstown State University (758-47-3)

4:00- 4:20 (6) Isometries, projections, and Wold decompositions. STEPHEN CAMPBELL, GARY FAULKNER, North Carolina State University, Raleigh and ROBERT SINE*, University of Rhode Island (758-46-3)


5:00- 5:20 (8) The invariant subspace problem. Preliminary report. Dr. JOSEPH G. STAMPFLI, Indiana University (758-47-9)

WEDNESDAY, 3:30 P.M.

Special Session on Yang-Mills Theory, Metcalf Auditorium
3:30- 3:50 (9) Singular Yang-Mills fields. Professor ARTHUR M. JAFFE, Harvard University (758-81-5)

4:00- 4:20 (10) Gauge fields, functional integrals, and geometry. Dr. MICHAEL E. PESKIN, Harvard University (758-81-4) (Introduced by Professor Raoul Bott)

WEDNESDAY, 3:30 P.M.

Special Session on Mathematical Economics I, 141 Barus-Holley Building
3:30- 4:20 (11) Price adjustment models with infinitesimal traders. Professor H. JEROME KEISLER, University of Wisconsin, Madison (758-90-10)

4:30- 5:20 (12) On algorithms for solving \( f(x) = 0 \). Professor MORRIS W. HIRSCH* and Professor STEPHEN SMALE, University of California, Berkeley (758-65-1)

WEDNESDAY, 3:30 P.M.

Special Session on Several Complex Variables I, 145 Barus-Holley Building
3:30- 3:50 (13) Interpolation by entire functions of exponential type. Preliminary report. Professor CARLOS A. BERENSTEIN, University of Maryland and Professor B. A. TAYLOR*, University of Michigan (758-32-1)

4:00- 4:20 (14) A counterexample to regularity for the complex Monge-Ampère equation. ERIC BEDFORD* and JOHN ERIK FORNAESS, Princeton University (758-32-6)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.
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<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker, Institution and Notes</th>
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<tbody>
<tr>
<td>4:30-4:50</td>
<td>Invariants of pseudo-convex hypersurfaces. J. J. Kohn, Princeton University (758-32-5)</td>
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<tr>
<td>5:00-5:20</td>
<td>Holomorphic approximation in weakly pseudoconvex domains. Frank Beatrous, Tulane University and Rice University (758-32-3)</td>
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**WEDNESDAY, 3:30 P.M.**

**Special Session on Geometric Methods in Control Theory I, 168 Barus-Holley Building**

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<th>Time</th>
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<th>Speaker, Institution and Notes</th>
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<tr>
<td>4:00-4:20</td>
<td>Parametric identifiability of deterministic nonlinear systems. Dr. Eduardo D. Sontag, Rutgers University (758-93-3)</td>
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<tr>
<td>4:30-4:50</td>
<td>Formal Martingale integrals. Preliminary report. Professor Arthur J. Krener, University of California, Davis (758-60-9)</td>
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<tr>
<td>5:00-5:20</td>
<td>Limits of solutions of matrix Riccati equations and the Lie theory of vector fields on Grassmannians. Dr. Robert Hermann, Harvard University (758-93-5)</td>
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**WEDNESDAY, 3:30 P.M.**

**Special Session on Conceptual Analysis in Rational Thermomechanics I, 166 Barus-Holley Building**

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<th>Time</th>
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<th>Speaker, Institution and Notes</th>
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<tr>
<td>3:30-3:50</td>
<td>Nonlinear versions of classical linear problems. Professor Stuart S. Antman, University of Maryland (758-73-3)</td>
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<tr>
<td>4:00-4:20</td>
<td>On the entropy of materials with memory. Professor Bernard D. Coleman, Carnegie-Mellon University (758-73-1) (Introduced by Professor C. Truesdell)</td>
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<tr>
<td>5:00-5:20</td>
<td>On the foundations of continuum thermodynamics. Professor Morton E. Gurtin, Carnegie-Mellon University (758-80-1)</td>
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**WEDNESDAY, 3:30 P.M.**

**Special Session on History of Mathematics, Carmichael Auditorium**

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<th>Time</th>
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<tr>
<td>3:30-3:50</td>
<td>On Dirichlet's contributions to potential theory. UTA C. Merzbach, Smithsonian Institution, Washington, D. C.</td>
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<tr>
<td>4:00-4:20</td>
<td>Archimedes and the pre-Euclidean proportion theory. Preliminary report. Professor Wilbur Knorr, Brooklyn College (758-01-2) (Introduced by Professor Raymond G. Ayoub)</td>
<td></td>
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<tr>
<td>4:30-4:50</td>
<td>&quot;By no other method...&quot;: Leibnizian calculus and Newtonian mechanics in the Paris Academy of Sciences, 1690-1725. Preliminary report. Professor Michael S. Mahoney (758-01-3)</td>
<td></td>
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<tr>
<td>5:00-5:20</td>
<td>Cauchy and the partial differential equations of wave optics. Preliminary report. Professor Jed Z. Buchwald, University of Toronto (758-01-4) (Introduced by Professor M. S. Mahoney)</td>
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**WEDNESDAY, 3:30 P.M.**

**Session on Differential and Integral Equations I, 158 Barus-Holley Building**

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<th>Time</th>
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<th>Speaker, Institution and Notes</th>
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<tr>
<td>3:30-3:40</td>
<td>Behavior of nonconinuous solutions of a retarded differential equation. Dr. Terry L. Herdman, Virginia Polytechnic Institute and State University (758-34-6)</td>
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<tr>
<td>3:45-3:55</td>
<td>On certain solutions of $g * \tau = f$. Preliminary report. Professor W. R. Madych, Iowa State University (758-45-1)</td>
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<tr>
<td>4:00-4:10</td>
<td>Solutions of nonlinear elliptic differential inequalities. Preliminary report. Dr. John Jones, Jr., Air Force Institute of Technology, Dayton, Ohio (758-65-3)</td>
<td></td>
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<tr>
<td>4:15-4:25</td>
<td>Solution of a hyperbolic differential equation arising in the modelling of a lightning stroke. Preliminary report. Dr. Dennis W. Quinn, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio (758-65-4)</td>
<td></td>
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</tbody>
</table>
4:30- 4:40 (33) A Bernstein theorem for a class of elliptic equations on multiply-connected plane domains. Professor PETER A. McCoy, U. S. Naval Academy, Annapolis, Maryland (758-35-4)


WEDNESDAY, 3:30 P. M.

Session on Geometry, 301 Wilson Hall
3:30- 3:40 (35) On the dodecahedral space-fillers. Mr. MICHAEL GOLDBERG, Washington, D. C. (758-50-1)

3:45- 3:55 (36) An unnecessary assumption in the fundamental theorem of projective geometry. Professor MARTIN H. DULL*, Saint Mary's College and Mr. ALAN J. SAALFELD, Rosslyn, Virginia (758-50-2)

4:00- 4:10 (37) A counterexample to a "Theorem" on \( L_\infty \) sets. Professor JOHN D. BAILDON, Pennsylvania State University, Worthington-Scranton Campus (758-52-1)

4:15- 4:25 (38) Recession cones of nonconvex sets and increasing functions. Dr. GERALD BEER, California State University, Los Angeles (758-52-2)

4:30- 4:40 (39) Classification of real forms of Hermitian symmetric spaces. Professor DOMINIC S. P. LEUNG, U. S. Naval Academy, Annapolis, Maryland (758-53-1)

4:45- 4:55 (40) Existence of closed geodesics in framed manifolds. Preliminary report. NIRMALA PRAKASH, Massachusetts Institute of Technology (758-53-2)

WEDNESDAY, 3:30 P. M.

Session on Combinatorics, 101 Wilson Hall
3:30- 3:40 (41) A fixed edge theorem for graphs with loops. RICHARD NOWAKOWSKI* and IVAN RIVAL, University of Calgary (758-05-1)

3:45- 3:55 (42) A unicursal problem of \( r \) salesmen. Professor JOSEPH ARKIN, Spring Valley, New York (758-05-2)

4:00- 4:10 (43) Perfect codes in association schemes. Dr. CHRISTOPHER LANDAUER, Pattern Analysis and Recognition Corporation, Rome, New York (758-05-3)

4:15- 4:25 (44) Commutative Moufang 3-loops. Preliminary report. ROBERT ROTH* and D. K. RAY-CHAUDHURI, Ohio State University (758-05-6)

4:30- 4:40 (45) Finite inversive planes with bundle theorem. Mr. JEFF KAUS, Ohio State University (758-05-12) (Introduced by Professor D. K. Ray-Chaudhuri)

THURSDAY, 8:30 A. M.

Special Session on Interacting Particle Systems I, 302 Wilson Hall
8:30- 8:50 (46) Clustering and dispersion rates for some interacting particle systems on \( \mathbb{Z} \). Professor MAURY BRAMSON*, Courant Institute of Mathematical Sciences and Professor DAVID GRIFFETH, University of Wisconsin (758-60-2)

9:00- 9:20 (47) Translation invariant spin-flip processes. LAWRENCE GRAY, University of Minnesota (758-60-6)

9:30- 9:50 (48) Random flows in the plane constructed from consistent sets of diffusions. Preliminary report. Professor T. E. HARRIS, University of Southern California, Los Angeles (758-60-3)

THURSDAY, 8:30 A. M.

Special Session on Several Complex Variables II, 145 Barus-Holley Building
8:30- 8:50 (49) \( \mathcal{CO} \) peak functions. Professor THOMAS BLOOM, University of Toronto (758-32-2)

9:00- 9:20 (50) Existence of complex submanifolds of a real submanifold. Preliminary report. Professor MICHAEL FREEMAN, University of Kentucky (758-32-7)

9:30- 9:50 (51) On mapping an \( n \)-ball into an \( (n+1) \)-ball in complex space. S. M. WEBSTER, Princeton University (758-32-8)
THURSDAY, 8:30 A.M.

Special Session on Mathematical Economics II, 141 Barus-Holley Building

8:30–9:20 (62) Edgeworth's conjecture. Dr. ROBERT M. ANDERSON, McMaster University (758-90-6)

9:30–10:20 (53) Inequality and altruism across generations. Professor GLENN C. LOURY, Northwestern University (758-90-12)

THURSDAY, 8:30 A.M.

Special Session on Combinatorics, Carmichael Auditorium

8:30–8:50 (64) Generalized Hadamard matrices over groups. DAVID A. DRAKE, University of Florida (758-05-4)

9:00–9:20 (55) Spreads and ovoids of the known finite generalized quadrangles. Dr. STANLEY E. PAYNE, Miami University (758-05-5)

9:30–9:50 (56) Eulerian posets and Reed-Muller codes. Professor KENNETH P. BOGART, Dartmouth College (758-05-7)

10:00–10:20 (57) An application of Hodge theory to extremal set theory. Professor RICHARD P. STANLEY, Massachusetts Institute of Technology (758-05-13)

10:30–10:50 (58) Removal-cospectral sets of vertices in a graph. Professor ALLEN J. SCHWENK, U. S. Naval Academy, Annapolis, Maryland (758-05-8)

11:00–11:20 (59) A noncommutative generalization and q-analog of the Lagrange inversion formula. Dr. IRA GESSEL, IBM T. J. Watson Research Center, Yorktown Heights, New York (758-M1)

THURSDAY, 8:30 A.M.

Special Session on Galois Theory, Metcalf Auditorium

8:30–8:50 (60) Abelian p-extensions, Preliminary report. Professor H. F. KREIMER, Florida State University (758-16-2)

9:00–9:20 (61) Higher derivation Galois theory of fields. Professor NICKOLAS HEEREMA, Florida State University (758-12-2)


10:00–10:20 (63) Extensions of Chase's modular Galois theory. Preliminary report. Professor RAYMOND T. HOOBLED, City College of New York (758-13-2)

10:30–10:50 (64) The algebraic set of subextensions of a purely inseparable extension. Professor MURRAY GERSTENHABER, University of Pennsylvania and RALPH M. MAY*, Center for Naval Analyses, Arlington, Virginia (758-12-6)

THURSDAY, 8:30 A.M.

Special Session on Operator Theory and Functional Analysis II, 110 List Hall

8:30–8:50 (65) Some applications of functional analysis to topological measure theory. Professor GEORGE BACHMAN, Polytechnic Institute of New York (758–46-1)

9:00–9:20 (66) The dimension of the set of invariant means of a semigroup. MARIA M. KLAWE, Oakland University (758–43-1)

9:30–9:50 (67) Hecke operators. Professor MARVIN KNOPP, Temple University (758–30-5)

10:00–10:20 (68) Strongly analytic subspaces. Dr. RIDGLEY LANGE, University of New Orleans (758–47-7)

10:30–10:50 (69) Characterizations of almost periodic strongly continuous groups and semigroups. Professor SEYMOUR GOLDBERG*, University of Maryland and Dr. HARM BART, Vrije Universiteit, Amsterdam, Holland (758–47-4)

THURSDAY, 8:30 A.M.

Special Session on Conceptual Analysis in Rational Thermomechanics II, 166 Barus-Holley Building

8:30–8:50 (70) Postulates for phenomenological thermodynamics. Professor JAMES SERRIN, University of Minnesota (758–80-2)

9:00–9:20 (71) Thermodynamics, line integrals, and actions on systems. Professor DAVID R. OWEN, Carnegie-Mellon University (758–80-3)
THURSDAY, 8:30 A. M.

Special Session on Algebraic Topology of Smooth Algebraic Varieties I, 102 Wilson Hall

8:30-8:50  (73) Extensions of mixed Hodge structures. Preliminary report. Professor JAMES A. CARLSON, University of Utah (758-14-5)

9:00-9:20  (74) Hodge classes on Abelian varieties. Preliminary report. Professor RON DONAGI, University of California, Los Angeles (758-14-13)

THURSDAY, 8:30 A. M.

Special Session on Problems in Logic Arising from Mathematics I, 120 List Hall

8:30-8:50  (75) The jump operation on the degrees of unsolvability. Preliminary report. Dr. DAVID B. POSNER, University of Chicago (758-02-14)

9:00-9:20  (76) Initial segments of the degrees below 0'. Preliminary report. Professor MANUEL LERMAN, University of Connecticut (758-02-8)

9:30-9:50  (77) Recursively saturated nonstandard models of arithmetic. Dr. C. SMORYŃSKI, Westmont, Illinois (758-02-2)

THURSDAY, 8:30 A. M.

Special Session on Geometric Methods in Control Theory II, 168 Barus-Holley Building

8:30-8:50  (80) On Kronecker indices and system reliability. Preliminary report. Professor CHRISTOPHER I. BYRNES, Harvard University (758-93-6)

9:00-9:20  (81) Feedback constructions for systems with parameters. Preliminary report. Professor PETER L. FALB, Brown University (758-93-7)

9:30-9:50  (82) WITHDRAWN

10:00-10:20  (83) WITHDRAWN

THURSDAY, 8:30 A. M.

Session on Applied Mathematics, 301 Wilson Hall

8:30-8:40  (84) WITHDRAWN

8:45-8:55  (85) Stress and temperature discontinuities due to a thermal shock on the bounding plane of a semi-infinite perfectly conducting elastic medium in the presence of a magnetic field. Preliminary report. Professor P. PURI, University of New Orleans (758-73-4)

9:00-9:10  (86) Flow of a micropolar liquid between two infinite slowly rotating disks. Preliminary report. Professor P. PURI and Professor P. K. KULSHRESTHA*, University of New Orleans (758-76-1)

9:15-9:25  (87) The scalar quasi-potential in photic field theory. Preliminary report. Dr. DOMINA EBERLE SPENCER* and Mr. PAUL L. LYSIAC, University of Connecticut (758-78-1)

9:30-9:40  (88) Construction of spin–orbit potentials. Preliminary report. Dr. M. A. HOOSHTAR, Pahlavi University, Shiraz, Iran (758-81-1) (Introduced by Professor H. Kharaghani)

9:45-9:55  (89) An axiomatic foundation for finite-dimensional quantum theory. Dr. RAY E. ARTZ, Carnegie-Mellon University (758-81-3)

10:00-10:10  (90) Viscous centering force on a fiber in a coating applicator. Preliminary report. Dr. TERRENCE A. LENAHAN, Bell Laboratories, Norcross, Georgia (758-76-2)
THURSDAY, 8:30 A. M.

Session on Differential and Integral Equations II, 158 Barus-Holley Building

8:30- 8:40 (91) Area-splitting centroids. Preliminary report. Professor STEVEN MINSKER, Rutgers University (758-34-1)

8:45- 8:55 (92) Global stability and Jacobian problems. Preliminary report. Professor GARY H. MEISTERS, University of Nebraska (758-34-2)

9:00- 9:10 (93) Liapunov stability theory for nonautonomous functional differential equations. Mr. J. W. PALMER, Brown University (758-34-3)


THURSDAY, 10:00 A. M.

Special Lecture, Meehan Auditorium

(95) Fostering and hindering creativity in mathematics. Professor HASSLER WHITNEY, Institute for Advanced Study (758-98-2)

THURSDAY, 11:00 A. M.

Invited Address, Meehan Auditorium

(96) The limits of effectivity in classical mathematics. Professor ANIL NERODE, Cornell University (758-02-5)

FRIDAY, 8:30 A. M.

Special Session on Combinatorial Aspects of Mathematical Programming I, 168 Barus-Holley Building

8:30- 8:50 (97) Cutting planes in combinatorial arguments. Professor VÁCLAV CHVÁTAL, Université de Montréal (758-05-10)

9:00- 9:20 (98) Facets, subadditivity, and duality. ELLIS L. JOHNSON, IBM T. J. Watson Research Center, Yorktown Heights, New York (758-20-4)

9:30- 9:50 (99) A unique representation theorem for integer points in certain polyhedral cones. Preliminary report. Professor RICHARD P. STANLEY, Massachusetts Institute of Technology (758-90-3)

FRIDAY, 8:30 A. M.

Special Session on Functional Differential Equations I, 166 Barus-Holley Building

8:30- 8:50 (100) Some numerical procedures for estimating parameters in hereditary dynamical models. Dr. J. A. BURNS* and Dr. E. M. CLIFF, Virginia Polytechnic Institute and State University (758-98-1)

9:00- 9:20 (101) Discretizations for control problems with delays. Professor GEORGE W. REDDIEN, Vanderbilt University (758-65-2)


FRIDAY, 8:30 A. M.

Special Session on Interacting Particle Systems II, 302 Wilson Hall

8:30- 8:50 (103) Random invariant measures for Markov chains, and independent particle systems. Professor THOMAS M. LIGGETT, University of California, Los Angeles (758-60-4)

9:00- 9:20 (104) Recent results for discrete time particle systems. Mr. DAVID GRIFFEATH, University of Wisconsin (758-60-5)

9:30- 9:50 (105) A continuous migration model with stable demography. Professor STANLEY SAWYER*, University of Washington and Yeshiva University and Professor J. FELSENSTEIN, University of Washington (758-60-7)

FRIDAY, 8:30 A. M.

Special Session on Problems in Logic Arising from Mathematics II, 120 List Hall

8:30- 8:50 (106) Model theory of fields. Professor WILLIAM H. WHEELER, Indiana University (758-02-9)
9:00- 9:20 (107) Some applications of model theory to universal algebra. Mr. JOHN T. BALDWIN, University of Illinois at Chicago Circle (758-02-1)

9:30- 9:50 (108) Model completeness and nonassociative algebras. Preliminary report. Dr. BRUCE I. ROSE, University of Notre Dame (758-02-10)

10:00-10:20 (109) Abelian recursively profinite groups. Preliminary report. Mr. RICK SMITH, Pennsylvania State University (758-02-15)

FRIDAY, 10:00 A. M.

Special Lecture, Meehan Auditorium
(110) On the 4 group theorem. Professor HANS J. ZASSENHAUS, Ohio State University (758-20-7)

FRIDAY, 11:00 A. M.

Invited Address, Meehan Auditorium
(111) Hodge theory for the algebraic topology of nonsingular varieties. Professor JOHN W. MORGAN, Columbia University (758-14-12)

FRIDAY, 1:00 P. M.

Invited Address, Meehan Auditorium
(112) Automorphic forms and the trace formula. Professor JAMES G. ARTHUR, Duke University (758-12-8)

FRIDAY, 1:00 P. M.

Special Session on Problems in Logic Arising from Mathematics III, 120 List Hall
1:00- 1:20 (113) Constructibility and large cardinals. Preliminary report. WILLIAM J. MITCHELL, Rockefeller University (758-04-1)

1:30- 1:50 (114) On measurable cardinals and partition relations. E. KLEINBERG, Massachusetts Institute of Technology (758-02-7)

2:00- 2:20 (115) On Dedekind cardinals and non-standard models of arithmetic. Professor GERSHON SAGEEV, Ohio State University (758-02-13)

2:30- 2:50 (116) Infinite exponent partition relations and forcing. MITCHELL SPECTOR, Massachusetts Institute of Technology (758-02-12)

FRIDAY, 1:00 P. M.

Special Session on Functional Differential Equations II, 166 Barus-Holley Building
1:00- 1:20 (117) A characterization of neutral linear difference-differential equations which are asymptotically stable globally in the delays. Professor E. F. INFANTE* and Dr. F. S. P. TSEN, Brown University (758-39-1)

1:30- 1:50 (118) Some stability properties of linear differential-difference equations in a Hilbert space. Preliminary report. Professor RICHARD F. DATKO, Georgetown University (758-34-5) (Introduced by Professor H. T. Banks)

2:00- 2:20 (119) Controllability and stabilizability of linear systems. Preliminary report. MARC Q. JACOBS, University of Missouri (758-49-4)

2:30- 2:50 (120) Completeness and F-completeness of eigenfunctions associated with retarded functional differential equations. Preliminary report. Dr. A. MANITIUS, Université de Montréal (758-34-8) (Introduced by Professor H. T. Banks)

3:00- 3:20 (121) Can the future influence the present? Professor R. D. DRIVER, University of Rhode Island (758-34-7)

FRIDAY, 1:00 P. M.

Special Session on Combinatorial Aspects of Mathematical Programming II, 168 Barus-Holley Building
1:00- 1:20 (122) Converting linear programs to network problems. ROBERT E. BIXBY, Northwestern University and WILLIAM H. CUNNINGHAM*, Carleton University (758-05-11) (Introduced by Professor Louis J. Billera)

1:30- 1:50 (123) Linear programming in oriented matroids. Preliminary report. Professor ROBERT G. BLAND, State University of New York at Binghamton and Cornell University (758-90-7)
2:00-2:20 (124) Topology of oriented matroids. Preliminary report. Professor JACK EDMONDS and Mr. ARNALDO MANDEL*, University of Waterloo (758-05-9)

2:30-2:50 (125) Fixed point algorithms that allow restarting without an extra dimension. Professor MICHAEL J. TODD, Cornell University (758-90-5)

3:00-3:20 (126) Diameters and shellings of convex polyhedra—a unifying approach. Preliminary report. Dr. J. SCOTT PROVAN*, State University of New York at Stony Brook and Dr. LOUIS J. BILLERA, Cornell University (758-90-8)

FRIDAY, 1:00 P. M.

Special Session on Some Aspects of the Biology and Mathematics of Neural Modeling, 110 List Hall
1:00-1:20 (127) Neurophysiology, neuroanatomy and neural models. Preliminary report. Professor JAMES A. ANDERSON, Brown University (758-92-2) (Introduced by Professor Stuart Geman)

1:30-1:50 (128) Application of learning algorithms to selective learning and unlearning. Preliminary report. Dr. ERKKI OJA, Brown University (758-92-3) (Introduced by Professor Stuart Geman)

2:00-2:20 (129) The law of large numbers and the central limit theorem in neural modelling. Professor STUART GEMAN, Brown University (758-60-8)

FRIDAY, 1:00 P. M.

Special Session on Algebraic Topology of Smooth Algebraic Varieties II, 102 Wilson Hall
1:00-1:20 (130) Extensions of mixed Hodge structures. Preliminary report. Professor JAMES A. CARLSON, University of Utah (758-14-5)

1:30-1:50 (131) Hodge classes on Abelian varieties. Preliminary report. Professor RON DONAGI, University of California, Los Angeles (758-14-13)

FRIDAY, 1:00 P. M.

General Session on Analysis I, 302 Wilson Hall
1:00-1:10 (132) Ergodic measure-preserving homeomorphisms of $\mathbb{R}^n$. Dr. V. S. PRASAD, McGill University (758-28-1)

1:15-1:25 (133) A generalization of Wiener's criteria for the continuity of a Borel measure. Professor JEAN-MARC BELLEY* and Dr. PEDRO MORALES, Université de Sherbrooke (758-28-2)

1:30-1:40 (134) Which selfadjoint operator in the domain of a closed derivation satisfies the domain problem? Dr. DONG PYO CHI, Seoul National University, Seoul, Korea (758-46-2)

1:45-1:55 (135) Continuity of linear operators between vector sequence spaces. Dr. LUIS VERDE-STAR, Universidad Autónoma de Puebla, Mexico (758-46-4)

2:00-2:10 (136) Some remarks on matricial-convexity. RICHARD I. LOEBL, Wayne State University (758-46-5)

2:15-2:25 (137) An anti-open mapping theorem for Fréchet spaces. Professor STEVEN F. BELLENOT, Florida State University (758-46-6)

2:30-2:40 (138) A Korovkin result for set-valued functions. Professor RICHARD A. VITALE, Claremont Graduate School (758-41-8)

2:45-2:55 (139) Fourier series with bounded convolution powers. Professor CHARLES HEIBERG, U. S. Naval Academy, Annapolis, Maryland (758-42-1)

FRIDAY, 1:00 P. M.

Session on Algebra, 101 Wilson Hall
1:00-1:10 (140) Subalgebra and endomorphism structure of algebras. Dr. N. SAUER and Dr. M. G. STONE*, University of Calgary (758-08-1)

1:15-1:25 (141) Resultants and generalized circulants. Professor KAI WANG, State University of New York at Buffalo (758-15-1) (Introduced by Professor Richard Randell)

1:30-1:40 (142) Elementary theory of F-rings with unit. Preliminary report. Dr. MARGARET W. TAFT, Honeywell Information Systems, Inc., Billerica, Massachusetts (758-16-1)

1:45-1:55 (143) Conditions on ideals of Lie algebras. Dr. GARY E. STEVENS, Hartwick College (758-17-1)
2:00- 2:10 (144) Sweedler’s two-cocycles and Hochschild cohomology. Preliminary report. Dr. DAVE RIFFELMACHER, General Research Corporation, McLean, Virginia (758-18-1)

2:15- 2:25 (145) Realization of cohomology classes by torsors under hypergroupoids. Dr. PAUL GLENN, Union College (758-18-2)

2:30- 2:40 (146) A commutator identity. Preliminary report. Professor ANTHONY M. GAGLIONE, U. S. Naval Academy, Annapolis, Maryland (758-20-1)

2:45- 2:55 (147) On the graph of a generalized Sylow tower group. Preliminary report. Professor A. FATTANI, Pahlavi University, Shiraz, Iran (758-20-3)

3:00- 3:10 (148) Fuzzy matrices. Professor JIN BAI KIM*, West Virginia University and Dr. YONG M. LEE, Trenton State College (758-20-5)

3:15- 3:25 (149) A construction of super-nilpotent radical classes. Preliminary report. Professor DWIGHT M. OLSON, Cameron University (758-16-3)

FRIDAY, 1:00 P. M.

Session on Topology, 301 Wilson Hall
1:00- 1:10 (150) θ-rigidity and the idempotent θ-closure. Professor ROBERT A. HERRMANN, U. S. Naval Academy, Annapolis, Maryland (758-54-1)

1:15- 1:25 (151) Further characterizations of $E^1$. Preliminary report. Dr. T. M. ADENIRAN, College of Science and Technology, Port Harcourt, Nigeria (758-54-2)

1:30- 1:40 (152) Irreducible spaces and property $b_2$. Preliminary report. J. C. SMITH, Virginia Polytechnic Institute and State University (758-54-3)

1:45- 1:55 (153) C-embedding in functionally normal spaces. Preliminary report. C. E. AULL, Virginia Polytechnic Institute and State University (758-54-5)

2:00- 2:10 (154) Twisted free tensor products. Preliminary report. Dr. E. KATZ, University of Haifa, Haifa, Israel (758-55-1)

2:15- 2:25 (155) A natural transformation $K \rightarrow KO$ analogous to the Bockstein homomorphism. Mr. JAMES M. STORMES, Brown University (758-55-4)

2:30- 2:40 (156) Homeomorphisms of the 2-sphere minus a finite union of closed disks and open disks. Preliminary report. Dr. DAVID SPROWS, Villanova University (758-57-1)

2:45- 2:55 (157) The von Neumann kernel and minimally almost periodic groups. Dr. SHELDON ROTHMAN, Baruch College, City University of New York (758-22-1)

3:00- 3:10 (158) An example of a nontrivial knot and the property $P$ conjecture. Mr. FRANCIS D. LONERGAN, Lexington, Massachusetts (758-55-2)

FRIDAY, 2:15 P. M.

Invited Address, Meehan Auditorium
(159) Global problems in the singularities theory. Professor BORIS MOISHEZON, Columbia University (758-14-6)

SATURDAY, 8:30 A. M.

Special Session on Algebraic Topology of Smooth Algebraic Varieties III, 301 Wilson Hall
8:30- 8:50 (160) Extensions of mixed Hodge structures. Preliminary report. Professor JAMES A. CARLSON, University of Utah (758-14-5)

9:30- 9:50 (161) Hodge classes on Abelian varieties. Preliminary report. Professor RON DONAGI, University of California, Los Angeles (758-14-13)

SATURDAY, 8:30 A. M.

Special Session on Approximation Theory I, 168 Barus-Holley Building
8:30- 8:50 (162) Positivity of some Cotes numbers. Professor RICHARD ASKEY, University of Wisconsin (758-41-1)

9:00- 9:20 (163) Polynomials of binomial type and approximation theory. Dr. MOURAD E. M. ISMAIL, McMaster University (758-41-2)

9:30- 9:50 (164) A refinement of Kolmogorov’s inequality. Professor A. S. CAVARETTA, Jr., Kent State University (758-41-4)

10:00-10:20 (165) Efficient $L_2$ approximation by splines. D. L. BARROW and P. W. SMITH*, Texas A & M University (758-41-5)

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SATURDAY, 8:30 A. M.

Special Session on the Identity Problem I, 102 Wilson Hall
8:30– 8:50 (166) On the 2-dimensionality of CW-complexes and groups. Dr. JOHN G. RATCLIFFE, Massachusetts Institute of Technology (758-20-6)
9:00– 9:20 (167) Algebraic unknotting of spheres in codimension two. Dr. PHILIP HIRSCHHORN*, Amherst College and Dr. JOHN G. RATCLIFFE, Massachusetts Institute of Technology (758-57-2)
9:30– 9:50 (168) Immersions of surfaces in \( R^2 \). Preliminary report. Mr. DONALD L. WOLITZER, Northeastern University (758-54-4)
10:00–10:20 (169) The fundamental group of a group. Preliminary report. Dr. BRADLEY W. JACKSON, Pennsylvania State University (758-57-3)

SATURDAY, 8:30 A. M.

Special Session on Partial Differential Equations I, 120 List Hall
8:30– 8:50 (170) The confinement problem for solenoidal vector fields. Professor MEL S. BERGER, Institute for Advanced Study (758-35-8)
9:30– 9:50 (172) Local solvability of differential operators on nilpotent Lie groups. LINDA PREISS ROTHSCILD, University of Wisconsin (758-35-11)
10:00–10:20 (173) The layering method for the Navier–Stokes equations. Preliminary report. Professor AVRON DOUGLIS, University of Maryland and Professor EUGENE FABES*, University of Minnesota (758-35-9)
10:30–10:50 (174) Propagation of singularities for operators with non-involutive characteristics, Dr. NICHOLAS HANGES, Rutgers University (758-35-6)

SATURDAY, 8:30 A. M.

Special Session on Number Theory, 110 List Hall
8:30– 8:50 (175) Tamagawa numbers of abelian varieties with complex multiplication, Preliminary report. BENEDICT H. GROSS, Princeton University (758-12-1)
9:00– 9:20 (176) Independence of modular units on Tate curves. Professor DANIEL S. KUBERT*, Cornell University and Professor SERGE LANG, Yale University (758-10-1)
9:30– 9:50 (177) Class numbers and \( \mathbb{Z}/p \)-extensions. LAWRENCE C. WASHINGTON, University of Maryland (758-12-4)
10:00–10:20 (178) New examples of quasi-Abelian varieties, and complete reducibility. BRUCE A. DODSON, Universita Degli Studi, Florence, Italy (758-14-3)
10:30–10:50 (179) The Iwasawa invariants of certain \( \mathbb{Z}/p \)-extensions. Dr. JOSEPH CARROLL, Miami, Florida and Dr. H. KISILEVSKY*, Concordia University (758-12-7) (Introduced by Professor Larry J. Goldstein)

SATURDAY, 8:30 A. M.

Session on Algebraic Geometry, 101 Wilson Hall
8:30– 8:40 (180) A vanishing theorem for \( H^*(SL/B, L) \). Professor WALTER L. GRIFFITH, JR., University of Missouri–St. Louis (758-14-2)
8:45– 8:55 (181) Meromorphic 2-forms on elliptic surfaces. Preliminary report. Professor WILLIAM L. HOYT, Rutgers University (758-14-4)
9:00– 9:10 (182) A cellular decomposition of the Fermat surface. Preliminary report. Professor ALLEN ADLER, Brandeis University and Professor MARVIN TRETKOFF*, Stevens Institute of Technology (758-14-7)

SATURDAY, 8:30 A. M.

General Session I, 309 Wilson Hall
8:30– 8:40 (183) The genesis of mathematical ideas: Why we can't quite automate the modelling process. Preliminary report. Dr. G. ARTHUR MIHRAM, Haverford, Pennsylvania (758-90-11)

9:00– 9:10 (185) A model of the thermal response of the head to radio frequency electromagnetic radiation. Preliminary report. Dr. DAVID K. COHOON, USAF School of Aerospace Medicine, San Antonio, Texas (758-92-4)

9:15– 9:25 (186) On a general problem of stabilization of polynomials. Mr. RAYMOND CHEN, University of Florida (758-93-2)

9:30– 9:40 (187) Odd \([M, 3]\) group codes for the Gaussian channel. Professor JOHN KARLOF* and Professor CHARLES DOWNEY, University of Nebraska at Omaha (758-94-1)

9:45– 9:55 (188) A discrete approach to computer oriented calculus. Dr. SHELDON P. GORDON, Suffolk Community College (758-98-1) (Introduced by Dr. F. S. Gordon)

SATURDAY, 8:30 A. M.

General Session on Analysis II, 302 Wilson Hall

8:30– 8:40 (189) Zeros of successive derivatives of some entire functions. Preliminary report. Dr. CARL PRATHER, Virginia Polytechnic Institute and State University (758-30-1)

8:45– 8:55 (190) Riemann surfaces and bounded holomorphic functions. Preliminary report. WALTER PRANGER, DePaul University (758-30-2) (Introduced by Professor Jerry Goldman)

9:00– 9:10 (191) Convex starlike meromorphic functions. Dr. JAMES E. MILLER, West Virginia University (758-30-3)

9:15– 9:25 (192) Two classes of analytic functions depending on three real parameters. Preliminary report. Professor EDWARD J. MOULIS, JR., U. S. Naval Academy, Annapolis, Maryland (758-30-6)

9:30– 9:40 (193) Silov boundaries of algebras of CR-functions. Preliminary report. Professor L. R. HUNT*, Texas Tech University and Dr. MIKE KAZLOW, Rice University (758-32-4)

9:45– 9:55 (194) Nest-subalgebras of von Neumann algebras. Preliminary report. Professor FRANK GILFEATHER and Professor DAVID R. MOULIS*, University of Nebraska, Lincoln (758-47-1)

10:00–10:10 (195) The commutative product \(V_1V_2 = V_2V_1\) for isometries \(V_1\) and \(V_2\). JOSE BARRIA, Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela (758-47-8)


10:30–10:40 (197) Invariant solutions of lowest dimension to the oriented Plateau problem. Professor DAVID BINDSCHADLER, Wayne State University (758-49-3)

10:45–10:55 (198) On the sufficiency of a numerical downstream continuation. Dr. CHARLIE H. COOKE, Old Dominion University (758-35-2) (Introduced by Professor James L. Schwing)

SATURDAY, 8:30 A. M.

Special Session on Algebraic Cycles, 166 Barus-Holley Building

8:30– 8:50 (199) Excess intersection of hypersurfaces in \(\mathbb{P}^n\). Preliminary report. Mr. ROBERT LAZARSFELD, Brown University (758-14-8) (Introduced by William Fulton)

9:00– 9:20 (200) Intersection theory and enumerative geometry. Preliminary report. WILLIAM FULTON* and ROBERT MACPHERSON, Brown University (758-14-9)

9:30– 9:50 (201) Localization in K-theory and algebraic cycles. DANIEL R GRAYSON, Columbia University (758-14-10)

10:00–10:20 (202) Torsion algebraic cycles. SPENCER J. BLOCH, University of Chicago (758-14-11)

SATURDAY, 11:00 A. M.

Invited Address, Meehan Auditorium

(203) On the geometry of algebraic cycles. Professor SPENCER BLOCH, University of Chicago (758-14-1)
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>SATURDAY, 1:00 P. M.</td>
<td>Invited Address, Meehan Auditorium. Professor JAMES V. RALSTON, University of California, Los Angeles (758-35-5)</td>
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<tr>
<td>SATURDAY, 2:10 P. M.</td>
<td>Special Session on Partial Differential Equations II, 120 List Hall.</td>
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<tr>
<td>2:10- 2:30</td>
<td>Uniqueness results for the characteristic Cauchy problem and strong unique continuation for higher order P.D.E.'s. Preliminary report. Professor S. ALINHAC and Professor M. S. BAOUENDI*, Purdue University (758-35-3)</td>
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<tr>
<td>2:40- 3:00</td>
<td>Analytic hypoellipticity for $\square_b$ and the 3-Neumann problem. Professor DAVID S. TARTAKOFF, University of Illinois (758-35-13)</td>
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<tr>
<td>3:10- 3:30</td>
<td>On some existence theorems for semi-linear elliptic equations. HERBERT AMANN, Ruhr-Universität, Bochum, Federal Republic of Germany and MICHAEL G. CRANDALL*, University of Wisconsin (758-35-12)</td>
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<tr>
<td>3:40- 4:00</td>
<td>A well-posed boundary-value problem for partial differential operators of principal type. Preliminary report. Dr. PAUL R. WENSTON, University of Georgia (758-35-10)</td>
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<td>4:10- 4:30</td>
<td>Invariant criteria for existence of solutions to second order quasilinear elliptic boundary value problems. Professor RICHARD J. KRAMER*, Pennsylvania State University and Professor JERRY L. KAZDAN, University of Pennsylvania (758-35-1)</td>
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<td>4:40- 5:00</td>
<td>Unique continuation for some overdetermined systems of P.D.E.'s. Preliminary report. Professor BARRY MacKICHAN*, New Mexico State University and Professor C. DENSON HILL, State University of New York at Stony Brook (758-35-14)</td>
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<td>SATURDAY, 2:10 P. M.</td>
<td>Special Session on Energy Model Algorithms and Related Mathematical Research, 302 Wilson Hall.</td>
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<tr>
<td>2:10- 2:30</td>
<td>Structured linear programs and energy modeling. Preliminary report. Dr. JAMES K. HO, Brookhaven National Laboratory, New York (758-90-2)</td>
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<tr>
<td>2:40- 3:00</td>
<td>Convergence properties of an algorithm for calculating market equilibrium. Professor CAULTON L. IRWIN, West Virginia University (758-90-4)</td>
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<td>SATURDAY, 2:10 P. M.</td>
<td>Special Session on Approximation Theory II, 168 Barus-Holley Building.</td>
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<td>2:10- 2:30</td>
<td>Characterization of functions by their Gauss-Chebyshev quadratures. Preliminary report. Professor I. BOROSH* and Professor C. K. CHUI, Texas A &amp; M University (758-41-3)</td>
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<tr>
<td>2:40- 3:00</td>
<td>An application of spline approximation with variable knots to optimal estimation of the derivative. Preliminary report. Professor C. K. CHUI* and Professor PHILLIP W. SMITH, Texas A &amp; M University (758-41-6)</td>
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<td>3:10- 3:30</td>
<td>On the boundedness of orthonormal polynomials. Professor GEZA FREUD, Ohio State University (758-41-7)</td>
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<td>3:40- 4:00</td>
<td>Discrete polynomial splines on the circle. A. SHARMA, University of Alberta (758-41-9)</td>
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<td>Special Session on the Identity Problem II, 102 Wilson Hall.</td>
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<td>2:10- 2:30</td>
<td>On a formula of Torres. Preliminary report. Mr. NOBUYUKI A. SATO, Brandeis University (758-57-4)</td>
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<tr>
<td>2:40- 3:00</td>
<td>Cohomology of real Grassmannians. Preliminary report. Mr. HOWARD L. HILLER, Massachusetts Institute of Technology (758-55-3)</td>
</tr>
<tr>
<td>3:10- 3:30</td>
<td>Simple extensions for groups. Preliminary report. Mr. MAURICIO A. GUTIERREZ, Tufts University (758-55-5)</td>
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<tr>
<td>3:40- 4:00</td>
<td>New infinite families in the stable homotopy groups of spheres and of Moore spaces. Preliminary report. Dr. RALPH L. COHEN, Brandeis University (758-55-6)</td>
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2:25-2:35 (222) Residue classes of $p(n) \pmod{5^k}$. Professor D. W. MacLEAN, University of Saskatchewan (758-10-2)
2:40-2:50 (223) Eichler cohomology and Eisenstein series. MICHAEL J. RAzar, University of Maryland (758-10-3)
2:55-3:05 (224) Class groups of real quadratic fields. PAUL B. MASSELL, Battelle Memorial Institute, Washington, D. C. (758-12-5)
3:10-3:20 (225) Cyclic cohomology groups in dimension 2 for class field theory. Preliminary report, Dr. RONALD M. BRZENK, Hartwick College (758-12-3)
3:25-3:35 (226) Real quadratic identities for evaluating $\sum_{x=1}^{n} P(x) F_{kx+s}$. Mr. GREGORY WULCZYN, Bucknell University (758-10-4) (Introduced by Professor Raymond Ayoub)

SATURDAY, 2:10 P. M.

General Session II, 309 Wilson Hall
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2:40-2:50 (229) Semantical completeness theorems in logic and algebra. Dr. VLADIMIR LIPSCHITZ, Brigham Young University (758-02-11)
2:55-3:05 (230) Semi martingales in the limit. Professor LOUIS H. BLAKE, City University of New York, College of Staten Island (758-60-1)
3:10-3:20 (231) Behrens-Fisher degrees of freedom inequalities. Dr. PAUL STEWART SCHNARE, University of Petroleum and Minerals, Dhahran, Saudi Arabia (758-62-1) (Introduced by Dr. Harold O. Ladd)
3:25-3:35 (232) Higher moments for a conditioned gambler's ruin problem. Mr. W. A. BEYER, Los Alamos Scientific Laboratory, Los Alamos, New Mexico (758-60-10)

University Park, Pennsylvania

Raymond G. Ayoub
Associate Secretary

TRANSLATIONS OF MATHEMATICAL MONOGRAPHS

THE MARKOV MOMENT PROBLEM AND EXTREMAL PROBLEMS
by M. G. Krein and A. A. Nudel'man

In this book an extensive circle of questions originating in the classical work of P. L. Čebyšev and A. A. Markov is considered from the contemporary standpoint. It is shown how results and methods of the generalized moment problem are interlaced with various questions of the geometry of convex bodies, algebra and function theory. From this standpoint the structure of convex and conical hulls of curves is studied in detail and isoperimetric inequalities for convex hulls are established; a theory of orthogonal and quasiorthogonal polynomials is constructed; problems of the St. Petersburg school on limiting magnitudes of integrals and on least deviating functions (in various metrics) are generalized and solved; problems in approximation theory and interpolation and extrapolation in various function classes (analytic, absolutely monotone, almost periodic, etc.) are solved, as well as certain problems in optimal control of linear objects.

The last chapter establishes a duality principle between problems of best approximation in a normed space and the abstract $L$-problem of moments. Various illustrations of the principle are given.

This volume was translated from the Russian through the Israel Program for Scientific Translations by D. Louvish.

Volume 50
417 pages; list $47.20; member price $35.40
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PRELIMINARY ANNOUNCEMENTS OF MEETINGS

759TH MEETING

Claremont Colleges
Claremont, California
October 19–21, 1978

The seven hundred fifty-ninth meeting of the American Mathematical Society will be held at the Claremont Colleges on the campus of Pomona College, Claremont, California, Thursday through Saturday, October 19–21, 1978. The meeting will be held jointly with the Southern California Sections of the Mathematical Association of America (MAA) and the Society for Industrial and Applied Mathematics (SIAM). SIAM will meet on Friday, the AMS and MAA will meet on Friday and Saturday, and some AMS special sessions will also take place on Thursday.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses, RALPH S. PHILLIPS of Stanford University will speak on "Scattering theory for automorphic functions" and DANIEL W. STROOCK of the University of Colorado, Boulder, will lecture on "Scattering theory for automorphic functions." The times of these hour addresses will be given in the October issue of these Notices.

By invitation of the same committee, there will be three special sessions of invited twenty-minute papers. KIRBY A. BAKER of the University of California, Los Angeles, and ALDEN F. PIXLEY of Harvey Mudd College are organizing a special session on Varieties of algebraic systems and related topics, which will take place from Thursday afternoon through Saturday.

Speakers are expected to include R. P. Dilworth, Ralph S. Freese, George A. Grätzer, Bjarni Jónsson, Ralph N. McKenzie, E. T. Schmidt, and Walter F. Taylor. The balance of the session will consist of informal workshops (presentation by arrangement, no abstracts required) devoted to particular aspects of varieties. Details concerning the workshops are available from the organizers, STAVROS N. BUSENBERG of Harvey Mudd College and RICHARD H. ELDERKIN of Pomona College are organizing a special session on Ordinary and functional differential equations and their applications. Part of this session will be devoted to applications of differential equations to biological and ecological problems. The partial list of speakers includes: Donald S. Cohen, Courteney S. Coleman, Jim M. Cushing, Stephen P. Diliberto, Allan L. Edelson, B. S. Goh, William A. Harris, Jr., Alan Hastings, Kurt Kreith, Roy B. Leipnik, Richard E. Plant, Simeon Reich, Robert J. Sacker, Klaus Schmitt, Victor L. Shapiro, Hal L. Smith, and George W. Swan. Further information can be obtained from the organizers, M. M. Rao and NEIL E. GRETSKY of the University of California, Riverside, are organizing a special session on Stochastic processes and functional analysis. A tentative list of speakers includes J. R. Blum, Michael D. Brennan, John Theodore Cox, Ronald K. Getoor, Neil E. Gretsky, Aggie Ho, Robert C. James, James B. Robertson, and Howard G. Tucker.

There will be sessions of contributed ten-minute papers. Abstracts should be sent to the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, so as to arrive prior to the deadline of August 28, 1978. Late papers will be accepted for presentation at the meeting, but will not be listed in the printed program.

SIAM is tentatively planning a luncheon on Friday and MAA is tentatively planning a luncheon on Saturday. The SIAM program will include a workshop on Mathematics Clinics. Details of the MAA and SIAM programs will appear in the October Notices.

REGISTRATION

The registration desk will be located on the patio of Millikan Laboratory at the corner of 6th Street and College Avenue. It will be open on Thursday and Friday from 9:00 a.m. to 5:00 p.m. and on Saturday from 9:00 a.m. to noon. The registration fees will be: $3 for members of AMS, MAA or SIAM, $5 for nonmembers, and $1 for students and unemployed.

ACCOMMODATIONS

The following motels are located in Claremont, California, zip code 91711. A block of rooms at Griswold's Inn is being held for conference participants at the special rates listed until October 7. Griswold's Inn is a pleasant twenty-minute walk (1 1/2 kilometers) from the registration desk. The other motels are approximately 2 kilometers from the registration desk. All the motels have good restaurant facilities at or near the motel. Participants should make reservations directly with the motels. Rates listed do not include a tax.

GRISWOLD'S INN
555 W. Foothill Boulevard
Telephone: (714) 626-2411
Single $26
Double 28

HOWARD JOHNSON'S MOTOR LODGE
721 S. Indian Hill Boulevard
Telephone: (714) 626-2431
Single $25.50 - $29 up
Double 36.00 up

RODEWAY INN
840 S. Indian Hill Boulevard
Telephone: (714) 621-4831
Single $26 up
Double 32 up
FOOD SERVICE AND ENTERTAINMENT

Several restaurants are in the downtown area which is within easy walking distance of campus. A list of restaurants will be available at the registration desk.

There will be a wine and cheese tasting on Friday evening for a reasonable, but as yet undetermined, charge. Persons interested in the wine and cheese should sign up at the registration desk before 2:00 p.m. on Friday.

TRAVEL

Claremont is served by Greyhound Bus Lines and Ontario International Airport. This airport has direct flights to most major cities and is served by many airlines, including American, Continental, Pacific Southwest, United, and Western. The major local motels provide free limousine service. Ontario International Airport is a 15-minute drive from Claremont, whereas Los Angeles International Airport is a 75-minute drive and from there ground transportation to Claremont costs approximately $20.

760TH MEETING

Syracuse University
Syracuse, New York
October 27–28, 1978

The Seven hundred sixtieth meeting of the American Mathematical Society will be held at Syracuse University, Syracuse, New York, on Friday and Saturday, October 27–28, 1978.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there will be four invited one-hour addresses. Lectures will be presented by MICHAEL BARRETT of Northwestern University, and SYLVAN CAPPEL, Courant Institute of Mathematical Sciences, New York University. The titles of their addresses are not yet available. DAVID DRASIN of Purdue University will lecture on "Quasiconformal methods in the theory of analytic and meromorphic functions"; and IRWIN KRA, State University of New York at Stony Brook, will talk on "Canonical mappings between Teichmüller spaces."

By invitation of the same committee, there will be eleven special sessions of selected twenty-minute papers. The names of the organizers, and the titles of these special sessions, are as follows: DOUGLAS R. ANDERSON of Syracuse University, Geometric topology; LEONARD ASIMOW, University of Wyoming and Syracuse University, Rigidity; LIPMAN BERS of Columbia University, Kleinian groups; JOHN HARPER, University of Rochester, Unstable homotopy theory; THOMAS JECH, Pennsylvania State University, Set theory; LEOPOLDO NACHBIN, University of Rochester, Functional analysis; ALAN C. NEWELL, Clarkson College of Technology, Nonlinear waves; CHANCHAL SINGH, St. Lawrence University, Operations research; DANIEL WATERMAN, Syracuse University, Real analysis; CHARLES WATTS, University of Rochester, Homological algebra; and ALLEN WEITSMAN of Purdue University, Complex analysis.

PARKING

Millikan Laboratory is located at the northeast corner of Sixth Street and College Avenue in Claremont. To reach the area from Interstate 10, take Exit #47, proceed north on Indian Hill Boulevard to Sixth Street, and then turn right (east) and proceed to College Avenue. There is adequate parking on the streets and in nearby lots. To reach Griswold's Inn instead, do not turn at Sixth Street, but continue north on Indian Hill Boulevard to Foothill Boulevard, then turn left (west) and proceed to Griswold's Inn.

LOCAL INFORMATION

For further local information, write to AMS-MAA-SIAM Meeting, Department of Mathematics, Pomona College, Claremont, California 91711 or telephone (714) 621-8000, extension 2994.

Kenneth A. Ross
Associate Secretary

Eugene, Oregon

ACCOMMODATIONS

Rooms are being held at the following motels for participants attending the meeting. Participants should make their reservations directly with the motels, and in order to obtain these special rates should be sure to mention that they will be attending the AMS meeting. Deadline for reservations is October 15. The rates shown do not include tax.
HOLIDAY INN (10 blocks)
701 East Genesee Street
Telephone: (315) 474-7251
Single $25
Double 30

TREADWAY MOTOR INN (8 blocks)
1016 East Genesee Street
Telephone: (315) 476-4212
Single $16
Double 22

FOOD SERVICE
Breakfast and lunch may be obtained at the University Cafeteria in Slocum Hall, but dinner will not be available. There are numerous restaurants within three blocks of the campus, and a list of restaurants in the area will be available at the registration desk.

TRAVEL
Syracuse is served by Eastern, American, and Allegheny Airlines, as well as by Greyhound Bus Line and Amtrak. For individuals driving to the meeting, the most direct routes to Syracuse are via the New York Thruway (Interstate 90), east-west route, or Interstate 81, north-south route. More complete directions for reaching the campus upon arrival in Syracuse will be included in the final announcement in the October issue of the Notices.

PARKING
There will be ample parking space available on campus during the meeting, and permits for parking will be available at the registration desk.

Raymond G. Ayoub
Associate Secretary
University Park, Pennsylvania

INVITED SPEAKERS AT AMS MEETINGS

This section lists the individuals who have accepted invitations to address the Society at the times and places listed below. For some meetings, the lists of speakers are incomplete.

Claremont, California, October 1978
Ralph S. Phillips
Sydney, New York, October 1978
Michael Barrett
Sylvan Cappell
Charleston, South Carolina, November 1978
Roger W. Brockett
Michael Schlessinger
Chicago, Illinois, November 1978
Ronald R. Coifman

Biloxi, Mississippi, January 1979
Michael Artin
Jacob Feldman
John E. Fornaess
Phillip A. Griffiths
Heinz-Otto Kreiss

Honolulu, Hawaii, March 1979
Henry A. Dye
William A. Harris, Jr.

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by Alan Weinstein

The first six sections of these notes contain a description of some of the basic constructions and results on symplectic manifolds and lagrangian submanifolds. §7, on intersections of lagrangian submanifolds, is still mostly internal to symplectic geometry, but it contains some applications to mechanics and dynamical systems. §§8, 9, and 10 are devoted to various aspects of the quantization problem. In §10 there is a feedback of ideas from quantization theory into symplectic geometry itself.

In addition to an introduction and references, the following lectures are included in these notes: Symplectic manifolds and lagrangian submanifolds, examples; Lagrangian splittings, real and complex polarization, Kähler manifolds; Reduction, the calculus of canonical relations, intermediate polarizations; Hamiltonian systems and group actions on symplectic manifolds; Normal forms; Lagrangian submanifolds and families of functions; Intersection Theory of lagrangian submanifolds; Quantization on cotangent bundles; Quantization and polarizations; Quantizing lagrangian submanifolds and subspaces, construction of the Maslov bundle.

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Prepayment is required for all American Mathematical Society publications.
Send for the book(s) above to: AMS, P.O. Box 1571, Annex Station, Providence, RI 02901.
The seven hundred sixty-first meeting of the American Mathematical Society will be held at the College of Charleston in Charleston, South Carolina, from noon Friday to 5:00 p.m., Saturday, November 3 and 4, 1978. Sessions will be held in Maybank Hall, where the mathematics department is located, and in the Science Center.

By invitation of the Committee to Select Hour Speakers for Southeastern Sectional Meetings there will be three invited one-hour addresses. ROGER W. BROCKETT of Harvard University will talk on "Mathematical aspects of control theory." MICHAEL SCHLESSINGER of the University of North Carolina, Chapel Hill, will talk on "The Lie algebras of deformation theory." LAWRENCE ZALCMAN of the University of Maryland, College Park, will talk on "Modern perspectives on classical function theory."

By invitation of the same committee, there will be at least four special sessions. CLYDE MARTIN of Case Western Reserve University is organizing a special session on Geometric and algebraic methods in control theory; HERB SILVERMAN of the College of Charleston is organizing a special session on Classical complex analysis; JERRY E. VAUGHAN of the University of North Carolina, Greensboro, is arranging a special session on General topology; and JONATHAN M. WAHL of the University of North Carolina, Chapel Hill, is organizing a special session on Classification and deformation of singularities.

There will be sessions for contributed ten-minute papers. Abstracts should be submitted to the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, so as to arrive prior to the deadline of August 28. If necessary, late papers will be accepted for presentation, but will not be listed in the printed program of the meeting.

REGISTRATION

The registration desk will be in the lobby of the Science Center and will be open from 10:00 a.m. to 4:00 p.m. on Friday, November 3, and from 8:30 a.m. to 11:00 a.m. on Saturday. The registration fees for the meeting will be $5 for nonmembers, $3 for members, and $1 for students or unemployed persons. Please use the form on page A-567 of these Notices to pre-register.

ACCOMMODATIONS

Accommodations are available within easy walking distance of the meeting. Blocks of rooms have been reserved at the two locations listed below. Participants should make their own reservations directly with the hotel, and should identify themselves as participants at the AMS meeting. Reservations must be received by the Holiday Inn—Downtown no later than October 15, and by the Francis Marion Hotel no later than October 19.

FRANCIS MARION HOTEL (1 block)
387 King Street
Telephone: (803) 722-8831
Single $18
Double or Twin 24
Additional persons in room 4 each

HOLIDAY INN—DOWNTOWN (2 blocks)
125 Calhoun Street
Telephone: (803) 722-3391
Single $24
Double or Twin 31
Additional persons in room 4 each

FOOD SERVICE

Food service on campus is available at the student cafeteria and at the snack bar in the Stern Student Center. Numerous restaurants and a cafeteria are within walking distance of the campus. A list of restaurants and their locations will be available at the registration desk. Refreshments will be available in Maybank Hall throughout the meeting.
TRAVEL

Charleston is located approximately 100 miles north of Savannah and 110 miles southeast of Columbia. The city may be reached by car via US 17 or I-26 and is served by Amtrak, Greyhound and Trailways bus lines, and Delta, Eastern, and National Airlines. One-way limousine service between Charleston Airport and the downtown hotels is $2.50. Taxi service is $5 for one or two persons.

ENTERTAINMENT

Charleston is an historic city (circa 1670) with many tourist attractions and points of historic interest. Information concerning tourist attractions and tours will be available at the registration desk.

A beer party will be held Friday night at the Francis Marion Hotel beginning at 7:00 p.m. Tickets for the party may be purchased at the registration desk.

WEATHER

The weather in November is generally mild. The average mean temperature during the month of November is 56.3°F (13.5°C). The average daily maximum temperature is 68.4°F (20.2°C), and the average daily minimum temperature is 44.1°F (6.7°C). The average rainfall for the month of November is 2.13 inches (5.41 cm).

PARKING

A city parking garage is located next to the campus on the corner of St. Philip and George Streets. The rates are 20 cents per hour or $1 per day.

EMERGENCY MESSAGES

Emergency messages may be left at the office of the Department of Mathematics (803) 792-5730.

Frank Birtel
New Orleans, Louisiana
Associate Secretary
762ND MEETING
University of Chicago
Chicago, Illinois
November 12, 1978

The seven hundred sixty-second meeting of the American Mathematical Society will be held on Sunday, November 12, 1978 at the University of Chicago, Chicago, Illinois. All sessions of the meeting will be held in the Center for Continuing Education, 1307 East 60th Street, which will also be the hotel headquarters for the meeting.

The time and place for the meeting were approved by the Executive Committee of the Council on October 1, 1977. The time of the meeting was selected in accordance with the following resolution approved by the Council at its meeting on August 23, 1976: "Since a considerable number of members of the Society have religious beliefs prohibiting attendance at meetings on Saturdays, the Society should schedule an appreciable fraction of its one-day meetings on other days of the week."

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, there will be two invited one-hour addresses. PETER E. ORLIK of the University of Wisconsin, Madison, will speak at 11:00 a.m., on the topic "Singularities and group actions." RONALD R. COIFMAN of Washington University, St. Louis, will address the Society at 1:45 p.m., on the subject "Fourier transforms and noncommutative harmonic analysis."

By invitation of the same committee, there will be two special sessions of selected twenty-minute papers. ROBERT J. STANTON of the Institute for Advanced Study and Rice University is organizing a special session on Harmonic analysis on real groups. JOHN W. WOOD of the University of Illinois at Chicago Circle is organizing a special session on Topology of varieties. Most of the talks to be presented in these two special sessions will be by invitation. However, anyone submitting an abstract for the meeting who feels that his or her abstract would be particularly suitable for one of these special sessions should indicate this clearly on the abstract and mail it in time to reach the office of the American Mathematical Society in Providence by August 29, 1978, three weeks before the normal deadline for abstracts of contributed papers.

There will also be sessions of contributed ten-minute papers as needed. The abstract deadline is September 19, 1978.

Detailed information on travel and accommodations will be given in the October issue of these Notices.

Paul T. Bateman
Urbana, Illinois
Associate Secretary

764TH MEETING
University of Hawaii
Honolulu, Hawaii
March 30–April 1, 1979

The seven hundred sixty-fourth meeting of the American Mathematical Society will be held at the University of Hawaii at Manoa in Honolulu, Hawaii, from Friday, March 30, through Sunday, April 1, 1979.

A symposium on The Geometry of the Laplace Operator is planned for the period March 27–30. Financial support from an agency of the United States Government is being solicited. The topic of the symposium was selected by the 1978 Committee to Select Hour Speakers for Far Western Sectional Meetings, which consists of Paul C. Fife (chairman), David M. Goldschmidt, Robert Osserman, Ringham Ree, and the associate secretary. The Organizing Committee, responsible for selecting the speakers and arranging the symposium program, consists of David D. Bleecker, Victor W. Guillemin, Henry P. McKean, Jr., Robert Osserman, Karen Uhlenbeck, Joel L. Weiner, and Leslie C. Wilson. The co-chairmen are David D. Bleecker at the University of Hawaii, and Robert Osserman of Stanford University.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. These will be given by HENRY A. DYE of the University of California, Los Angeles, and by WILLIAM A. HARRIS, JR., of the University of Southern California.

By invitation of the same committee, there will be at least six special sessions of invited twenty-minute papers. The titles of the special sessions and the names of the organizers are as follows: Geometric topology: CHRISTOPHER J. ALLDAY, HUGH M. HILDEN, and BOB LITTLE; Quadratic forms: RONALD P. BROWN and THOMAS C. CRAVEN; Countable models: WILLIAM P. HANF and DALE W. MYERS; Non-associative algebras and applications: NOBUO NOBUSAWA and ARTHUR A. SAGLE; Semigroups and Markov processes: TOM PITCHER and LAWRENCE J. WALLEN; Commutative harmonic analysis: L. THOMAS RAMSEY and BENJAMIN B. WELLS, JR. All of the organizers are at the University of Hawaii at Manoa except for Arthur A. Sagle, who is at the University of Hawaii at Hilo.

The meeting coincides with a very busy tourist season in Hawaii, so participants should make their plans as soon as possible! Reservations for air travel and hotel accommodations can be made through Hawaii Conference Planners, 2222 Kalakaua Avenue, P.O. Box 8519, Honolulu, Hawaii 96815. They will provide a choice of hotels, group air fare rates, and optional tours and activities. Participants communicating with Hawaii Conference Planners should mention that they are attending the mathematics meeting.

Kenneth A. Ross
Eugene, Oregon
Associate Secretary
ORGANIZERS AND TOPICS OF SPECIAL SESSIONS

Names of the organizers of special sessions to be held at meetings of the Society are listed below, along with the topic of the session. Papers will be considered for inclusion in special sessions, if their abstracts are submitted to the Providence office by the deadlines given below. These deadlines are three weeks earlier than those for abstracts for regular sessions of ten-minute contributed papers. The most recent abstract form has a space for indicating that the abstract is for a special session. If you do not have a copy of this form, be sure your abstract is clearly marked "For consideration for special session (title of special session)." Papers not selected for special sessions will automatically be considered for regular sessions unless the author gives specific instructions to the contrary.

<table>
<thead>
<tr>
<th>Location</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claremont, California, Oct 1978</td>
<td>Kirby A. Baker and Alden F. Pixley, Varieties of algebraic systems and related topics</td>
</tr>
<tr>
<td></td>
<td>Stavros N. Busenberg and Richard H. Elderkin, Ordinary and functional differential equations and their applications</td>
</tr>
<tr>
<td></td>
<td>M. M. Rao and Neil E. Gretsky, Stochastic processes and functional analysis</td>
</tr>
<tr>
<td></td>
<td>Leonard Asimow, Rigidity</td>
</tr>
<tr>
<td></td>
<td>Lipman Bers, Kleinian groups</td>
</tr>
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<td></td>
<td>John Harper, Unstable homotopy theory</td>
</tr>
<tr>
<td></td>
<td>Thomas Jech, Set theory</td>
</tr>
<tr>
<td></td>
<td>Leopoldo Nachbin, Functional analysis</td>
</tr>
<tr>
<td></td>
<td>Alan C. Newell, Nonlinear waves</td>
</tr>
<tr>
<td></td>
<td>Chanchal Singh, Operations research</td>
</tr>
<tr>
<td></td>
<td>Daniel Waterman, Real analysis</td>
</tr>
<tr>
<td></td>
<td>Charles Watts, Homological algebra</td>
</tr>
<tr>
<td></td>
<td>Allen Weitsman, Complex analysis</td>
</tr>
<tr>
<td>Charleston, South Carolina, Nov 1978</td>
<td>Clyde Martin, Geometric and algebraic methods in control theory</td>
</tr>
<tr>
<td></td>
<td>Herb Silverman, Classical complex analysis</td>
</tr>
<tr>
<td></td>
<td>Jerry E. Vaughan, General topology</td>
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<tr>
<td></td>
<td>Jonathan M. Wahl, Classification and deformation of singularities</td>
</tr>
<tr>
<td>Chicago, Illinois, Nov 1978</td>
<td>Robert J. Stanton, Harmonic analysis on real groups</td>
</tr>
<tr>
<td></td>
<td>John W. Wood, Topology of varieties</td>
</tr>
<tr>
<td>Biloxi, Mississippi, Jan 1979</td>
<td>Stefan Burr, Number theory and its applications</td>
</tr>
<tr>
<td></td>
<td>Douglas N. Clark, Operator theory</td>
</tr>
<tr>
<td></td>
<td>Paul Ehrlich, Differential geometry and general relativity</td>
</tr>
<tr>
<td></td>
<td>John R. Graef and A. G. Kartsatos, Ordinary differential equations: oscillation and asymptotic behavior</td>
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<tr>
<td></td>
<td>William C. Hoffman, Modern mathematical psychology</td>
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<tr>
<td></td>
<td>Marvin Knopp, Modular and automorphic functions in a single complex variable</td>
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<tr>
<td></td>
<td>William Lucas, Game theory</td>
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<tr>
<td></td>
<td>Richard Millman, Global differential geometry</td>
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<tr>
<td></td>
<td>Ray Mines and Fred Richman, Constructive mathematics</td>
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<tr>
<td></td>
<td>M. Z. Nashed, Integral equations</td>
</tr>
<tr>
<td></td>
<td>B. E. Rhoades, Summability and related topics</td>
</tr>
<tr>
<td></td>
<td>Robert J. Thompson, Industrial mathematics</td>
</tr>
<tr>
<td>Honolulu, Hawaii, Mar 1979</td>
<td>Christopher J. Allday, Hugh M. Hilden, and Bob Little, Geometric topology</td>
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<tr>
<td></td>
<td>Ronald P. Brown and Thomas C. Craven, Quadratic forms</td>
</tr>
<tr>
<td></td>
<td>William P. Hanf and Dale W. Myers, Countable models</td>
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<tr>
<td></td>
<td>Nobuo Nobusawa and Arthur A. Sage, Nonassociative algebras and applications</td>
</tr>
<tr>
<td></td>
<td>Tom Pitcher and Lawrence J. Wallen, Semigroups and Markov processes</td>
</tr>
<tr>
<td></td>
<td>L. Thomas Ramsey and Benjamin B. Wells, Jr., Commutative harmonic analysis</td>
</tr>
</tbody>
</table>
ELECTION INFORMATION

The ballots for election of members of the Council and Board of Trustees of the Society for 1979 will be mailed early in September, in order for members to receive their ballots well in advance of the November 10 deadline. Prior to casting their ballots members are urged to consult the following articles and sections of the Bylaws of the Society: article I, section 1; article II, sections 1, 2; article III, sections 1, 2, 3, 4; article IV, sections 1, 2, 4; article VII, sections 1, 2. The complete text of the Bylaws appears on pages 457—460 of the November 1977 issue of these Notices. A list of the members of the Council and Board of Trustees serving terms during 1978 appears on page 336 of this issue.

SUGGESTIONS FOR 1979 NOMINATIONS

Each year the members of the Society are given the opportunity to propose for nomination the names of those individuals they deem both qualified and responsive to their views and needs as part of the mathematical community. Members are requested to write in the appropriate spaces their suggestions for members of the Council and Board of Trustees to replace those members whose terms expire December 31, 1979. See page 336 of this issue for the list of current members of the Council and Board of Trustees. The completed form should be addressed to

American Mathematical Society
Attn: The Nominating Committee
P. O. Box 6248
Providence, R. I. 02940


| TO: Nominating Committee for 1979, American Mathematical Society |
| RE: Suggestions for members of the Council and Board of Trustees |
| President-elect (1) | Members of the Proceedings Editorial Committee (3) |
| Vice Presidents (2) |
| Associate Secretaries (2) |
| Member of the Bulletin Editorial Committee (1) |
| Member of the Colloquium Editorial Committee (1) |
| Member of the Mathematical Reviews Editorial Committee (1) |
| Member of the Mathematical Surveys Editorial Committee (1) |
| Member of the Mathematics of Computation Editorial Committee (1) |
| Members-at-large of the Council (5) |
| Member of the Board of Trustees (1) |

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The purpose of this announcement is to call to your attention some items of importance involving the submission of research proposals to the National Science Foundation.

The Mathematical Sciences Section of the National Science Foundation again announces that in order to insure full consideration, proposals requesting support beginning prior to November 1, 1979 should be in the hands of the cognizant program director at least eight months prior to the desired starting date of such support, but not later than October 25, 1978. If early preparation and submission of proposals can occur without significantly affecting their quality, investigators are encouraged to submit proposals earlier whenever possible.

The Section also wishes to encourage greater attention to the NSF brochure "Grants for Scientific Research" (NSF 76-38) in the writing of proposals. Of particular importance are the following:

1. Recent budgetary and policy shifts have made possible a substantial number of awards of durations greater than one year, in response to proposals of significant merit. Consequently, Principal Investigators are encouraged to apply for support periods of two or three years, whenever appropriate. In such cases, separate itemized budgets should be submitted for each year during which support is requested, using the NSF Summary Proposal Budget Form;

2. Proposal cover sheets should prominently display the first two digits of the most applicable numbers from the AMS(MOS) Subject Classification Scheme used in the Mathematical Reviews Subject Index. Individual topics proposed for research should be identified with the appropriate full subject classification number or numbers. Principal Investigators may, if they wish, state the program in which they expect their proposals to be considered (although final determination of program assignment will be made by the Foundation); and

3. Each proposal must contain a 200–300 word summary of the work being proposed (in the entire proposal), following the format of the NSF Project Summary Form, available from local university research administration offices. The abstract is sent to the Smithsonian Science Information Exchange and to persons requesting information if a grant is awarded. The abstract must be self-contained, the pertinent subfield of science should be stated explicitly in the first sentence, its phrasing should avoid first-person pronouns and symbols not on standard typewriters, it should be informative to other scientists, and, insofar as possible, be expressed in language that can be understood by a scientifically literate reader.

In addition, each proposal should contain:

4. A full description of all other current research support or pending applications for such, for all proposed investigators; in case there is no other support and no other application is pending or contemplated, the proposal must contain such a statement explicitly (for example: None of the listed investigators has any other research support and no other application is pending or contemplated);

5. In requests for renewed support, estimates both of total expenditures and commitments under the existing award to the date at which new funding is desired and of the project residual balance, if any (see NSF 76-38, pp. 17–18);

6. Justification for any but the most usual items of support; in particular, this should be done in requests for partial support of sabbatical leaves;

7. Curricula vitae of the proposed investigators, including for each a list of publications relevant to the proposed research; and

8. A bibliography of other pertinent publications.

It would be helpful if each proposal listed the telephone numbers of the department and the principal investigator(s).

The check list below may be useful in preparation of proposals.

Cover Page
Table of Contents
Project Abstract

For each investigator:
Description of proposed research
Curriculum Vita
Publication List (arranged chronologically)

Separate Budget for each year
Residual Fund statement (for renewal of support only)
Other support statement
Appendices
10 copies of proposal
REPORT ON THE 1977 AMS NONACADEMIC SALARY SURVEY  

by Robert J. Thompson

Since 1957 the American Mathematical Society has conducted an annual survey of faculty salaries. In addition, new recipients of the doctorate are surveyed annually for a study that includes both academic and nonacademic salaries. The results of the most recent of those two salary surveys appeared in these Notices, October 1977, pages 336–361. Those surveys were made under the direction of the Society’s Committee on Employment and Educational Policy (CEEP), whose members in 1977 were Lida K. Barrett, David Blackwell, Wendell H. Fleming (chairman), Hugo Rossi, Martha K. Smith, and Robert J. Thompson. Because of the growing importance of the employment of mathematicians outside traditional academic areas, CEEP decided in 1977 to conduct a salary survey of nonacademically employed Ph.D.’s, Daniel H. Wagner, who was a committee member in 1975 and 1976, was particularly active in planning for the survey and in the construction of the questionnaire. The committee is grateful to members of the AMS staff, especially Lincoln K. Durst and Peggy Reynolds, for the efficiency with which the survey was conducted and for the preliminary organization of the data. A survey of this type may occasionally be done in the future. Comments or suggestions may be directed to the committee.

The AMS Nonacademic Salary Survey was designed for individuals with a doctorate in the mathematical sciences who had full-time nonacademic employment in the U.S. and who were citizens or permanent residents of the U.S. A suitable list of people who fit these criteria, however, did not exist. At the instigation of the Society’s Committee on Employment and Educational Policy, the 1977 AMS dues notice contained several questions to be used for constructing such a list; in this manner 555 individuals were identified. The Mathematical Association of America graciously provided a list of MAA members with doctorates and nonacademic employment; from this list 431 additional people were identified, but their citizenship and full-time employment status were not known. Finally, another list was compiled from those AMS members who did not answer the questions on the 1977 dues notice but whose institutional affiliation indicated they were employed in the nonacademic sector; a total of 239 individuals were identified in this way, but it was not known how many of these individuals fit all the criteria mentioned above.

In October 1977 questionnaires were mailed to 1,225 individuals; 564 were returned and all but 9 of them were usable. Respondents were asked to provide information that was accurate as of October 15, 1977. (The questionnaire is reproduced below.) There are certainly a number of people in the intended group who were not sent the questionnaire. How many people were missed and how they would have affected the results reported here are not known. One comparison with another survey has been made, and the results are surprisingly good. The AMS survey of new doctorates referred to above reported a median twelve-month salary of $21,600 for males accepting jobs in business and industry in 1977; for the survey reported here, the median twelve-month salary of new doctorates (1 year or less) who are employed in business and industry is $21,500. The corresponding medians for government are $19,200 and $19,000 for the two surveys.
In Figures 1–5 of this report the heavy horizontal lines designate median salaries; the lighter horizontal lines mark the first and third quartiles; thus the vertical lines joining them represent the range of the middle fifty percent of the salaries reported. The numbers in parentheses above the "sample size" on these five graphs are, respectively, the minimum and maximum salaries reported. For example, (25; 100) means that the minimum salary reported was $25,000 and the maximum was $100,000. All of the figures use the same horizontal and vertical scales so that comparisons can be made easily.

It is not clear what is the most appropriate measure of seniority for nonacademic mathematicians. Figure 1 displays salaries as a function of years since receipt of doctorate. This measure is used almost exclusively in this report, but, for comparison, Figure 2 shows salaries as a function of years of nonacademic professional experience. Comparison of the sample sizes tabulated on the two figures shows the difference in the distribution of the population using these two measures. A number of young mathematicians in recent years have taken nonacademic jobs after spending several years in the academic sector and perhaps failing to receive tenure. Presumably for many of these people the number of years since doctorate substantially exceeds the number of years of nonacademic experience. On the other hand, for many of the respondents the years of nonacademic experience exceeded the years since doctorate—sometimes considerably.

An arbitrary decision was made that people who reported that they spent at least 30% of their time supervising others or in administration would be classified as supervisors and/or administrators. This yielded a subset containing 146 people. Figure 3 is based on their salaries.

A recent report issued by the National Research Council compares information on employment, compensation and geographic distribution of mathematics doctorates with doctorates in other subjects. The report includes data on unemployment rates and work activity, and gives some comparative salary and employment information for men and women. The NRC report is reproduced in its entirety on pages 311–314 of this issue of the Notices, with the gracious permission of the Commission on Human Resources of the National Research Council.

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In order to compare the nonacademic salaries reported in the accompanying article with academic salaries, a graphical representation is given for the faculty salaries of doctorates, 1977-1978, which were reported in the October 1977 issue of these *Notices*, pages 338-340. It should be observed that the faculty salaries published last fall and depicted here are all nine-month salaries, while all the nonacademic salaries represented in the other graphs are twelve-month salaries. In addition, some faculty members earn more in the year than the nine-month figures indicate (from summer teaching, research support, etc.), but many do not. No information is available on the distribution of the individuals with such supplemental income.

As in the October report, the salary data for this graph have been divided into groups according to the highest degree offered in the mathematical sciences. Group I is the set of the 27 highest ranked departments of mathematics in the 1969 A.C.E. study*, and Group II is the set of the other 36 doctorate granting departments of mathematics rated in the same study. Group III contains the remaining U.S. doctorate granting departments of mathematics, Group IV is the set of U.S. doctorate granting departments of statistics and biostatistics, and Group V is the set of other U.S. departments granting doctorates in the mathematical sciences. Groups M and B are, respectively, the sets of master and bachelor granting departments in the U.S. and Canada. Information on the size of these classes and the rates of response for each can be found in the October 1977 *Notices*; the maximum and minimum salaries reported for each group can also be found there.

The data published last fall for academic salaries is in a form different from that of the nonacademic salaries. Each department was asked to report for each rank the minimum, median, and maximum salaries paid. The heavy vertical segments depict the middle half of the range of medians reported; the lighter vertical segments show the middle halves of the ranges of minima (lower segments) and maxima (upper segments).

LKD

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*The findings were published in "A Rating of Graduate Programs" by Kenneth D. Roose and Charles J. Andersen, American Council of Education, Washington, D.C., 1969, 115 pp. The information on mathematics was reprinted by the Society and can be found on pages 338-340 of the February 1971 issue of these *Notices*.
Figures 4 and 5 are based, respectively, on the 389 respondents employed in business/industry and the 137 respondents employed by the federal government. Twenty-one respondents were employed by other governments—city, state or county. For this group the median salary was $22,300, $18,500 and $28,300.

Respondents were asked to select from among several general areas the one which best described their field of doctoral thesis. Results were: Pure Mathematics 60%, Probability 5%, Statistics 5%, Operations Research 2%, Computer Science 4%, and Other Applied Mathematics 24%.

Respondents were asked to report the percentage of their time at work spent in each of the activities listed below (a category "other" was included, and the total was supposed to be 100%). The table shows for each activity what percent of the respondents reported it as their maximum. For example, ten percent of the respondents reported that they spend at least as much time on basic research as they spend on other activities. The totals in each column are over 100% because there were many ties.

The next table shows how many people reported that they spent no time in research.

Finally, the respondents were asked to estimate how many people with a doctorate in the mathematical sciences were employed by their companies. If the company operated at several geographic locations, only the number at the respondent's location was to be estimated. This question was included in order to get some indication of whether or not nonacademic mathematicians typically work at places which employ a large number of mathematicians. The results were: 48% estimated their companies employed 1 to 5 Ph.D. mathematicians, 11% estimated 6 to 10, 9% estimated 11 to 15, 5% estimated 16 to 20, and 27% thought their companies employed more than 20 Ph.D. mathematicians.
LABOR FORCE

- The total population of Ph.D. scientists and engineers in the U.S. in 1977 who had received their degrees between January 1934 and July 1976 was estimated to be 295,800 of whom 280,200 were in the labor force. The equivalent figures for the humanities were 79,200 in the population* and 73,100 in the labor force.

- Only 10 percent of the doctoral scientists and engineers were women, compared with 22 percent of the humanities Ph.D.'s.

- Members of racial minority groups numbered 19,000 and accounted for 6 percent of the total population of doctorate recipients in science and engineering, and 2,500, or 3 percent, of the humanities doctoral population.

EMPLOYMENT FIELDS

1977 Employment Fields for Science/Engineering Ph.D.'s

<table>
<thead>
<tr>
<th>Field of Doctorate</th>
<th>Labor Force</th>
<th>% Women</th>
<th>% Minorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math and Computer Sciences</td>
<td>16,671</td>
<td>6.9</td>
<td>6.3</td>
</tr>
<tr>
<td>Physics</td>
<td>25,355</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Chemistry</td>
<td>41,667</td>
<td>6.1</td>
<td>6.7</td>
</tr>
<tr>
<td>Earth Sciences</td>
<td>9,198</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Engineering</td>
<td>43,072</td>
<td>0.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>12,924</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Agricultural</td>
<td>7,647</td>
<td>13.3</td>
<td>9.2</td>
</tr>
<tr>
<td>Medical</td>
<td>49,533</td>
<td>15.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Biological</td>
<td>32,636</td>
<td>23.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Psychology</td>
<td>41,519</td>
<td>14.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>16,100</td>
<td>13.4</td>
<td>3.1</td>
</tr>
<tr>
<td>History</td>
<td>16,793</td>
<td>28.0</td>
<td>1.9</td>
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<tr>
<td>English</td>
<td>11,735</td>
<td>32.6</td>
<td>2.9</td>
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<tr>
<td>Other Languages</td>
<td>15,511</td>
<td>18.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Other Humanities</td>
<td>311</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The humanities estimates include 13,700 Ph.D.'s in the fields of archeology, linguistics, area studies, political science, public administration, and international relations. These selected social science fields are also included in the science/engineering estimates.
UNEMPLOYMENT

• An estimated 3,300 Ph.D.'s in science and engineering were unemployed and seeking employment in February 1977, yielding an unemployment rate of 1.2 percent of the labor force.

• An estimated 2,100 Ph.D.'s in the humanities were unemployed and seeking employment in February 1977, yielding an unemployment rate of 2.9 percent of the labor force.

Employed Doctoral Scientists, Engineers, and Humanists by Employment Sector (Excluding Postdoctoral Appointees), 1977

Employed Doctoral Scientists, Engineers, and Humanists by Primary Work Activity (Excluding Postdoctoral Appointees), 1977

Unemployment Rates of Ph.D.'s in Science, Engineering, and the Humanities, 1977

<table>
<thead>
<tr>
<th>Field of Doctorate</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Sciences</td>
<td>0.9%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>1.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>1.1%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Math and Computer Sciences</td>
<td>0.9%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Psychology</td>
<td>0.9%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Engineering</td>
<td>0.6%</td>
<td>3.0%</td>
</tr>
<tr>
<td>History</td>
<td>1.7%</td>
<td>10.4%</td>
</tr>
<tr>
<td>English</td>
<td>2.1%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Other Languages</td>
<td>2.6%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Other Humanities</td>
<td>2.4%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

Note: Only those seeking employment are included in the calculation of unemployment rates.

EMPLOYMENT SECTOR AND WORK ACTIVITY

• Educational institutions employed 56 percent of the doctoral scientists and engineers and 88 percent of the humanities Ph.D.'s who were working full-time or part-time in 1977.

• Approximately two-thirds of the employed Ph.D.'s in the humanities were engaged primarily in teaching, compared with only one-third of the science and engineering Ph.D.'s.
SALARIES

- The median annual salary for full-time employed science and engineering Ph.D.'s was $25,600, with men receiving $26,000 and women earning $20,700 as median salaries.

- Ph.D.’s in the humanities earned a median annual salary of $21,000 in 1977, with men and women earning $22,100 and $18,300, respectively.

Note: Only salaries of full-time employed civilians have been included; academic year salaries have been multiplied by 11/9 to adjust to a full-year scale.
### ACADEMIC RANK

<table>
<thead>
<tr>
<th>Ph.D. Year and Rank</th>
<th>Science/Engineering Ph.D.</th>
<th>Humanities Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Total, 1950-1959 Ph.D.'s</td>
<td>25,704</td>
<td>1,828</td>
</tr>
<tr>
<td>Professor</td>
<td>81.9</td>
<td>53.5</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>9.9</td>
<td>23.2</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>0.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Other/No Report</td>
<td>7.3</td>
<td>17.9</td>
</tr>
<tr>
<td>Total, 1960-1969 Ph.D.'s</td>
<td>53,159</td>
<td>5,167</td>
</tr>
<tr>
<td>Professor</td>
<td>42.8</td>
<td>21.6</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>41.9</td>
<td>38.7</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>6.9</td>
<td>20.4</td>
</tr>
<tr>
<td>Other/No Report</td>
<td>8.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Total, 1970-1974 Ph.D.'s</td>
<td>40,062</td>
<td>6,921</td>
</tr>
<tr>
<td>Professor</td>
<td>4.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>29.5</td>
<td>17.8</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>46.9</td>
<td>53.1</td>
</tr>
<tr>
<td>Other/No Report</td>
<td>19.2</td>
<td>27.1</td>
</tr>
</tbody>
</table>

### GEOGRAPHIC DISTRIBUTION

Percentage Geographic Distribution of Ph.D.'s in Science, Engineering, and the Humanities, 1977

The statistics in this report are estimates derived from a sample survey of 79,400 Ph.D.'s in science, engineering, and the humanities. The survey was conducted in the spring of 1977 by the National Research Council (NRC) with support from the National Science Foundation (NSF), the National Endowment for the Humanities (NEH), and the National Institutes of Health (NIH). The findings reported here pertain to scientists, engineers, and humanists who earned doctorates within the period 1934-1976 and who were residing in the United States in February 1977. More detailed data from the 1977 survey are given in the report, *Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile* (1978). Copies are available without charge from the Commission on Human Resources, National Research Council, 2101 Constitution Avenue, N.W., Room JH712, Washington, D.C., 20418. Telephone: (202) 389-6528.
AMS RECIPROCITY AGREEMENTS

Between 1922 and 1932 the American Mathematical Society concluded “reciprocity agreements” with the London Mathematical Society, the Unione Matematica Italiana, the Deutsche Mathematiker-Vereinigung, and the Greek Mathematical Society. A number of similar agreements were subsequently made with other mathematical organizations around the world. A current list appears below. These agreements provide for reduced dues for members of these organizations who choose to join the AMS and who reside outside of the U. S. and Canada. Reciprocally, members of the AMS who reside in the U. S. or Canada may join these organizations at a reduced rate. A summary of the privileges available to AMS members who join these organizations under the terms of the reciprocity agreement is given on the following pages. Members of these organizations who join the AMS as reciprocity members enjoy all the privileges available to ordinary members of the Society. AMS dues for reciprocity members are currently $18 per year. (Each organization was asked to review and update its listing in the Spring of 1978. An asterisk indicates that no response to this request had been received when this issue went to press.)

Argentina

**Unión Matemática Argentina**

*Apply for membership to:* Secretary of the Unión Matemática Argentina, Casilla de Correo 3588, Buenos Aires, Argentina.

*Dues:* $6

*Pay dues to:* Unión Matemática Argentina

*Privileges of membership:* REVISTA de la Unión Matemática Argentina (two issues/year), NOTICIERO (nine issues/year).

*Officers:* Orlando E. Villamayor (President), Carlos Germán D. Gregorio (Secretary).

Belgium

**Société Mathématique de Belgique**

*Apply for membership to:* Professor Guy Hirsch, Secretary, Société Mathématique de Belgique, 317, avenue Charles Woeste, Brussels 1090, Belgium.

*Dues:* $12

*Pay dues to:* Professor Guy Hirsch, Secretary.

*Privileges of membership:* BULLETIN de la Société Mathématique de Belgique (quarterly periodical, about 500 printed pages a year).

*Officers:* R. Debever (President), G. Hirsch (Secretary), J. Depunt (Treasurer).

Brazil

**Sociedade Brasileira de Matemática**

*Apply for membership to:* The Secretary, Sociedade Brasileira de Matemática, Rua Luiz de Camões, 68-Centro, 20.000 Rio de Janeiro, RJ, Brazil.

*Dues:* $5

*Pay dues to:* Sociedade Brasileira de Matemática.

*Privileges of membership:* BOLETIM and NOTICIAIRO da Sociedade Brasileira de Matemática (each, two issues/year).

*Officers:* D. G. DeFigueiredo (President), S. N. Sidki (Secretary), D. G. Costa (Treasurer).

Republic of China

**Mathematical Society of the Republic of China**

*Apply for membership to:* Dr. Shing-Ming Lee, President M.S.R.C., National Central University, Chung-Li, Taiwan, Republic of China.

*Dues:* N.T. $100 (U.S. $2.50)

*Pay dues to:* Dr. Shing-Ming Lee, President.

*Privileges of membership:* NOTICES (one issue/year), CHINESE JOURNAL OF MATHEMATICS (two issues/year).

*Officers:* Shing-Ming Lee (President), Pyng Wang (Secretary).

Denmark

**Dansk Matematisk Forening**

*Apply for membership to:* Mogens Esrom Larsen, Secretary, Dansk Matematisk Forening, Univer-
Subjectsparken 5, 2100 København, Ø, Denmark.

Dues: $5

Pay dues to: Mogens Esrom Larsen, Secretary.

Privileges of membership: MATHEMATICA SCANDINAVICA (D.kr. 85/volume), NORDISK MATHEMATISK TIDSSKRIFT (N.kr. 49/volume). (Members of the American Mathematical Society do not have to join Dansk Matematisk Forening to obtain the journals. Subscription orders should be sent directly to the journals: Nordisk Matematisk Tidsskrift, Matematik Institut, Blindern, Oslo, Norge; Mathematica Scandinavica, Matematisk Institut, Aarhus Universitetet, 8000 Aarhus C, Denmark.)

Officers: Flemming Topsøe (President), Mogens Esrom Larsen (Vice-President), Mogens Flensted-Jensen (Treasurer), Mogens Esrom Larsen (Secretary), Johan Dupont, Bodil Branner-Jørgensen.

Finland

Suomen Matemaattinen Yhdistys

Apply for membership to: Dr. Matti Lehtinen, Secretary, Department of Mathematics, University of Helsinki, Hallituskatu 15, SF-00100 Helsinki 10, Finland.

Dues: $12

Pay dues to: Professor Lauri Myrberg, Treasurer, Suomen Matemaattinen Yhdistys, Department of Mathematics, Hallituskatu 15, SF-00100 Helsinki 10, Finland.

Privileges of membership: ARKHI MEDES.

Officers: Olli Lehto (Chairman), Olli Martio (Vice-Chairman), Lauri Myrberg (Treasurer), Matti Lehtinen (Secretary).

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Société Mathématique de France

Apply for membership to: American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

Dues: $16 or $30

Pay dues to: American Mathematical Society.

Privileges of membership: Individuals who pay dues of $16 are entitled to receive CIRCULAIRE and GAZETTE. Individuals who pay dues of $30 are entitled to CIRCULAIRE, GAZETTE, BULLETIN, and four issues of ASTÉRISQUE.

Officers: J. L. Koszul (President), M. Berger, I. Ekeland, J. Neveu (Vice-Presidents), J. L. Nicolas (Treasurer), M. Mignotte, J. Velu (Secretaries).

Federal Republic of Germany

Berliner Mathematische Gesellschaft e. V.

Deutsche Mathematiker-Vereinigung e. V.

Apply for membership to: Professor Dr. K. P. Grotomeyer, Universitätsstrasse, 4800 Bielefeld 1, Federal Republic of Germany.

Dues: DM 20


Officers: H. Witting (President), H. Tietz (Secretary), K. P. Grotomeyer (Treasurer).

Iceland

Íslenska Staerдрfraðafélagið

Apply for membership to: Íslenska Staerдрfraðafélagið, Raunvisindastofnun Háskólaun, Dunhaga 3, Reykjavik, Iceland.

Dues: $5

Pay dues to: Íslenska Staerдрfraðafélagið.

Officers: Sven Sigurdsson (President), Kristín H. Jónsdóttir (Treasurer), Jón Kr. Arason (Secretary).

India

Allahabad Mathematical Society

Apply for membership to: Dr. S. R. Sinha, Secretary, Allahabad Mathematical Society, 5, C. Y. Chintamani Road, Allahabad—211002, India.

Dues: $2.50 (annual); $50 (life)

Pay dues to: Dr. K. G. Mithal, Treasurer.

Privileges of membership: INDIAN JOURNAL OF MATHEMATICS (three issues/year); back volumes available at 25% discount.

Officers: U. N. Singh (President), D. P. Gupta and P. Srivastava (Vice-Presidents), S. R. Sinha (Secretary), K. G. Mithal (Treasurer), S. N. Bhatt (Editor).

Calcutta Mathematical Society

Apply for membership to: Professor M. Dutta, Secretary, Calcutta Mathematical Society, 92, Acharya Prafulla Chandra Road, Calcutta 9, India.

Dues: $2; admission fee $1

Pay dues to: Professor M. Dutta.

Privileges of membership: BULLETIN, NEWS BULLETIN.


Indian Mathematical Society

Apply for membership to: Professor P. C. Jain, Hon. Secretary, IMS, Department of Mathematics, I.I.T., Powai, Bombay 400076, India.

Dues: $7

Pay dues to: Professor D. K. Sinha, Department of Mathematics, Jadavpur University, Jadavpur—W. Bengal, India.

Privileges of membership: JOURNAL of Indian Mathematical Society or MATHEMATICS STUDENT.

Officers: U. N. Singh (President), P. C. Jain (Secretary), D. K. Sinha (Treasurer), S. Raghavan (Academic Secretary), K. G. Ramanathan (Editor of JOURNAL of Indian Mathematical Society), I. S. Luther (Editor of MATHEMATICS STUDENT).

Vijnana Parishad of India

Apply for membership to: Professor H. M. Srivastava, Foreign Secretary, VPI, Department of Mathematics, University of Victoria, Victoria,
British Columbia, Canada, V8W 2Y2 or Dr. R. C. Singh Chandel, Secretary, VPI, Department of Mathematics, D. V. Postgraduate College, Orai—285001, U.P., India.

**Dues:** $5 (annual); $50 (life)

**Pay dues to:** Vijñana Parishad, c/o Department of Mathematics, D. V. Postgraduate College, Orai—285001, U.P., India.

**Privileges of membership:** Jñánabha (an interdisciplinary mathematical journal currently published once a year); back volumes available at 25% discount.

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### Ireland

**Iranian Mathematical Society**

**Officers:** V. Davarpaneh (Secretary).

### Israel

**Israel Mathematical Union**

**Apply for membership to:** Professor M. Perles, Treasurer, Institute of Mathematics, The Hebrew University of Jerusalem, Jerusalem, Israel.

**Dues:** $3

**Pay dues to:** Professor M. Perles, Treasurer.

**Privileges of membership:** NEWSLETTER; may attend and present papers at meetings.

**Officers:** Y. Katznelson (Chairman), M. Perles (Treasurer), A. Zabrodsky (Secretary).

### Italy

**Unione Matematica Italiana**

**Apply for membership to:** Segreteria della Unione Matematica Italiana, Istituto Matematico dell'Università, Piazza Porta S. Donato, 5, 40127 Bologna, Italy.

**Dues:** $12

**Pay dues to:** Segreteria della Unione Matematica Italiana.

**Privileges of membership:** BOLLETTINO Unione Matematica Italiana – Sezione A.

**Officers:** Carlo Pucci (President), Gianfranco Capriz (Vice-President), Giulio Cesare Barozzi (Secretary), Adriano Barlotti (Treasurer).

### Japan

**Mathematical Society of Japan**

**Apply for membership to:** Mathematical Society of Japan, c/o The Toyo Bunko, 28-21, Honkomagome 2-chome, Bunkyo-ku, Tokyo 113, Japan.

**Dues:** $13

**Pay dues to:** Mathematical Society of Japan, The Daiichi Kangyo Bank Ltd., Hongo Branch, Hongo, Bunkyo-ku, Tokyo, Japan.

**Privileges of membership:** JOURNAL of the Mathematical Society of Japan; SUGAKU (in Japanese) for $2 additional dues.

**Officers:** Toshihisa Kimura (President).

### Korea

**Korean Mathematical Society**

**Apply for membership to:** Membership Committee, Korean Mathematical Society, Department of Mathematics, College of Natural Sciences, Seoul National University, Seoul, 151 Korea.

**Dues:** W4,000 (U.S. $8)

**Privileges of membership:** Free receipt of BULLETIN (two issues/year) and JOURNAL of the Korean Mathematical Society (two issues/year).

**Officers:** Eulyong Pak (President), Taeyun Kwon (Vice-President), Yungzin Chung (Treasurer), Okkyung Yoon (Secretary).

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**Malaysian Mathematical Society**

**Apply for membership to:** The Secretary, Malaysian Mathematical Society, c/o Department of Mathematics, University of Malaya, Kuala Lumpur, Malaysia.

**Dues:** $10

**Privileges of membership:** MMS NEWSLETTER, BULLETIN of the Malaysian Mathematical Society (two issues/year), reduced rate for MENEMUI MATEMATIK (three issues/year).

**Officers:** Chong-Keang Lim (President), Pak-Soong Chee (Vice-President), Kok-Eam Khor (Treasurer), Keng-Teh Tan (Secretary).

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**Sociedad Matematica Mexicana**

**Apply for membership to:** Sociedad Matematica Mexicana, C.l.E.A. del I.P.N., Apartado Postal 14-740, Mexico 14, D.F., Mexico.

**Dues:** $6

**Pay dues to:** Sociedad Matematica Mexicana.

**Privileges of membership:** Choice of two of the following publications: REVISTA MATEMATICA MATEMATICAS Y ENSEÑANZA, MISCELANEAS MATEMATICA, BOLETIN de la Sociedad Matematica Mexicana.

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### Netherlands

**Wiskundig Genootschap**

**Apply for membership to:** Dr. E. M. J. Bertin, Mathematisch Instituut, De Uithof, Budapestlaan 6, 3508TA, Utrecht, Netherlands.

**Dues:** Hfl. 24

**Pay dues to:** Amro Bank, Utrecht, Netherlands, Account 45.65.88.167, Penningmeester Wiskundig Genootschap.

**Privileges of membership:** NIEUW ARCHIEF VOOR WISKUNDE (three issues a year containing articles and a problem section), MEDEDELINGEN (nine issues a year containing announcements and book reviews), PROCEEDINGS of the Royal Academy of Sciences—"Indagationes Mathematicae" (can be obtained at a reduced subscription rate of Hfl. 55).

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**Norsk Matematisk Forening**

**Apply for membership to:** Norsk Matematisk
Forening, Matematisk institutt, Postboks 1053 Blindern, Oslo 3, Norway.
Dues: N.kr. 10
Pay dues to: Norsk Matematisk Forening.
Officers: Erling Størmer (President), Karl Egil Aubert (Vice-President), Arne Strøm (Treasurer), Gunnar Olsen (Secretary), Per Holm (Executive Member).

The Philippines
Mathematical Society of the Philippines
Apply for membership to: Membership Committee, Mathematical Society of the Philippines, Department of Mathematics, Ateneo de Manila University, P.O. Box 154, Manila, The Philippines.
Dues: $3.
Pay dues to: Mathematical Society of the Philippines.
Privileges of membership: Publications and newsletters of the Mathematical Society of the Philippines.
Officers: Bienvenido F. Nebres (President).

Poland
Polskie Towarzystwo Matematyczne*
Apply for membership to: Polskie Towarzystwo Matematyczne, Sniadeckich 8, Warszawa, Poland.
Dues: $6
Pay dues to: Polskie Towarzystwo Matematyczne.
Privileges of membership: Any two of the five series of ANNALES SOCIETATIS MATHEMATICAE POLONAE (Conmemtationes Mathematicae, in congress languages; Wiadomosci Matematyczne - Mathematical News, in Polish; Matematyka Stosowana - Applied Mathematics, in Polish; Fundamenta Informaticae, in congress languages; Popularny Miesiecznik Matematyczno-Fizyczny "Delta" - Popular Mathematical-Physical Monthly "Delta", in Polish); participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions.
Officers: Wladyslaw Orlicz (President), Wieslaw Zelazko (Vice-President), Tadeusz Iwinski (Secretary), Eugeniusz Fidelis (Treasurer).

Spain
Real Sociedad Matemática Española*
Apply for membership to: Sr. Secretario, Real Sociedad Matemática Española, Serrano, 123, Madrid 6, Spain.
Dues: $3.50
Pay dues to: Sr. Secretario.
Privileges of membership: REVISTA MATEMÁTICA HISPANO-AMERICANA, GACETA MATEMÁTICA. Officers: José Javier Etayo (President), Gonzalo Calero Rosillo (Secretary), Juan Llovet Verdugo (Associate Secretary).

Sweden
Svenska Matematikersamfundet
Apply for membership to: Svenska Matematikersamfundet, Matematiska Institutionen, Lunds Universitet, Box 725, 220 07 Lund 7, Sweden.
Dues: S.kr. 30
Pay dues to: Svenska Matematikersamfundet.
Officers: Lars Hörmander (President), Olof Hanner (Vice-President), Lennart Bryniesllson (Treasurer), Göran Wanby (Secretary).

Switzerland
Société Mathématique Suisse
Apply for membership to: Secretary SMS, Mathe. Institut, Univ. Rheinsprung 21, 4051 Basel, Switzerland.
Dues: SFR. 10.-- for members of the AMS residing in the U.S. or Canada.
Pay dues to: Secretary SMS.
Privileges of membership: COMMENTARIUM MATHEMATICI HELVETICI (reduced price).
Officers: Ande Delessert (President), Pierre Gabriel (Vice-President), Bruno Scarpellini (Secretary-Treasurer).

United Kingdom
Edinburgh Mathematical Society
Apply for membership to: The Honorary Secretary, Edinburgh Mathematical Society, Department of Mathematics, James Clerk Maxwell Building, Kings Buildings, Mayfield Road, Edinburgh, EH9 3JZ, Scotland.
Dues: $10 (preferably £5 sterling)
Pay dues to: The Honorary Treasurer, Edinburgh Mathematical Society.
Privileges of membership: PROCEEDINGS. Officers: A. D. Sands (President), R. A. Rankin (Vice-President), T. A. Gillespie (Secretary), J. D. P. Meldrum (Secretary), A. C. McBride (Treasurer).

Glasgow Mathematical Association
Apply for membership to: Treasurer, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, Glasgow G12 8QW, Scotland.
Dues: $15
Pay dues to: Treasurer.
Privileges of membership: GLASGOW MATHEMATICAL JOURNAL. Officers: J. Haselgrove (President), K. Stewart (Vice-President), W. Wilson Stothers (Treasurer), E. A. McHarg (Secretary).

London Mathematical Society
Dues: £3.25
Pay dues to: London Mathematical Society.
Privileges of membership: LMS NEWSLETTER. Reduced rates for the BULLETIN, JOURNAL, and PROCEEDINGS of the LMS; JOURNAL OF APPLIED PROBABILITY; QUARTERLY JOURNAL OF MATHEMATICS; LMS Lecture Notes; LMS Monographs. (Please write to the LMS for complete details.)
Officers: C. T. C. Wall (President), D. A. Brannan (Secretary), D. B. Singmaster (Secretary), I. M. James (Treasurer).
NSF SEEKS PROPOSALS
FOR REGIONAL RESEARCH CONFERENCES
IN THE MATHEMATICAL SCIENCES

The National Science Foundation is seeking proposals from prospective host institutions in the U.S. for five-day regional conferences, each to feature ten lectures by a distinguished guest lecturer on a subject of current research interest in the mathematical sciences. An applying institution should have at least a minimal research competence in the area of its proposal. The conferences are to be held during the summer of 1979 (not earlier than June) or during the succeeding fall or winter. The objective of the project is to stimulate and broaden mathematical research activity, particularly in regions of the country where such activity needs further development. The organization of the conferences, evaluation of proposals, and arrangements for publication of monographs based on the guest speakers' lectures are carried out by the Conference Board of the Mathematical Sciences, Washington, D.C., under contract with the Foundation.

Approximately ten conferences per year are projected, each to take place at a host institution during a week of the summer of 1979, or possibly during the succeeding academic year. Topics for conferences may be concerned with any of the subdisciplines of the mathematical sciences.

Each conference must plan for a single principal guest lecturer and about twenty-five other invited participants, the latter to be active research mathematicians from the broad geographic region around the host institution. It is expected that the lecturer will give two lectures per day during the five days of the conference, with the remainder of the time available for study, informal discussion, and exchange of ideas.

All invited participants in a conference receive allowances for travel and subsistence under the host institution's grant from the Foundation for the conference. In addition, the principal lecturer receives from the Conference Board a fee for delivering his lectures and a second fee for organizing these into a substantial monograph. The Conference Board arranges the editing and publication of these papers.

Inquiries regarding details of proposals for these regional conferences should be addressed to the Conference Board of the Mathematical Sciences, 1200 Seventeenth Street, N.W., Washington, D.C. 20036. Proposals by prospective host institutions (twenty copies) should be sent directly to the Mathematical Sciences Section (Attention Dr. William H. Pell), National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550, and must be received in the Foundation no later than November 15, 1978.

Proposals will be evaluated by a panel of the Conference Board and awards of conference grants will be made by the National Science Foundation with the advice of the panel.

NSF Release
June 13, 1978
ACKNOWLEDGEMENTS

The Society acknowledges with gratitude the support rendered by members during the past year. In addition to the contributing members who have paid a minimum of $48 per year in dues, mathematicians also contributed to the Mathematical Reviews Fund, the AMS Research Fellowship Fund, the AMS Research Fellowship Fund in Memory of Richard Brauer and of Norman Levinson, the Delbert Ray Fulkerson Fund, and made general contributions; some contributors have requested that their names remain anonymous. These extra funds paid by members provide vital support to the work of the Society. The names below are those which were received by May 31, 1978, the end of the accounting year.

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Abbott, James H.
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Amir-Moez, Ali R.
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Fletcher, Peter
Foster, Cheryl A.
Francis, Eugene A.
Fuller, Leonard E.
Garrison, George N.
Gillman, Leonard
Glass, A. M. W.
Glasser, Andrew M.
Gordon, Hugh
Gould, Henry W.
Grace, Edward E.
Graves, Robert L.
Greif, Stanley J.
Gromov, Mikhail
Grosswald, Emil
Guggenbuhl, Laura
Haddad, George F., B.
Halbig, Bernhard
Hart, William L.
Hassinger, Bill, Jr.
Hattman, David W.
Hendrickson, Morris S.
Herwitz, Paul S.
Hilt, Arthur L.
Hirschman, I. I., Jr.
Hochstadt, Harry
Hochster, Melvin
Horrigan, Timothy J.
Horvath, John M.
Howe, Roger E.
Huford, George A.
Hulke, George W.
Humphreys, M. Gwenneth
Hunt, Richard A.
Hutchinson, George A.
Ingraham, Mark H.
Jacobsen, Chester Alan
Jackson, Stanley B.
Johnson, Roy A.
Jorgensen, P. E. T.
Kaplan, Wilfred
Kelly, John B.
Killean, John
Kist, Joseph E.
Knuth, Donald E.
Kunen, Kenneth
Laning, J . H.
Leger, George F.
Lemay, William H.
LeVeque, William J.
Lewis, Hugh L.
Lindley, Thomas L., III
Macy, Josiah, Jr.
Mamelak, Joseph S.
Man, W. Robert
Mansfield, Maynard J.
Mattson, H. F., Jr.
McConnell, Robert K.
McCulloh, Leon R.
McNaughton, Robert
McNeel, Robert B.
Meder, Albert E., Jr.
Miller, W. F.
Moo, Richard A.
Morrey, Charles B., Jr.
Naimpally, Somashekhar A.
Nased, M. Zuhair
Newman, Morris
Nishiura, Togo
Nobel, John A.
Norman, Edward
Offenbacher, Robert E.
Orlik, Peter P.
Orloff, Leo N.
Ohrn, Gene M.
Oerema, Scott C.
Owens, Owen G.
Paige, Eugene C., Jr.
Palmis, Richard S.
Palmer, Theodore W.
Pandey, Jagdish N.
Peabody, Mary K.
Pearson, Robert W.
Pell, William H.
Pellitier, Robert E.
Pendegast, Joe
Pflaum, C. W.
Potter, Murray H.
Redheffer, Raymond M.
Rees, Carl J.
Reese, Matthias F.
Rich, Ellis J.
Riney, John S.
Rose, Donald C.
Rosenblum, Marvin
Ross, Kenneth A.
Rovnyak, James L.
Sallie, Paul J., Jr.
Sapon, Charles H.
Scheffer, Vladimir
Schur, August L.
Scott, Walter T.
Seligman, George B.
Sexauer, Norman E.
Shabaz, Abdul Alim
Shanks, Merrill E.
Shapiro, Harold N.
Sheeles, Allen L.
Shiffman, Max
Singmaster, David B.
Sink, Carl J.
Smith, Duane B.
Smith, Frank
Smith, Frank A.
Sotgenfrey, Robert H.
Starkey, Joel B.
Sternberg, David
Sudler, Culbrett, Jr.
Susan, Richard W.
Swokowski, Earl W.
Taylor, Michael E.
Thompson, Layton O.
Tso, Sherman
Uhlenbeck, Karen
Wallach, Sylvan
Wendroff, Burton
White, George N., Jr.
Whitmore, William F.
Whitney, D. Ransom
Williams, J. Ernest, Jr.
Wills, Paul A.
Wilson, Robert Lee
Woeppel, James J.
Wolfe, Stephen James
Wopenstler, Maria J.
Wright, Edward T., Jr.
Wright, Robert K.
Wu, Hung-Hsi
Yahya, S. M.
Young, Gail S.
Zelinsky, Daniel
Ziebur, Allen D.
Zink, Robert E.
Anonymous (3)
The Society also acknowledges with gratitude the support rendered by the following corporations, who held either Corporate Memberships or Institutional Associatehips in the Society during the past year.

**CORPORATE MEMBERS**

- Bell Laboratories
- General Motors Corporation
- International Business Machines Corporation
- Rockwell International

**INSTITUTIONAL ASSOCIATES**

- Chelsea Publishing Company
- Princeton University Press
- Prindle, Weber & Schmidt
- Springer-Verlag New York Incorporated
- Springer-Verlag, Heidelberg
- Daniel H. Wagner, Associates
Beginning with the November 1978 issue (issue number 37), the first issue of the next academic year, several important changes will take place in EIM (Employment Information for Mathematicians).

FIRST. The name of the publication will be changed to "EMPLOYMENT INFORMATION IN THE MATHEMATICAL SCIENCES", in order to reflect more accurately the fact that this publication is (as it has always been) devoted to employment for all those within the mathematical sciences.

SECOND. Beginning with the November 1978 issue, subscribers will no longer have to contend with second class postal service. All subscribers in the U.S. will receive their copies by first class mail. Subscribers in Canada may also receive their copies by first class mail, but an option for air mail delivery will be available. Subscribers in other countries will receive their copies by air mail.

Subscriptions for individuals begin with the next issue published after receipt of their order, and continue through the August issue of the subscription year. The rate depends on the number of issues received and varies with the starting date:

<table>
<thead>
<tr>
<th>Date</th>
<th>Initial Issue</th>
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<td>July 15</td>
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</table>

Single issues are not available separately, except for the August issue. Unemployed individuals (not graduate students) are eligible for a fifty percent reduction in these rates.

An institutional subscription consists of six consecutive issues and may or may not coincide with the academic year. In addition to modest increases in subscription rates to cover the improved postal service, a reclassification of the institutional subscribers has been made which simplifies the calculation of prices for institutional subscriptions. Subscription rates for academic institutions vary with the type of program offered in the mathematical sciences. For institutions offering bachelors degrees or masters degrees but not doctorates in the mathematical sciences, the annual rate is $60; for doctorate granting institutions not ranked among the top twenty-seven in mathematics in the 1969 American Council of Education survey, the annual rate is $72; for the top twenty-seven*, the annual rate is $96. For nonacademic institutions the annual rate is $60.

Subscription order forms may be found on pages A-559 and A-560 in this issue of these Notices and in future issues of EIMS.

THIRD. Because of continuing substantial deficits borne by the sponsoring organizations, a charge will be made for listings beginning with the November 1978 issue. The charge will be $25 per listing, with the option to repeat the listing in one or both of the following two issues. Invoices will be sent after publication.

The charge of $25 for as many as three appearances is far below that made by publications which carry similar advertisements in other subject areas. In the first six years of its existence, EMPLOYMENT INFORMATION has become the standard place for all employment advertisements in the mathematical sciences including statistics, computing, and related subjects. The $25 fee is not expected to eliminate the deficits entirely, but is expected to reduce them substantially.

*The institutions with departments ranked among the top twenty-seven in mathematics are University of California (Berkeley), Harvard University, Princeton University, University of Chicago, Massachusetts Institute of Technology, Stanford University, Yale University, New York University, University of Wisconsin (Madison), Columbia University, University of Michigan (Ann Arbor), Cornell University, University of Illinois (Urbana-Champaign), University of California (Los Angeles), Brandeis University, Brown University, California Institute of Technology, University of Minnesota, University of Pennsylvania, University of Washington, Purdue University, Rockefeller University, Johns Hopkins University, Northwestern University, University of Virginia, University of California (San Diego), and Indiana University.
### BACKLOG OF MATHEMATICS RESEARCH JOURNALS

Information on the backlog of papers for research journals is published in the February and August issues of these journals with the cooperation of the respective editorial boards. Since some columns in the table are not self-explanatory, we include further details on their meaning. When a paper is revised, the waiting time between an editor's receipt of the final revision and its publication may be much shorter than is the case otherwise, so these figures are low to that extent.

(Publication refers to the fact that the journal has actually been received by a subscriber in the Providence, Rhode Island area; in some cases this may be two months later than publication abroad.)

#### Observing Waiting Time: The quartiles give a measure of normal dispersion. They do not include extremes which may be misleading.

<table>
<thead>
<tr>
<th>Journal</th>
<th>Number Issues per Year</th>
<th>Approximate Number Pages per Year</th>
<th>5/31/78</th>
<th>12/15/77</th>
<th>BACKLOG</th>
<th>Estimated Time for Paper Submitted Currently to be Published (In Months)</th>
<th>Observed Waiting Time in Latest Published Issue (In Months)</th>
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*No response received.
**The latest issue consisted of two articles.
***Not computable for this journal.
#Next-to-last-issue: last issue was a conference proceedings and not typical.
##Date of receipt of manuscript not indicated in journal.
###Based on date accepted.
####This journal new to the listing; 1977 figures unavailable.
PERSONAL ITEMS

VICTOR S. ALBIS-GONZÁLEZ has been appointed president of the Universidad de Sucre, Sincelejo, Colombia.

LOKENATH DEBNATH of East Carolina University has been awarded a Fulbright Fellowship and has been appointed to the University Grants Commission visiting professorship at Calcutta University for the summer of 1978. He has also been appointed Managing Editor of the International Journal of Mathematics and Mathematical Sciences.

RICHARD B. HOLMES of Purdue University will be on leave at the Massachusetts Institute of Technology, Lincoln Laboratory, for the coming year.

HOWARD W. LAMBERT of the University of Iowa has been appointed to a visiting professorship at the University of Costa Rica for the period July 1 to November 30, 1978.

VED P. MADAN has resumed the position of Coordinator of Applied Sciences at Red Deer College, Red Deer, Alberta, Canada.

EVERETT PITCHER of Lehigh University has been appointed Consultant to the President of Lehigh University.

NORMAN H. RICKER of the University of Oklahoma received the Distinguished Alumnus Award of the Association of Rice Alumni at Rice University's commencement.

JUSTIN SMITH of Rice University has been appointed to an assistant professorship at the University of Hawaii at Manoa.

RONALD SVERDLOVE of the Claremont Graduate School has been appointed to an assistant professorship at the University of Notre Dame.

PROMOTIONS

To Provost, University of Notre Dame: O. T. O'MEARA.

To Professor, Stevens Institute of Technology: RALPH TINDELL; University of Northern Iowa: HYO CHUL MYUNG; University of Notre Dame: ALAN HOWARD.

To Associate Professor, Lycoming College: JOHN R. HUBBARD; University of Notre Dame: ALEXANDER J. HAHN.

DEATHS

Professor JOAQUIM B. DIAZ of Rensselaer Polytechnic Institute died on June 16, 1978, at the age of 58. He was a member of the Society for 34 years.

Dean Emeritus JAMES R. OVERMAN of Bowling Green State University died on May 22, 1978, at the age of 90. He was a member of the Society for 55 years.

AMS MEMBER'S CHANGE OF ADDRESS OR STATUS NOTIFICATION

Peel off the NOTICES mailing label and place in this space. If you do not have the mailing label, please print your complete name and former zip code in the spaces below.

Mailing address changes result in the automatic deletion of existing Combined Membership List information unless the Society is instructed otherwise. If no institution is provided, your name will appear in the geographic section under the city and state only; if no position is provided, no position will appear in the CML entry.

Name ______________________________ Former Zip Code ________________

CML INFORMATION

Institution or Business __________________ Position __________________

Location of institution or business (city & state only) __________________

MAILING ADDRESS to be used for the CML, all subscriptions, and correspondence

The above is: ☐ Home Address ☐ Institution or Business Address

Date this change becomes effective ____________________________

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SPECIAL MEETINGS INFORMATION CENTER

THIS CENTER maintains a file on prospective symposia, colloquia, institutes, seminars, special years, and meetings of other associations, helping the organizers become aware of possible conflicts in subject matter, dates, or geographical area. The printed lists contain announcements of meetings of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings or symposia devoted to specialized topics. The lists also contain announcements of regularly scheduled meetings of national or international mathematical organizations.

AN ANNOUNCEMENT will be published in these (Nobad) if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the page and issue in which the complete information appeared.

IN GENERAL, SMIC announcements of meetings held in the United States and Canada carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadline dates for abstracts or contributed papers, and name of person to write for further information. Meetings held outside the United States and America may carry more detailed information. Information on the pre-­preliminary planning will be stored in the files, and will be available to anyone desiring information on prospective conferences. All communications on special meetings should be sent to the Special Meetings Information Center of the American Mathematical Society in Providence.

DEADLINES are the same as the deadlines for abstracts. They are listed on the inside front cover of each issue.


AUGUST 1978


6-9. Computers, Communications and Technology Transfer, Jerusalem, Israel. (25, p. 250)


6-10. International Seminar on Functional Analysis, Holomorphy and Approximation Theory, Universidade Federal do Rio de Janeiro, Brazil. (25, p. 65)


12-14. Helsinki Symposium on Integral Equations, Helsinki University of Technology, Helsinki, Finland. (24, p. 375)


21-25. NSF-CBMS Regional Conference on Nonlinear Semigroups and Variational Inequalities, Colorado State University, Fort Collins, Colorado. (25, p. 250)


22-25. IEEE International Conference on Parallel Processing, Shanty Creek Lodge, Bellaire, Michigan. (25, p. 132; 25, p. 250)

25-29. International Symposium on Group Theoretic Methods in Mechanics, Novosibirsk, USSR.


Information: Symposium Committee, Institute of Hydrodynamics, Novosibirsk 630090, USSR.

26-September 2. N.A.T.O. Advanced Study Institute on Polynomial and Spline Approximations with Applications, University of Calgary, Canada. (25, p. 251)


Information: G. Preuss, Institut für Mathematik, Freie Universität Berlin, Hüttenweg 9, D-1000, Berlin 33, Germany.

28-September 1. Eighth Australian Computer Conference, Canberra, Australia. (25, p. 65)


29-September 1. Sixth Australian Conference on Combinatorial Mathematics, Armidale, Australia. (25, p. 132)

30-September 1. International Conference on Finite Elements in Non-Linear Mechanics, The Institute of Statistics and Dynamics, University of Stuttgart, Federal Republic of Germany. (25, p. 251)

SEPTEMBER 1978

3-7. Twelfth European Meeting of Statisticians, Varna, Bulgaria.

Information: B. Penkov, National Committee for Mathematics, P. O. Box 373, 1000 Sofia, Bulgaria.

4-6. Fifth National Systems Conference, Punjab Agricultural University, Ludhiana, India. (February 1978, p. 132)

4-8. Meeting of General Topology, University of Trieste, Trieste, Italy.

Program: The meeting will include general conferences and communications and discussions. The aim is to give an opportunity for a wide exchange of knowledge and problems in general topology.
Invited Speakers: The following will give general conferences: R. Aló (United States), Z. Balogh (Hungary), A. Császár (Hungary), R. Z. Domiaty (Austria), R. Frič (Czechoslovakia) Z. Frolík (Czechoslovakia), D. Kurepa (Yugoslavia), S. Mardešić (Yugoslavia).
Organizing Committee: M. Dolcher, A. Volčič, R. Isler, G. Tironi.

Information: Institute of Applied Mathematics, Faculty of Engineering, University of Trieste, Piazzale Europa 1, 34100 Trieste, Italy.

4-9. First Colloquium on Applied Mathematics, France. (February 1978, p. 133)


Sponsor: The Institute of Mathematics and its Applications.

Program: The course will review general issues in Statistical Education and will consider certain specific issues suggesting use of similar relationships with other subjects and the role of Statistics in Education. There will be invited speakers in these specific areas. Time will be made available for group discussions and plenary sessions.

Invited Speakers: There will be an introduction by the chairman, G. T. Wain of the University of Leeds. Other topics and speakers are: "The Role of Statistics" (A. Smith, University of Nottingham), "Statistics, Mathematics and Other Subjects" (P. Holmes, University of Sheffield), "Simulation in Teaching Statistics" (M. Brown, Chelsea College), "Current Issues in Statistics Education" (V. Barnett, University of Sheffield).


OCTOBER 1978

4-6. Data Networks and Distributed Processing, Darmstadt, Federal Republic of Germany. (25, p. 251)

7-11. CBMS/NSF Regional Conference on the Topology of Manifolds, Oklahoma State University, Stillwater, Oklahoma.
Program: Robert D. Edwards will present ten lectures on the topology of manifolds. Topics include nonmanifold factors of topological manifolds, resolutions of generalized manifolds, mapping cylinder neighborhoods of ANR's, and tame-versus-wild embeddings of various types of compacta in manifolds. In addition there will be a limited number of talks on related topics by invited lecturers.

Principal Lecturer: Robert D. Edwards, University of California, Los Angeles.
Support: Subject to approval by NSF, a limited amount of support for travel and subsistence will be available.
Information: J. W. Maxwell, Department of Mathematics, Oklahoma State University, Stillwater, Oklahoma 74074.


16-20. Conference on Ordered Groups, Boise State University, Boise, Idaho. (June 1978, p. 251)


Invited Speakers: Speakers have been invited to cover areas of interest in each of the two symposia to be held. For the symposium on Mathematical Problems in Energy Research the speakers and topics are: Richard P. Kendall (Exxon Production Research Center), Oil Recovery; Walter S. Liggett, Jr. (Tennessee Valley Authority), Environmental Effects; Shawky E. Shamma (Energy Laboratory, MIT), Magneto-Hydrodynamics Energy Generation; Alan D. Solomon (Union Carbide Corp., Nuclear Division), Energy Storage; William F. Tinney (Bonneville Power Administration), Electrical Power Generation and Transmission; Efi Turkel (Courant Institute of Mathematical Sciences, NYU), Plasma Physics; Burton Wendroff (Los Alamos Scientific Laboratory), Two-Phase Flow. For the symposium on Approximation Theory the speakers and topics are: Bernard Harris (University of Wisconsin), Statistical Approximation; John R. Rice (Purdue University), Numerical Approximation; J. A. Roulier (North Carolina State University), Polynomial and Spline Approximation; Richard S. Varga (Kent State University), Classical Approximation.

NOVEMBER 1978


2-3. SIAM Symposium on Sparse Matrix Computations and their Applications, Knoxville Hyatt Regency Hotel, Knoxville, Tennessee. (June 1978, p. 252)

DECEMBER 1978

4-6. Association for Computing Machinery Annual Conference, Sheraton Park Hotel, Washington, D.C. (February 1979, p. 133)


JANUARY 1979

Program: The Symposium considers fundamental principles and important innovations in the design, definition, and implementation of programming languages. Both practical and theoretical concerns will be covered, and topics may include algorithms and complexity bounds for language processing tasks; automatic programming; error detection and recovery; experimental studies relevant to programming language principles; implementation issues (correctness, efficiency, modularity, portability); language features or characteristics; program certification and documentation; program measurement and optimization; unusual or special purpose languages that raise issues of principle.
Call for Papers: Those wishing to present papers should submit a summary (not a complete paper) explaining their work, including specific findings or results, and specific comparisons with relevant previous work. The committee will consider the appropriateness, clarity, originality, significance, and overall quality of each summary.

Instructions to Authors: Summaries should not contain author name and address; this information should only appear in a cover letter to the chairman. Suggested length of summaries is from 8 to 12 double-spaced typed pages. Seven copies of the summary should be sent to the Program Chairman, Barry K. Rosen, Computer Sciences Department, IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598.

Deadline for Summaries: August 11, 1978. Authors will be notified of acceptance or rejection by September 28, 1978.

Program Committee: Peter J. Downey, David Gries, Derek C. Oppen, Alan J. Perlis, Dennis M. Ritchie, Robert E. Tarjan, Barry K. Rosen (chairman).

Information: Aaron H. Konesl, Department of Computing and Information Sciences, Trinity University, San Antonio, Texas 78284.

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LETTERS TO THE EDITOR

Letters submitted for publication in the Notices are reviewed by the editorial committee whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and the publication of the earliest issue of the Notices in which it could appear. The committee adopted a policy that the Notices does not ordinarily publish complaints about reviews of books or articles, although, following an instruction from the Council, rebuttals and correspondence concerning reviews in the Bulletin will be considered for publication. Letters submitted for consideration by the editorial committee should be mailed to the Editor of the Notices, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

Our original invitation was extended in the spirit of cooperation with the mathematical community. In the same spirit, we now urge the officers of the AMS and the MAA to seek another location for the 1979 Summer Meeting. We at VPI & SU do not believe it would be a service to host a meeting that would not be well received. Furthermore, this University has no desire to be an innocent third party in a dispute over which it has no control.

We trust that the Society and the Association will have a successful 1979 Summer Meeting at a different university. We hope that some future invitation by VPI & SU will be accepted in the same gracious manner that the last invitation was originally accepted.

One final thought. In the future, I hope the AMS will either avoid political issues or ensure that every member be given an opportunity to vote on such issues.

C. Wayne Patty, Head Department of Mathematics Virginia Polytechnic Institute and State University
Editor, the Notices

I read with interest the announcement in the April issue of the Notices (pp. 200-201) of a 50 percent membership dues increase for 1979. The higher cost of publishing the Bulletin of the AMS was given as one reason for the necessity of a dues increase. I disagree with the position of the Committee on Publication Problems, the Council, and the Board of Trustees that the Bulletin should be kept as a privilege of membership. I have yet to find an article or paper in the Bulletin which could be useful to me.

However, if the consensus of the members and their representatives is to keep the Bulletin as a privilege of membership, then I plead for the opportunity to avoid receiving it. On previous occasions I have requested that copies of the Bulletin not be sent to me, hoping thereby to save the Society some publication costs. Unfortunately, I still receive the Bulletin.

I suggest that perhaps a large number of members would, like myself, be happy to donate to the Society, with no strings attached, the privilege of receiving the Bulletin. Therefore, I request that the AMS membership renewal form and/or procedure be modified to allow one to choose whether or not to receive the Bulletin. It should be made clear that not receiving the Bulletin will not reduce one's dues. In my opinion this would enable the Society to save a significant amount in publication costs and thereby would lessen the overall dues increase which is necessary.

Joseph S. Crowell
Oak Ridge, Tennessee

COMMENT: Members of the Society who are dissatisfied with the Bulletin as it has been, are urged to examine critically the six issues of the Bulletin/New Series of 1979. There are two major changes to be made that will alter the journal materially. One is in the institution of a series of research expository articles. The other is in the policy and operating procedures for research announcements. For a more detailed account, see p. 126 of the February 1978 issue of these Notices.

Editor, the Notices

The ugly neologism "indeterminant", which I first noticed creeping into mathematical papers and textbooks about six years ago, is becoming more and more widespread. It is plainly a careless corruption of "indeterminate", a perfectly appropriate mathematical term with impeccable etymology. Not only is "indeterminant" superfluous, it is offensive because it suggests some connection with the unrelated concept "determinant".

Phillip Schultz
University of Western Australia

Editor, the Notices

We have sent the following letter to Ambassador Anatoliy F. Dobrynin [of the Union of Soviet Socialist Republics]:

"Dear Ambassador Dobrynin:

It is with deep regret that we wish to inform you that we have cancelled a proposed trip to your country immediately following the International Mathematical Congress in Helsinki next August.

We have been looking forward to this opportunity to visit some of your universities and to meet with some of your scientists. However, the events of last week which terminated in the sentencing of Professor Yuri Orlov to seven years of hard labor and five years of Siberian exile for his concern for the lack of Soviet compliance with the human rights provisions of the 1975 Helsinki Accord make this impossible.

We feel sure that we are not alone in our reaction to these unfortunate developments and we hope that you will communicate this concern to your government."

D. H. Lehmer
Emma Lehmer
University of California, Berkeley

MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY

ON THE NUMBER OF SIMPLY CONNECTED MINIMAL SURFACES SPANNING A CURVE
by A. J. Tromba

The classical problem of Plateau is studied from the point of view of global nonlinear analysis. It is shown that minimal surfaces of the topological type of the two disc arise as the zeros of a Fredholm vector field on an infinite dimensional manifold. A framework is developed to prove the finiteness of solutions for an open and dense set of curves and to count the number of such solutions according to sign, although the complete results in this direction are not proved in this paper.

Number 194
121 pages; list $7.60; member $5.70
ISBN 0-8218-2194-6; LC 77-12180
Publication date: November 30, 1977
To order, please specify MEMO/194

Prepayment is required for all American Mathematical Society publications.

Send for the book(s) above to: AMS, P. O. Box 1571, Annex Station, Providence, RI 02901
MATHEMATICIANS HONORED BY WOLF FOUNDATION

Izrail' Moiseeviĉ Gel'fand, professor at the University of Moscow, and Carl Ludwig Siegel, professor emeritus at the University of Göttingen, shared a $100,000 prize awarded April 10, 1978, by the Wolf Foundation of Israel for outstanding contributions to science. The award ceremony was held in the Knesset, Professor Gel'fand was honored for his work on functional analysis and group representation, and for many original contributions to mathematics. Professor Siegel was recognized for his achievements in the areas of theory of numbers, theory of several complex variables, and celestial mechanics.

The Wolf Foundation was established in 1976, with an endowment of $10 million, for the purpose of promoting science and art throughout the world for the benefit of humanity. Income from the capital is used to award annual prizes in five fields of science and the arts, as well as to grant scholarships and to support scientific research. Scientific prizes are awarded to researchers in the areas of agriculture, chemistry, medicine, and physics, as well as in mathematics.

A report in The New York Times, April 17, 1978 contains the following passage:

"The prize was established in 1976 with an endowment of $10 million creating the Wolf Foundation pursuant to legislation passed by the Knesset the previous year. While it was announced that the prize pertained to 'the Wolf family, whose members are at present scattered throughout the world,' the benefactor was not named.

"Last week, however, the press in Israel identified him as Dr. Riccardo Sobirana y Lobo, born in Germany as Richard Wolf and now a resident of Israel. According to an account by Reuters, he became a millionaire through his innovations in steel manufacture and was a friend of President Fidel Castro of Cuba and of the Cuban Ambassador to Israel.

"The ceremony, at which he was present, was boycotted by Israel's President, Emphraim Katzir, and members of the Israeli Academy of Sciences, according to Reuters, because they believed the money should be used to aid young Israeli scientists rather than those who have already achieved fame elsewhere."

AMS RESEARCH FELLOWSHIP FUND
Request for Contributions

The AMS Research Fellowship Fund was established in 1973 because of the scarcity of funds for postdoctoral fellowships. From this fund AMS Research Fellowships are awarded annually to individuals who have received the Ph.D. degree, who show unusual promise in mathematical research, and who are citizens or permanent residents of a country in North America. Currently each fellowship carries a partially tax-exempt stipend of $11,000.

Fourteen Research Fellowships have been awarded including five granted for 1978–1979 (see the announcement in the June 1978 Notices, p. 254). The number of fellowships awarded depends, of course, on the contributions the Society receives. The Society itself contributes a minimum of $9,000 to the Fund each year, matching one-half of the funds in excess of $18,000 raised from other sources, up to a total contribution by the Society of $20,000. It is hoped that every member of the Society will contribute to the Fund.

Contributions to the AMS Research Fellowship Fund are tax deductible. Checks should be made payable to the American Mathematical Society, clearly marked "AMS Research Fellowship Fund", and sent to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, Rhode Island 02901.

AMS RESEARCH FELLOWSHIPS
Invitation for Applications

In order to announce the 1979–1980 AMS Research Fellowship Awards in February 1979, the application deadline has been set at December 31, 1978 one month earlier than in previous years. In addition the stipend has been increased to $11,000 (part of which is tax-exempt) plus an expense allowance of $500.

These postdoctoral fellowships will support research in mathematics during the academic year 1979–1980, and are open to individuals who have recently received the Ph.D. degree, regardless of age, and who are citizens or permanent residents of a country in North America. Recipients of the fellowships may not hold another grant or salaried position concurrently with the Research Fellowship.

For further information and application forms, write to Dr. William J. LeVeque, Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

ERRATUM

The title of James C. Goodwin, author of the article Affirmative Distractions, reprinted in the June 1978 issue of these Notices, was given incorrectly in the Report of the Ad Hoc Committee on Affirmative Action Procedures (page 237). It should have been Assistant to the Vice-President—University and Student Relations.
AMERICAN ACADEMY
OF ARTS AND SCIENCES

One hundred and seven scholars, scientists, public figures, and artists have been elected to membership in the American Academy of Arts and Sciences. Of the seven mathematicians elected, the following are members of the Society: Eugene B. Dynkin, Cornell University; Walter Feit, Yale University; David Gale, University of California, Berkeley; Barry C. Mazur, Harvard University; George D. Mostow, Yale University; and William P. Thurston, Princeton University.

In addition there were twenty-six foreign honorary members elected, of whom three were mathematicians: Pierre Deligne, Kunihiko Kodaira, and Herman Wold.

AMS-SIAM COMMITTEE ON
APPLIED MATHEMATICS

Each year the AMS-SIAM Committee on Applied Mathematics makes recommendations for symposia in Applied Mathematics to be held in conjunction with an AMS or SIAM meeting, and for Summer Seminars in Applied Mathematics to be held at different universities. The symposia are held annually and usually last two days. In April 1978, the topic was "Nonlinear oscillations in biology" with R. Burridge as chairman of the Organizing Committee. The Summer Seminars are held every other summer and are of two to four weeks duration. In June 1978, a two-week seminar on "Nonlinear oscillations in biology" was held at the University of Utah. Proceedings of the Symposia are published in the series SIAM-AMS Proceedings; lectures given at the Summer Seminars are published in the Lectures in Applied Mathematics series.

The AMS-SIAM Committee on Applied Mathematics would be very pleased to receive suggestions for topics for future symposia and seminars. Suggestions can be sent to any member of the committee or directly to the Committee Chairman: F. C. Hoppensteadt, Department of Mathematics, University of Utah, Salt Lake City, Utah 84112. The members of the committee are: D. J. Benney (Massachusetts Institute of Technology); Edward L. Reiss (Courant Institute of Mathematical Sciences); Martin Schultz (Yale University), and David Siegmund (Stanford University).

CUMULATIVE INDEX TO
MATHEMATICS OF COMPUTATION

The Cumulative Index to Mathematics of Computation, Volumes 1–23, 1943–1966 was described incorrectly in the April issue of these Notices, page 208. The title given there is incomplete, and the name of one of the authors was omitted. The authors of the Index are Yudell L. Luke, Jet Wimp, and Wyman Fair, who devised a classification scheme with over 200 categories and subcategories for the author and subject indexes which cover a 27-year span of the journal. The journal was called Mathematical Tables and Other Aids to Computation prior to 1960, and was published by the National Research Council from 1943 to 1961. It contains a variety of types of information, a fact which offered a special challenge for the authors of the cumulative index. In addition to research articles, there are reviews of articles and books, descriptions of tables in the UMT (unpublished mathematical table) file, errata, queries and replies, and supplementary microfiche included in a pocket in the back of many of the issues. The American Mathematical Society took over publication of Mathematics of Computation in 1962.

The 27-year Cumulative Index (xvii + 461 pp.) may be ordered from the Society, P.O. Box 1571, Annex Station, Providence, R.I. 02904. The price is $19.95 list, $9.98 member. Please refer to code MCOMIN/1 and include payment with your order.

A NEW INTERNATIONAL JOURNAL

A new journal, the International Journal of Mathematics and Mathematical Sciences, began publication in March 1978 under the joint sponsorship of the Calcutta Mathematical Society and East Carolina University. The new quarterly publishes original research papers, short research notes, book reviews and broad expository and survey articles (with or without original research contribution) with emphasis on unsolved problems, controversial issues and open questions in all branches of Mathematics and Mathematical Sciences.

Further information may be obtained from Lokenath Debnath (Managing Editor), Mathematics Department, East Carolina University, Greenville, North Carolina 27834.

KEY WORD INDEX

AMS (MOS) Subject Classification Scheme (1970)

The Mathematical Library of the University of Ljubljana, Yugoslavia, has prepared a comprehensive key word index to the AMS (MOS) Subject Classification Scheme (1970).1 The index is published in a 96-page, 20 x 28 cm, booklet. Each significant word used in the classification scheme is listed along with the subject number and the full text of the line in which it appears. Copies may be ordered by paying $15 for each to account no. 32009-007-900 (for Kosmija za tisk DMFA SRS, Ljubljana) at Ljubljanska banka, Ljubljana, Yugoslavia. Inquiries may be made to:

Mr. Ciril Velkovrh, Librarian
Department of Mathematics
University of Ljubljana
61001 Ljubljana
Jadranska c. 19, pp 543
Yugoslavia

1The AMS (MOS) Subject Classification Scheme (1970) was prepared with support from the National Science Foundation under GN-857.
NAS EXCHANGE PROGRAMS

USSR and Eastern Europe

The National Academy of Sciences (NAS) has announced the continuation of its scientific exchange programs with the academies of sciences of the USSR and Eastern Europe for the academic year 1979-1980. U. S. scientists may apply for visits of one to twelve months to the USSR, Bulgaria, Czechoslovakia, Hungary, Poland, Romania, or Yugoslavia. Application materials will be available from the NAS until November 3, 1978. The completed application must be submitted by November 17, 1978. For more information write to: Section on USSR and Eastern Europe, Commission on International Relations, National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

During the academic year 1977-1978 the program sponsored 126 exchange visits including 58 made by U. S. citizens to Europe and 68 made by Soviet and Eastern Europe scientists to the United States. Of the 126 exchange scientists, eleven were mathematicians. The following members of the Society participated in the exchange: Jerry L. Bona (University of Chicago), Frank B. Cannonito (University of California, Irvine), Thomas J. Jech (Pennsylvania State University), Mark Kac (Rockefeller University), Richard J. Libera (University of Delaware), David J. Lutzer (Texas Tech University), Manojo Maravic (University of Sarajevo, Yugoslavia), Sanford S. Miller (SUNY, Brockport), and George M. Reed (Ohio University, Athens).

German Democratic Republic

Applications are invited immediately for participation in a new exchange program being negotiated by the National Academy of Sciences with the Academy of Sciences of the German Democratic Republic (GDR) to commence in the fall of 1978. It is anticipated that the program will be similar to the existing NAS exchange programs with Eastern European academies, being open to scientists at the postdoctoral level who are U. S. citizens, and being open for one-month lecture and survey visits and three- to twelve-month research visits, with all necessary costs for participants to be covered by the two academies. Participants will be selected on the basis of merit in an annual competition.

Prospective participants are invited to request current information and application forms as soon as possible from: Section on USSR and Eastern Europe, Commission on International Relations, National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

QUERIES

Edited by Hans Samelson

QUESTIONS WELCOMED from AMS members regarding mathematical matters such as details of, or references to, vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures.

REPLIES from readers will be edited, when appropriate, into a composite answer and published in a subsequent column. All answers received will ultimately be forwarded to the questioner.

QUERIES AND RESPONSES should be typewritten if at all possible and sent to Professor Hans Samelson, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

○ QUERIES

155. F. S. Cater (Department of Mathematics, Portland State University, Portland, Oregon 97207). Let $E$ be a measurable subset of the interval $(0, \infty)$, let $f$ be a nonnegative function on $(0, \infty)$. Put

$$K_-(f, E) = \lim_{x \to \infty} \inf f \int_{(0,x) \cap E} f,$$

$$K_1(f, E) = \lim_{x \to \infty} \sup f \int_{(0,x) \cap E} f.$$ 

In particular,

$$K_{-1}(f, E) = \lim_{x \to \infty} \inf m(0, x) \cap E$$

and

$$K_1(1, E) = \lim_{x \to \infty} \sup m(0, x) \cap E$$

where $m$ denotes Lebesgue measure.

What are $K_+(f, E), K_+(f, E), K_{-1}(1, E), K_+(1, E)$ called? Are there any references on these concepts?

156. John Hays (Naval Research Laboratory, Code 2364, Washington, D.C. 20390). Definition. Given $n = \Pi q_i^{m_i}$ and $f/n$, $f$ is $r$-rich in $n$ iff $d(r) = \Pi q_i^{m_i}$, where $q_i$ is a $p_i$ of $n$, $r$ is nonsquare-free; $d(r)$ is the density of $r$-richness in $n$, iff $d(r)$ measures the number of factors $f$ that are $r$-rich in $n$. (For $n$ square-free, the densities are the binomial coefficients; for all $m_i$ equal, the densities are the multinomial coefficients.) For any $n$, the densities may be derived from a generating function, as in Liu, Introduction to combinatorial mathematics, or by multiplication with detached coefficients.

Problem. Is there a factorial formula generating the densities for any $n_i$ of which the binomial and the multinomial are special cases?

○ RESPONSES

The replies below have been received to queries published in recent issues of these Notices. The editor would like to thank all who have replied.

124. (vol. 24, p. 271, August 1977, Golan; vol. 24, p. 387, October 1977, response by E. Rosenthal): references to computer programs in advanced topics (algebras, etc.). Three bibliographies have recently appeared in SIGSAM Bulletin, a publication of the Special Interest Group on Symbolic and Algebraic Manipulation of the Association for Computing Machinery:
years ago I warned my advanced calculus class that L'Hôpital's rule has a two-variable version 140. (vol. 25, p. 145, February 1978, Miller; on L'Hôpital's rule for several variables.) In reply to Jay I. Miller's Query, five years ago I warned my advanced calculus class that L'Hôpital's Rule does not apply to functions of several variables except where substitution or separation of variables reduces it to a single-variable problem. One student ignored my warning and "successfully" used it on a two-variable limit. While seeking an example to show he was just "lucky" I discovered the following two-variable version (1/0 = 0/0) (xy) = ln(1 + xy)/sin x → 0 as (x, y) → (0, 0) in S since y/(1 + xy)cos x → 0. Likewise, ln(1 + xy)/sin y → 0 as (x, y) → (0, 0) in S 2 since 2cos θ sin θ/(1 + cos 2 θ sin θ) → 0 uniformly in θ as r → 0. Note that neither rule applies to examples in cartesian form and the polar limit at the pole requires the uniform version. Each could be solved by one-variable methods: multiply by xy/xy, substitute x = xy in part and/or change to polar form, but the above seems simpler.

One can also show f/g → L as (x, y) → (0, 0) in R 2 if either f 1/g 1 or f 2/g 2 does, |g| → ∞ and f, g are continuous in a deleted neighborhood of (0, 0). All proofs differ little from the one-variable case. The results adapt to limits at other than (0, 0), of course, and Y can be any set of points where the limit w.r.t. x of both f and g is zero as long as it meets any neighborhood of (0, 0) in a set whose projection on the y-axis contains a neighborhood of zero.

I would be interested in other replies to this query, if any. (Contributed by D. E. Sanderson)

142. (vol. 25, p. 197, April 1978, Knoebel; the infinite iteration of x^x, far and away the most popular question.) The first treatment of this appears to be by Euler: De formulis exponentialibus replicatis, Acta Acad. Sci. Imp. Petropolitanae (1777). (Contributed by Gabriel Klambauer; other contributors: S. Bochner, J. Elstrodt, A. P. Guinand, R. Arthur Knoebel, D. M. Rosenblum, Emilie State, G. Szekeres)

AMS TRANSLATIONS—SERIES 2

TOPOLOGICAL SEMIFIELDS AND THEIR APPLICATIONS TO GENERAL TOPOLOGY by M. Ja. Antonovskii, V. G. Boltjanskii and T. A. Sarymsakov

This book consists for the most part of results that are not strictly new. The goal of the authors is to bring series of heterogeneous questions and problems of general topology under one unifying concept. They have named this concept topological semifields. There is a rather detailed study of the concept of a semifield and also the concept of a topological Boolean algebra, which is closely connected with it.

This volume is based on three monographs from Soviet literature, Topological Boolean algebras and A sketch of the theory of topological semifields, written by all three authors, and Tihonov semifields and certain problems in general topology, by M. Ja. Antonovskii and V. G. Boltjanskii.

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  - Everett Pitcher
  - Kenneth A. Ross 1978
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  - William Browder 1978
  - Linda Preiss Rothschil 1978
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  - Linda Preiss Rothschil 1978
- **Committee on Nominating**
  - Peter D. Lax 1978

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- **NOTICES, Editorial Committee**
  - Ed Dubinsky 1978
  - Barbara L. Osofsky 1978
  - Lincoln K. Darst (ex officio) 1960
  - George Piranian 1960
  - Robson C. Kirby 1960
  - Everett Pitcher, chairman (ex officio) 1960
  - Arthur P. Mattuck 1960
  - Scott W. Williams 1978

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  - Cathleen S. Morawetz 1979
- Robert P. Langlands 1960
  - David Mumford 1961
- Richard K. Lashof 1980
  - Gian-Carlo Rota 1981
- Henry P. McKean, Jr. 1961
  - I. M. Singer, chairman 1981
- Hugh L. Montgomery 1960
  - Elias M. Stein 1979

**Research Expository Journal, Editorial Committee for the**

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- Felix E. Browder, chairman 1980
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- Morton L. Curtis, John T. Tate 1979
- Frederick W. Gehring 1979

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  - Barbara L. Osofsky 1980
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  - Everett Pitcher (ex officio) 1978
  - George D. Mostow 1978
  - Harold M. Stark 1978
  - Donald S. Ornstein 1980

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  - Jack C. Kieler 1979
- Hyman Bass 1978
- James M. Greenberg 1979

**Far Western Sectional Meetings, Committee to Select Hour Speakers for**

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  - Rimhak Ree 1979
- David M. Goldschmidt 1978
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  - Robert B. Gardner, chairman 1978
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- Barbara L. Osofsky 1978
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- **Academic Freedom, Tenure, and Employment Security, Committee on**
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  - Saul H. Bote 1978
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  - Alan J. Goldman 1980
  - Robert J. Thompson 1979
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- Morton L. Curtis, chairman
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In this memoir we discuss the existence and the asymptotic behavior of solutions of the singularly perturbed boundary value problem $cy'' = F(t, y, y')$, $a < t < b$, $y(a, e), y(b, e)$ prescribed, as $\epsilon \to 0^+$ for functions $F$ which grow at most quadratically with respect to $y'$. We also consider in detail the relationship between nonuniform convergence at $t = a$ and/or $t = b$ (that is, boundary layer behavior) and nonuniform convergence at points in $(a, b)$ (that is, interior layer behavior). Our results present a clear coherent explanation for some of the anomalies displayed by solutions of these problems such as shock layers, nonexponential boundary layers and singular layers.

PROCEEDINGS OF THE STEKLOV INSTITUTE
(ISSN 0081-5438)

INTERNATIONAL CONFERENCE ON MATHEMATICAL PROBLEMS OF QUANTUM FIELD THEORY AND QUANTUM STATISTICS. PART I.
AXIOMATIC QUANTUM FIELD THEORY
edited by V. S. Vladimirov

Number 135 (1975)
264 pages
List price $50.00; member price $37.50
ISBN 0-8218-3035-X; LC 78-6757
Publication date: August 31, 1978
To order, please specify STEKLO/135

This collection consists of some of the papers presented at the International Conference on Mathematical Problems in Quantum Field Theory and Quantum Statistics in Moscow in December 1972. The papers assembled here are devoted to various aspects of axiomatic quantum field theory.

Authors and articles included are:
V. A. Alebastrov and G. V. Efimov, On the construction of a nonlocal quantum field theory
H. Araki, Relative Hamiltonian for states of von Neumann algebras
N. N. Bogolubov, V. S. Vladimirov and A. N. Tavikelidze, On automodel asymptotics in quantum field theory
J. Bros and D. Isgolntzer, Causality and local analyticity: General results and some applications to quantum field theory
V. S. Vladimirov, Analytic functions of several complex variables and quantum field theory
J.-L. Bonnard and R. F. Streater, Local gauge models predicting their own superselection rules
M. K. Volkov, Exponential interaction of scalar massless fields (third order)
I. Ya. Arefieva, A. K. Pogrebkov, V. N. Sushko and I. V. Volovich, The renormalized Hamiltonian, the local fields, and the scattering theory for some translationally-invariant models of quantum field theory
J. Glimm, Particles and fields
S. Doplicher, Locality and particle statistics
C. Morette Dewitt, Feynman's path integral
O. I. Zavialov, Renormalization and the indefinite metric
Yu. M. Zinoviev, S. S. Horuzhy and V. N. Sushko, Equivalence properties of coherent superselection sectors and the description of physical symmetries in algebraic axiomatic theory
G. Sommer, On the dynamical content of two-particle structure, positivity, crossing symmetry, and analyticity
E. R. Caianiello, On the analytic renormalization of Green's functions
John R. Klauder, Ultralocal approach to quantum field theory: A survey of present results
G. Lassner and A. Uhlmann, On \( \text{Op}^* \)-algebras of unbounded operators
H. Lehmann, Chiral-invariant field theory and pion-pion scattering
A. Lichnerowicz, Quantum field theory on a curved manifold
B. V. Medvedev and A. D. Suhанov, \( T \)-products in Bogoljubov's axiomatics
K. Pohlmeyster, Higher order perturbation theory of exponential Lagrangians: fourth order
J. E. Roberts, Must there be a gauge group?
A. A. Slavnov, Renormalization of theories with nontrivial internal symmetry group
L. D. Faddeev, Differential-geometric structures and quantum field theory
M. Flato, J. Simon and D. Sternheimer, Remarks on axiomatic quantization of the gravitational field
A. S. Holevo, Mathematical problems in the theory of quantum channels
Ju. M. Sirokoy, Covariant expansions for field commutators at equal-time points
O. Steinmann, Scattering of infraparticles
B. Schroer, Review on recent progress in renormalization theory.

AMS TRANSLATIONS—SERIES 2
(ISSN 0065-9290)
NINE PAPERS ON ANALYSIS
Volume 111
224 pages
List price $26.00; member price $19.50
ISBN 0-8218-3061-9; LC 78-5442
Publication date: August 31, 1978
To order, please specify TRANS2/111

This volume contains nine papers on analysis. Authors and articles included are:
D. E. Men'sov, On limits of indeterminacy of partial sums of universal trigonometric series
D. E. Men'sov, On limit functions of trigonometric series
D. E. Men'sov, Universal sequences of functions
I. C. Gohberg and N. Ja. Krupnik, On the quotient norm of singular integral operators
I. C. Gohberg and N. Ja. Krupnik, On composite linear singular integral operators
V. M. Adamjan, D. Z. Arov and M. G. Krein, Infinite Hankel block matrices and related extension problems
A. D. Lja8ko and M. M. Karčevski, Study of difference schemes for nonlinear equations by a variational method
Petr Mandl, Foundations of multistage system optimization
I. M. Gel'fand, V. S. Gurfinkel' and M. L. Cetlin, On control tactics for complex systems and their relation to physiology.

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BOUNDARY VALUE PROBLEMS
OF MATHEMATICAL PHYSICS. IX

In this collection V. A. Solonnikov continues his investigations on overdetermined boundary value problems of elliptic type. In his paper the solvability of such problems is established in a broad scale of function spaces introduced by K. K. Golovkin (the so-called fractional spaces). Along the same lines, the paper by S. Sahaev studies an overdetermined problem of parabolic type arising in magnetohydrodynamics. In the paper by Sahaev and Solonnikov unique local solvability in the class of smooth functions is established for an initial-boundary value problem in magnetohydrodynamics. Unique solvability of this and two other problems in magnetohydrodynamics in certain classes of generalized solutions was proved earlier by Ladyženskaja and Solonnikov. Some generalizations of the system of Navier-Stokes equations are given by A. P. Os'kol'kov, establishing a number of estimates for solutions of these systems.

Quasilinear equations of elliptic type are studied in the papers of A. V. Ivanov and A. L. Treskunov. L. Stupjalis investigates unique solvability of initial-boundary value problems for equations of mixed type.

The papers by N. K. Korenev concern the grid method.

Number 127 (1975)
179 pages
List price $25.60; member price $19.20
ISBN 0-8218-3027-9; LC 67-6187
Publication date: June 30, 1977
To order, please specify STEKL0/127

THEORY OF FUNCTIONS
AND ITS APPLICATIONS

The collection begins with a review of the scientific activity of Academician S. M. Nikol'skii. This review reflects his fundamental results in the theory of approximation of functions, functional analysis, imbedding of function spaces and its applications, and Nikol'skii's outstanding role in training scientific personnel is evidenced.

The collection contains papers by colleagues, students and disciples of Nikol'skii, representing original scientific research in the theory of functions of one and several variables, as well as applications to differential equations.

Number 134 (1975)
458 pages
List price $50.00; member price $37.50
ISBN 0-8218-3034-1; LC 77-10017
Publication date: October 31, 1977
To order, please specify STEKL0/134

APPROXIMATIONS OF FUNCTIONS
AND OPERATORS

This collection consists of original papers devoted to the investigation of approximations of functions and operators, and related problems. Approximations of functions by splines (N. L. Zmatrakov, N. I. Cernyh) are studied, as well as interpolation in the mean by splines (Ju. N. Subbotin). The cycle of papers by V. V. Arestov and N. P. Kupcov is devoted to the approximation of operators, to Kolmogorov's inequality in $L_2[0,\infty)$ and to the dual problem of approximating a class by a class. The collection will be of interest to workers in the area of approximation theory and also to specialists in computational mathematics.

Number 138 (1975)
211 pages
List price $28.80; member price $21.60
ISBN 0-8218-3038-4; LC 77-8940
Publication date: October 31, 1977
To order, please specify STEKL0/138

Prepayment is required for all American Mathematical Society publications.
Send for the book(s) above to: AMS, P.O. Box 1571, Annex Station, Providence, RI 02901
REPORT OF THE TREASURER

The Treasurer this year again presents to the membership an abridged statement of the financial position of the Society, in semi-informal narrative style. A copy of the Treasurer's Report, as submitted to the Trustees and the Council, will be sent from the Providence Office to any member who requests it from the Treasurer. The Treasurer will be happy to answer any questions members may wish to put to him concerning the financial affairs of the Society.

I. A DESCRIPTION OF THE FINANCIAL POSITION OF THE SOCIETY AS OF DECEMBER 31, 1977

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Society had cash on deposit in the Rhode Island Hospital Trust Company</td>
<td>$ 29,367</td>
</tr>
<tr>
<td>Petty cash and drawing accounts</td>
<td>$ 30,352</td>
</tr>
<tr>
<td>It had investments in its agency account</td>
<td>$ 3,702,520</td>
</tr>
<tr>
<td>There was owing to it by members, subscribers, and others (less allowance for doubtful accounts)</td>
<td>$ 217,363</td>
</tr>
<tr>
<td>It had prepaid expenses and deposits</td>
<td>$ 61,688</td>
</tr>
<tr>
<td>It had invested in the headquarters building, Mathematical Reviews editorial offices, a computer, and other equipment</td>
<td>$ 1,024,845</td>
</tr>
<tr>
<td>Making a total of current and fixed assets of</td>
<td>$ 5,036,768</td>
</tr>
<tr>
<td>The Society also held investment securities and uninvested principal cash valued at</td>
<td>$ 1,557,011</td>
</tr>
<tr>
<td>(The approximate market value December 31, 1977 was $1,518,264.00)</td>
<td></td>
</tr>
<tr>
<td>Total assets, therefore, were</td>
<td>$ 6,593,779</td>
</tr>
</tbody>
</table>

Offsetting these assets, the Society had

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts payable</td>
<td>$ 571,373</td>
</tr>
<tr>
<td>Deferred payments of publication charges</td>
<td>$ 51,137</td>
</tr>
<tr>
<td>Reserved unearned dues and subscriptions</td>
<td>$ 2,642,027</td>
</tr>
<tr>
<td>Other miscellaneous liabilities</td>
<td>$ 162,896</td>
</tr>
<tr>
<td>Funds and grants received from various sources to support particular projects such as the summer institute, symposia, etc.</td>
<td>$ 48,472</td>
</tr>
<tr>
<td>A surplus in its publication funds</td>
<td>$ 1,295,458</td>
</tr>
<tr>
<td>Its general fund reflected a surplus balance of</td>
<td>$ 1,343,930</td>
</tr>
<tr>
<td>Thus, accounting for all the current funds</td>
<td>$ 265,405</td>
</tr>
<tr>
<td>The invested funds represent the following:</td>
<td>$ 5,036,768</td>
</tr>
<tr>
<td>1. The Endowment Fund, largely the gifts of members.</td>
<td>$ 100,000</td>
</tr>
<tr>
<td>2. Robert Henderson Endowment Fund</td>
<td>$ 548,223</td>
</tr>
</tbody>
</table>

(Continued on next page)
3. Joseph Fels Ritt Memorial Fund ............... 22,521
4. The Library Proceeds Fund, derived from the sale of
the Society's library in 1959 ................... 66,000
5. The various prize funds ....................... 162,431
6. Dues and publication reserve fund ............. 87,777
7. Mathematical Reviews subscription reserve fund . 80,000
8. Undistributed net gains on investment transactions .. 359,598
9. Friends of Mathematics Fund ................... $ 9,323
10. Other funds, derived mainly from bequests to the
Society by members, which Trustees were either
required to invest or which they have invested at
their option, the income being used for the general
purposes of the Society ............................ 121,138

A total of invested funds of ..................... 1,557,011
Total liabilities and fund reserves, therefore, were ............. $ 6,593,779

II. AN ACCOUNT OF THE FINANCIAL TRANSACTIONS OF THE SOCIETY
DURING THE FISCAL YEAR ENDED DECEMBER 31, 1977

The Society has two types of receipts: funds for special purposes and projects; and general funds,
from which are met the general operating expenses, including the publication of the Bulletin, the Proceedings, Mathematics of Computation, the Notices, Current Mathematical Publications, Mathematical Reviews, and the Transactions.

To meet its general obligations, the Society received from

Dues and contributions of individual members .......... $ 332,071
Dues of institutional members ........................ 146,175
Dues of corporate and associate members ............. 4,350

482,596

Less amount allocated to Notices and Bulletin .......... 360,027 $ 122,569
Sales of Society journals ........................... 2,797,374
Investments and trusts ............................. 204,455
Publication contributions ........................... 80,204
Miscellaneous sources .............................. 97,935

Total general receipts .............................. 3,302,537

These funds were expended for Publication of Society journals 2,707,911

Net transfers to special and publication funds, including support of membership services and costs of meetings 192,692

Miscellaneous ...................................... 179,680

Total general expenses and transfers ................... 3,080,283

Net Income added to general funds ................... $ 222,254

Respectfully submitted,

FRANKLIN P. PETERSON
Treasurer
REPORTS OF MEETINGS

THE MARCH MEETING IN NEW YORK

The seven hundred fifty-fourth meeting of the American Mathematical Society was held at the Biltmore Hotel, Madison Avenue at 43rd Street, New York City, on Thursday and Friday, March 30 and 31, 1978. There were 307 registrants including 248 members of the Society.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there were five invited one-hour addresses and seven special sessions. Two invited addresses and a special session devoted to the theme "Functional analysis in mathematical physics" were presented on Thursday, March 30. ARTHUR JAFFE, Harvard University, spoke on "Introduction to gauge fields"; he was introduced by Bertram Kostant, BARRY SIMON, Princeton University, lectured on "Spectral analysis of Schrödinger operators"; he was introduced by James G. Glimm, JAMES G. Glimm and ARTHUR WIGHTMAN organized the related special session on Applications of functional analysis to mathematical physics; the speakers were David Brydges, Volker Enss, Bertram Kostant, Elliot Lieb, Joel L. Lebowitz, Vladimir Scheffer, Erhard Seiler, and Eugene Trubowitz. RONALD G. DOUGLAS, SUNY Center at Stony Brook, lectured on "Equivalence of operators on Hilbert space." He was introduced by Lewis A. Coburn. In conjunction with this lecture, LEWIS A. COBURN organized a special session on Operator theory and several complex variables; the speakers were Charles A. Berger, Louis Boutet de Monvel, Alexander Dynin, P. R. Garabedian, N. Kerzman, Adam Koranyi, R. Michael Range, and E. M. Stein. ALAN DURFEE, University of Washington and Columbia University, gave an invited address entitled "Topological algebras and analysis"; he was introduced by Richard C. Randell, To accompany this address, a special session was organized by RICHARD C. RANDELL on Topology of varieties and singularities; the speakers were Igor Dolgachev, Martin Golubitsky, Henry C. King, Anatoly S. Libgober, Richard Mandelbaum, Linda A. Ness, Lee Rudolph, Kai Wang, and John W. Wood. OVED SHISHA, University of Rhode Island, gave an invited address on "Dominant and simple integrability: Advances in the theory and numerical analysis of improper integrals." He was introduced by Harry W. McLaughlin who organized a related special session on Approximation of functions and integrals, for which the speakers were Alexis Bachelis, Seymour Haber, H. W. McLaughlin, Charles F. Odgoood, T. J. Rivlin, John A. Roulier, Arthur H. Stroud, and Ricardo Zalik. JEFFREY COOPER of the University of Maryland organized a special session on Scattering theory; the speakers were Jeffrey Cooper, Percy A. Deift, Richard B. Lavine, R. B. Melrose, Cathleen S. Morawetz, Martin Schechter, Walter A. Strauss, and Peter Wolfe. LOWELL SCHOENFELD of SUNY Center at Buffalo organized a special session on Analytic and computational number theory; the speakers included Enrico Bombieri, Harold G. Diamond, P. X. Gallagher, Hugh L. Montgomery, Andrew Odlyzko, Daniel Shanks, H. P. F. Swinerton-Dyer, and Peter J. Weinberger. CHOY-TAK TAAM of George Washington University organized a special session on Ergodic theory; the speakers were J. B. Baillon, Richard Churchill, A. del Junco, Robert L. Devaney, W. F. Eberlein, D. C. Mayne, P. Milnes, Robert Sine, Choy-Tak Taam, and Robert J. Zimmer.

Sessions for contributed ten-minute papers were scheduled on both days. These were chaired by J. J. Buoni, Evin Cramer, Howard Fegan, Matthew I. Gould, S. M. Rankin III, Howard H. Wicke, and Miriam Lipschutz-Yevick.

With the support of the Energy Research and Development Administration and the National Science Foundation, a symposium on Mathematical Problems in Fracture Mechanics was held on Tuesday and Wednesday, March 28 and 29, 1978. This topic was selected by the AMS- SIAM Committee on Applied Mathematics. The organizing committee for the symposium included Keiti Aki, Massachusetts Institute of Technology; Robert Burrige, Courant Institute of Mathematical Sciences (chairman); James K. Knowles, California Institute of Technology; and James R. Rice, Brown University. The lecturers were J. D. Achenbach (Northwestern University); Keiti Aki; J. C. Amazigo (Rensselaer Polytechnic Institute); D. J. Andrews (U.S. Geological Survey); Robert Burridge; L. B. Freund (Brown University); James K. Knowles; R. A. Schapery (Texas A & M University); D. A. Simons (Brown University); and John R. Willis (University of Bath, England).

University Park, Raymond G. Ayoub
Pennsylvania Associate Secretary

THE APRIL MEETING IN HOUSTON

The seven hundred fifty-fifth meeting of the American Mathematical Society was held at the University of Houston, Houston, Texas, on Friday and Saturday, April 7-8, 1978. The 1978 spring meeting of the Association for Symbolic Logic was held on Thursday and Friday, April 6-7 in conjunction with the meeting of the Society.

There were 193 registrants, including 163 members of the Society.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings there were four invited one-hour addresses. TODD DUPONT of the University of Chicago spoke on the topic "Multigrid methods for com-
puting approximate solutions of elliptic equations”; he was introduced by Mitchell B. Luskin, FRED GALVIN of the University of Kansas addressed the Society on the subject “Set theoretic and topological games”; Gaisi Takeuti presided, JOHN P. HEMPEL of Rice University gave an hour talk on "Intersection calculus on surfaces, with applications to 3-manifolds”; he was introduced by Morton L. Curtis, ANDY R. MAGID of the University of Oklahoma spoke on the topic “Algebraic variety structures on analytic groups”; Amassa C. Fauntleroy presided.

By invitation of the same committee there were five special sessions of selected twenty-minute papers, CHARLES K. CHIU of Texas A & M University organized a special session on Approximation theory; the speakers were Theagenis Abatzoglou, Hermann G. Burchard, E. W. Cheney, R. A. DeVore, Frank R. Deutche, Stephen D. Fisher, Geza Freud, Myron S. Henry, George G. Lorentz, Donald E. McClure, Paul G. Nevai, Dennis D. Pence, Oved Shisha, Carolyn S. F. Shull, Sankatha P. Singh, William H. Summers, Arun K. Varma, and Joseph D. Ward, WILLIAM T. EATON of the University of Texas at Austin organized a special session on Topological and generalized manifolds; the speakers were C. McA. Gordon, William H. Row, Jr., T. Benny Rushing, Michael Starbird, Gerard A. Venema, and John J. Walsh, ROBERT M. FOSSUM of the University of Illinois at Urbana–Champaign organized a special session on Commutative algebra; the speakers were Winfried Bruns, Edward D. Davis, James K. Deveney, John A. Eagon, Amassa C. Fauntleroy, Hans-Bjorn Foxby, Raymond C. Heitmann, Robert A. Morris, Zensho Nakao, Jack E. Ohm, and Roger A. Wiegand, ANIL NERODE of Cornell University organized a special session on Recursion theoretic aspects of model theory and algebra; the speakers were K, Jon Barwise, Harvey M. Friedman, Carl G. Jockusch, Jr., Iraj Kalantari, Charlotte Lin, Thomas G. McLaughlin, Angus MacIntyre, Terrence S. Millar, Anil Nerode, Marian Boykan Pour–El, Jeffrey B. Remmel, Joseph G. Rosenstein, Allen Retzlaff, John S. Schlipf, James H. Schmerl, and Rick Smith, PETER PERCELL of the University of Houston and MARY FANETT WHEELER of Rice University organized a special session on Finite element approximations for partial differential equations; the speakers were Ivo Babuska, Randolph E. Bank, Alan E. Berger, James H. Bramble, Joel E. Dendy, Richard E. Ewing, Richard S. Falk, Linda J. Hayes, R. Bruce Kellogg, J. Tinsley Oden, John E. Osborn, Alfred H. Schatz, L. Ridgway Scott, and Lars B. Wahlbin.

There were four sessions of contributed ten-minute papers, for which David G. Bourgin, Linda J. Hayes, Andrew J. Matchett, and Carolyn S. F. Shull served as presiding officers. Of the 25 contributed papers scheduled in the program of the meeting, two were withdrawn, so that 23 contributed papers were actually presented.

The accompanying ASL meeting included invited hour addresses by Stephen G. Simpson and Gaisi Takeuti and invited half-hour talks by David Guaspari, William Heck, Anne M. Leggett, and Jeffrey B. Remmel.

THE SPRING MEETING IN SAN FRANCISCO

The seven hundred fifty-sixth meeting of the American Mathematical Society was held at San Francisco State University in San Francisco, California, on Friday and Saturday, April 14 and 15, 1978. The meeting was held jointly with the Northern California Section of the Society for Industrial and Applied Mathematics. There were 150 registrants including 107 members of the Society.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there were two invited one-hour addresses. WILLIAM CASSELMAN, University of British Columbia, lectured on Cohomology and infinite-dimensional representations; he was introduced by Adam Koranyi, ALEXANDRE JOEL CHORIN, University of California, Berkeley, spoke on Numerical models of vorticity generation in boundary layers. Professor Chorin was introduced by Jerrold E. Marsden.

By invitation of the same committee, there were four special sessions of invited papers. VINCENT J. BRUNO of San Francisco State University organized a special session on Nonlinear analysis; the speakers were Henry A. Antosiewicz, Ronald E. Bruck, Jr., Robert Finn, Jorge A. Ize, Tosio Kato, Jerrold E. Marsden, Simeon Reich, R. Tyrrell Rockafellar, and Elena Zagustin. ROLF JELTSCH of Stanford University organized a special session on Numerical solu-
BOOKS ON LOGIC AND FOUNDATIONS

MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY

★ TWO PAPERS ON THE PREDICATE CALCULUS
S. C. Kleene
1. Permutability of inferences in Gentzen's calculi \( LK \) and \( LJ \).
2. Finite axiomatizability of theories in the predicate calculus using additional predicate symbols.
1952; reprinted 1972, 68 pages; list $5.60; member $4.20

★ AN EXAMINATION OF A DECISION PROCEDURE
F. C. Oglesby
R. Stanley in "An extended procedure in quantification logic" presents a proof procedure for the universal validity of formulas of the first order predicate calculus. He shows in his paper that the procedure gives a method of decision for the monadic predicate calculus. Further, he states that the limits of the procedure, short of being a general method of decision, are not known, but that every universally valid formula which he has tested has been shown by his procedure to be valid.

The purpose of this paper is to examine Stanley's procedure to determine for certain decidable classes of formulas whether or not the procedure gives a method of decision.
1962; reprinted 1971, 148 pages; list $5.60; member $4.20

★ HIERARCHIES OF PREDICATES OF FINITE TYPES
D. A. Clarke
The discovery and initial investigation of hierarchies of number-theoretic predicates (in recursive-function theory) were by Kleene and were reported in Trans. Amer. Math. Soc. vol. 53 (1943) pp. 41–73 (and later, independently, by Mostowski in Fund. Math. vol. 34 (1946) pp. 81–112). This study was continued by Kleene, Mostowski, and Davis. It is some aspects of this theory of hierarchies of predicates of finite types which is studied in this paper. Much of the work here is in terms of the notion, originally due to Post, of degree of recursive unsolvability.
1964, 95 pages; list $4.40; member $3.30

A HIERARCHY OF FORMULAS IN SET THEORY
A. Lévy
1. Introduction
2. Definition of the hierarchy
3. The relative hierarchy
4. Formulas in \( \Sigma_0 \) and admissible terms
5. The satisfaction predicates
6. The semantical hierarchy theorem
7. Undecidable sentences
8. The syntactical hierarchy theorems
9. Reflection phenomena
10. The lower levels of hierarchy
Four Appendices and Bibliography

FORMALIZED RECURSIVE FUNCTIONALS AND
FORMALIZED REALIZABILITY
S. C. Kleene
Part I. Formalized Recursive Functionals.
1. Computation tree numbers
2. \( p \)-terms and \( p \)-functors; \( r \approx s \) (definition and basic properties)
3. Representations of \( p \)-terms by proper indices
4. The recursive theorems; the normal form theorem;
   \( \{r\}[\alpha] \) and \( \Lambda \alpha u [\alpha]; A \in \{A(R)\} \)
Part II. Formalized Realizability
5. Intuitionistically provable formulas are realizable
   and \( \aleph \)-realizable
1969, 106 pages; list $5.20; member $3.90

CONSTRUCTIVE MEASURE THEORY
E. Bishop and H. Cheng
The authors treat the Daniell integral constructively. The Daniell approach permits a general and flexible theory that constitutes a significant advance over previous treatments of the constructive theory of measure and integration. Not only is a measure constructed from an integral, but an integral is constructed from a measure, and the two constructions are compared. Convergence theorems, Fubini's theorem, and integrals in locally compact spaces are among the topics treated.
1972, 85 pages; list $4.00; member $3.00

PROCEEDINGS OF SYMPOSIA IN
PURE MATHEMATICS
★ RECURSIVE FUNCTION THEORY
Edited by J. C. E. Dekker
Clifford Spector, Provably recursive functionals of analysis: A consistency proof of analysis by an extension of principles formulated in current intuitionistic mathematics
Andrzej Mostowski, Representability of sets in formal systems
S. C. Kleene, Herbrand-Gödel-Style recursive functionals of finite types
J. C. E. Dekker, Infinite series of isols
John Myhill, \( \Omega = \Lambda \)
A. Nerode, Arithmetically isolated sets and nonstandard models
Dana Scott, Algebras of sets binumerable in complete extensions of arithmetic
J. W. Addison, Some problems in hierarchy theory
J. R. Shoenfield, The form of the negation of a predicate
Martin Davis, Applications of recursive function theory to number theory
A. W. Burks and J. B. Wright, Sequence generators and digital computers
Saul Gorn, The treatment of ambiguity and paradox in mechanical languages
John McCarthy, Computer programs for checking mathematical proofs
M. L. Minsky, Size and structure of universal Turing machines using tag systems
1962, 247 pages; list $16.80; member $12.60

AXIOMATIC SET THEORY
Edited by D. S. Scott
C. C. Chang, Sets constructible using \( L_{\kappa(K)} \)
Paul J. Cohen, Comments on the foundations of set theory
P. Erdős and A. Hajnal, Unsolvable problems in set theory
Harvey Friedman, A more explicit set theory
Petr Hájek, Sets, semisets, models
J. D. Halpern and A. Levy, The Boolean prime ideal theorem does not imply the axiom of choice
Thomàs Jech, On models for set theory without AC
Ronald B. Jensen and Carol Karp, Primitive recursive set functions
H. Jerome Keisler and Jack H. Silver, End extensions of models of set theory
G. Kreisel, Observations on popular discussions of foundations
Kenneth Kunen, Indescribability and the continuum
Azriel Levy, The sizes of the indescribable cardinals
Azriel Levy, On the logical complexity of several axioms of set theory
Saunders Mac Lane, Categorical algebra and set-theoretic foundations
R. Mansfield, The solution of one of Ulam's problems concerning analytic rectangles
Yiannis N. Moschovakis, Predicative classes
Jan Mycielski, On some consequences of the axiom of determinateness
John Myhill, Embedding classical type theory in 'intuitionistic' type theory
John Myhill and Dana Scott, Ordinal definability
Kanji Namba, An axiom of strong infinity and analytic hierarchy of ordinal numbers
Lawrence Namba, A more explicit set theory
Lawrence Pozsgay, Liberal Intuitionism as a basis for set theory
Gerald E. Sacks, Forcing with perfect closed sets
J. R. Shoenfield, Unramified forcing
Jack Silver, The independence of Kurepa's conjecture and two-cardinal conjectures in model theory
Jack Silver, The consistency of the GCH with the existence of a measurable cardinal
Robert M. Solovay, Real-valued measurable cardinals
G. L. Sward, Transfinite sequences of axiom systems for set theory
Gaisi Takeuti, Hypotheses on power set
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1974, 498 pages; list $44.00; member $33.00


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N. A. Šanin, Concerning the constructive interpretation of auxiliary formulas.


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★ CONSTRUCTIVE REAL NUMBERS AND FUNCTION SPACES

by N. A. Šanin, translated by E. Mendelson

This book is devoted to certain problems of constructive mathematical analysis.

In the mathematical literature the adjective "constructive" is used in various senses. In the present work the adjective "constructive" will be used only in the following sense: the presence of this adjective in the term for a concept, the name of a method, the name of a branch of mathematics, etc. will signify that the indicated concept, method, branch of mathematics, etc. belongs to the constructive approach to mathematics. The constructive approach to mathematics is characterized by the following features: 1) in mathematical theories belonging to this approach, only constructive objects figure as objects of study; 2) in the study of constructive objects one is permitted a certain idealization, the so-called abstraction of potential realizability but the use of the abstraction of actual infinity is completely forbidden; 3) in accordance with the type of objects of study and the abstraction of potential realizability as a meaningful basis for the construction of mathematical theories one takes the constructive interpretation of mathematical judgments.


PROCEEDINGS OF THE STEKLOV INSTITUTE OF MATHEMATICS

★ PROBLEMS IN THE CONSTRUCTIVE TREND IN MATHEMATICS, IV

Edited by V. P. Orevkov and N. A. Šanin

The present collection of papers from the Mathematical Logic Seminar of the Leningrad Branch of the Steklov Institute of Mathematics has as its subject the theory of logical deduction and its applications to the construction of automatic deduction search algorithms.

The papers concern the calculi of both constructive and classical logic. The calculi of classical logic are nowhere employed as the logical foundation of any investigation, however; they are considered only as constructively defined objects of study and are investigated on the basis of the principles of the constructive trend in mathematics, as are certain constructively defined objects of other types. The present collection may therefore be regarded as belonging to the constructive trend in mathematics. It forms a part of the series "Problems of the Constructive Trend in Mathematics".
THE CALCULI OF SYMBOLIC LOGIC. I
Edited by V. P. Orevkov

This book is the fourth collection of articles by the Seminar in Mathematical Logic and the Seminar on Constructive Mathematics in the Leningrad Branch of the Steklov Institute of Mathematics. The present collection contains articles on the general theory of calculi, and on constructive mathematical logic and analysis; all the articles were completed, presented to the seminars and prepared for publication during the years 1963–1966.

Part I. General theory of algorithms and calculi
S. Ju. Maslov  Ju. V. Matijasevič

Part II. Constructive mathematical logic
A. V. Idašëon  V. A. Lifščic  Fan Dînţ Zieu

Part III. Constructive mathematical analysis
V. P. Orevkov  Fan Dînţ Zieu
A. O. Slisenko  G. E. Minc

1971, 229 pages; list $25.60; member $19.20

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Edited by V. P. Orevkov and N. A. Šanin

N. K. Kosovskyi, Some questions in the constructive theory of normed Boolean algebras
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1972, 292 pages; list $26.40; member $19.80

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Phan Diňh-Diêu

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4. Constructive generalized functions
5. Order, support, and value at a point, for a constructive generalized function
6. Spaces of constructive infinitely differentiable functions and constructive functionals on them

Appendix. Two lemmas on constructive real numbers

1974, 238 pages; list $38.00; member $28.50

LOGICAL AND LOGICO-MATHEMATICAL CALCULII. II
Edited by V. P. Orevkov

This volume is the second collection of papers from the seminar on mathematical logic at the Leningrad Branch of the Steklov Mathematical Institute of the Academy of Sciences of the USSR. The collection consists of papers on the theory of logical inference and its application to the construction of algorithms for machine search for inference. Increasing recent interest in this domain of mathematical logic is connected with the development of mathematical cybernetics, in particular those of its divisions in which the question of simulation on computers of complex forms of human intellectual activity is considered.

In the papers of this collection calculi of constructive logic are considered as well as calculi of classical logic. But here calculi of the second type never occur as the logical basis of any investigations; they are considered only as constructively defined objects of study and, like constructively defined objects of other types considered in this collection, they are investigated on the basis of principles of the constructive trend in mathematics. In this sense it is possible to say that this collection belongs to the constructive trend in mathematics and borders on the series Problems in the constructive trend in mathematics.

All the papers published in this collection were completed and delivered at seminars in 1965–1971.

N. V. Zamov  G. E. Minc  A. Ju. Pliškevičene
S. Ju. Maslov  V. P. Orevkov  M. G. Rogova
1974, 183 pages; list $25.40; member $19.80

PROBLEMS IN THE CONSTRUCTIVE TREND IN MATHEMATICS. VI
Edited by V. P. Orevkov and N. A. Šanin

This volume is the sixth collection of papers which were presented in a seminar on constructive mathematics at the Leningrad Branch of the Steklov Mathematical Institute of the Academy of Sciences of the USSR (and at the same time a scientific seminar of the Mathematics-Mechanics Faculty of Leningrad University). The collection consists of papers on the theory of complexity of algorithms, constructive mathematical analysis and constructive mathematical logic.

N. K. Kosovskyi, Constructive versions of the laws of large numbers
V. P. Orevkov, On the complexity of expansion of algebraic irrationalities in continued fractions
A. O. Slisenko, Recognizing a symmetry predicate by multithread Turing machines with input.
N. A. Šanin, On a hierarchy of methods of interpreting propositions in constructive mathematics
1976, 272 pages; list $55.60; member $41.70

MATHEMATICAL LOGIC, THE THEORY OF ALGORITHMS AND THE THEORY OF SETS
Edited by S. J. Adjan
Translated by M. Greendlinger

This collection opens with three survey articles on
P. S. Novikov's scientific and pedagogical activity, on his work in descriptive set theory and in algorithmic problems of algebra. The fundamental results obtained by Novikov in these fields are described in these articles, and his outstanding role in the training of scientific personnel is shown.

The rest of the collection's papers are results of the investigations of Novikov's students in various branches of mathematical logic, set theory, the theory of algorithms and its applications. The paper by Novikov's student, V. Ja. Arsenin, in which approximate solutions to integral equations are studied, is an exception in this respect.

N. D. Gileiko V. I. Fukson V. A. Oslupa
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N. V. Beljakin A. A. Mužnik S. V. Jablonski
D. A. Bočvar A. N. Maslov

1977, 280 pages; list $39.60; member $29.70
(Publication June, 1977)
ABSTRACTS

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Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)

V. SITA RAMAIAH, Andhra University, Waltair 530003, India. The Unitary divisor function over certain class of Integers.

Let \( k \geq 2 \) and \( u \geq 1 \) be any two fixed integers and \( x \) a real variable \( \geq 3 \). Let \( \Lambda \) be any regular convolution. An integer \( m \) is called semi-\( \Lambda \)-\( k \)-free if \( p^{k} \not| \Lambda(m) \) for no prime \( p \). These' include as special cases the \( k \)-free, unitarily \( k \)-free and \( (k,r) \)-free integers. Let \( \omega(m) \) denote the number of distinct prime factors of \( m \) and \( q_{A,k}^{s} \) denote the characteristic function of the semi-
\( \Lambda \)-\( k \)-free integers. In this paper we obtain an asymptotic formula for the sum

\[
\sum_{\substack{m \leq x \\ (m,u)=1}} 2^{\omega(m)} q_{A,k}^{s}(m),
\]

with error term \( O(x^{k \log^{2} x} \sigma_{-a}^{2}(u)) \) or \( O(x^{k \delta(s)}(u)) \), according as \( k=2 \) or \( k \geq 3 \), where \( \sigma_{s}(u) \) is the sum of the \( s \)-th powers of the square free divisors of \( u \), \( a \) is the number appearing in the Dirichlet divisor problem and

\[
\delta(x) = \exp \left( -H \log^{3/5} x \ ( \log \log x)^{-1/5} \right),
\]

\( H \) being a positive constant. These improve results due to I. Katai and M.V. Subbarao and D. Suryanarayana. (Received March 28, 1978.) (Author introduced by Professor Rao K. Nageswara).

A-477
Let \( f_n \) \((n \geq 0)\) be positive real numbers with generating function \( f(x) = \sum f_n x^n \). Assume \( f(x) \) has the following properties: \( x_0 \) is the only singularity of \( f(x) \) on its circle of convergence and \( y_0 = f(x_0) \) converges; \( y = f(x) \) satisfies an analytic identity \( F(x, y) = 0 \) near \((x_0, y_0)\); \( y_0 = 0 \) \(\Rightarrow\) \( x_0 \). We show there are constants \( \gamma \) (a positive rational) and \( c \) such that \( f_n \sim c \frac{1}{n^{1+\gamma}} \). Furthermore we show i) in all cases how to determine \( \gamma \) and \( c \) from \( f(x, y) \) and ii) in certain cases how to determine them from \( F(x, y) \). This generalizes results for \( k = 2 \) which appear for i) in Harary, Robinson, and Schwenk, Twenty-Step Algorithm for Determining the Asymptotic Number of Trees of Various Species, J. Austral. Math. Soc., 20 (Series A), 1975, pp. 483-503 and for ii) in Bender, Asymptotic Methods in Enumeration, Siam Review, 16, 1974, pp. 485-515. (Received March 27, 1978.)

**Pontryagin duality in universal algebra.**

It is shown that if a variety \( V \) of finitary universal algebras contains a finite injective cogenerator \( Q \), is normal, and is associative and distributive, then the category of compact totally disconnected algebras of \( V \) is opposite to \( SP(G) \) in \( [P_0, En] \) where \( P_0 \) is the category formed by the injective cogenerator (i.e. \( P_0(Q) = V(Q, Q) \)) and \( G : P_0 \to En \) is the forgetful functor. Examples of \( V \) include: (1) Boolean rings with \( Q = \mathbb{Z}_2 \); (2) Abelian torsion groups cogenerated by \( Q = \mathbb{Z}_n \); (3) Vector spaces over a finite field \( Q \); (4) Rings cogenerated by \( Q = GF(p^n) \). (Received March 27, 1978.)

**Removable cycles in 2-connected graphs of minimum degree at least four.** Preliminary report.

Theorem: Let \( G \) be a simple 2-connected graph and each vertex of \( G \) have degree at least four. Let \( a \bar{b} \) be an edge of \( G \). Then \( G - a \bar{b} \) contains a cycle \( C \) such that \( G - E(C) \) is 2-connected. (Received April 7, 1978.)

**Maximal Subgroups with Trivial Intersection.**

Let \( H \trianglelefteq G \). We say that \( H \) satisfies \( P(G) \) provided \( H \) is disjoint from all the maximal subgroups of \( G \) which don't contain \( H \). In this note we determine those groups \( G \) which contain a maximal subgroup \( H \) which satisfies \( P(G) \). We show that a finite group \( G \) contains a maximal subgroup which satisfies \( P(G) \) if and only if (i) \( G \) is cyclic of prime-power order, (ii) \( |G| = pq, p, q \) primes, or (iii) \( G = HK, H \trianglelefteq G, H \) elementary abelian \( p \)-group for some prime \( p, K = \langle y \rangle \) is cyclic of order \( q, q \neq p \), and \( y \) acts irreducibly on \( H \).

Some corollaries of this result are established. (Received April 17, 1978.)

This continues the investigation of Boolean near-rings begun by the authors in Boolean Near-Rings I, II (Notices, April 1978). Let \((B,+,,\cdot,)\) be a Boolean near-ring defined on a Boolean ring \((B,+,,A)\) via a linking mapping \(\phi\). The structure of the one-sided ideals and hence the ideals is given for these near-rings. As before let \(\phi = x\) and \(C(B) = \{b \in B : \phi b = 0\}\), \(Z(B) = \{b \in B : 0 \cdot b = b\}\).

**Key Lemma.** For each \(c \in C(B), z \in Z(B), c \cdot z = (c+z)\cdot z\).

**Structure Theorem.** Each left (right, two-sided) ideal \(I\) of \((B,+,,\cdot,)\) can be written as the direct sum of left (right, two-sided) ideals \(I_1 \cdot \mathbb{Z}(B)\) and \(I_2 \cdot \mathbb{C}(B)\); conversely, if \(I_1\) is any subgroup of \((Z(B),+,)\) and \(I_2\) is a left (right, two-sided) ideal of \((C(B),+,\cdot,)\), then \(I_1 \cdot I_2\) and \(I_1 \oplus I_2\) are ideals of \((B,+,,\cdot,)\). Theorem 2. If \((C(B),+,\cdot,)\) is a ring and \(I\) an ideal of \((B,+,,\cdot,)\), then \(B/I\) is a Boolean ring if and only if \(Z(B) \subseteq I\). Theorem 3. If \(\phi = 0\), then \(B \phi\) is a subring and \(\phi\) is a join endomorphism; if \(B \phi\) is a subring, then \(0 \phi = 0\). (Received April 24, 1978.)

HANSRAJ GUPTA, 402 Mumfordganj, Allahabad 2, Panjab University, Chandigarh, India 160014. A new look at the permutations of the first \(n\) natural numbers. Preliminary report.

Let \(a_1 a_2 \cdots a_n\) be any permutation of the first \(n\) natural numbers. Then the degree of any element \(a_k\) of the permutation is the number of \(a\)'s which are less than \(a_k\) and are on its right in the permutation. The index of \(a_k\) is \(k\) if \(a_k > a_{k+1}\), \(1 \leq k \leq n-1\), and zero otherwise. The degree of the permutation is the sum of the degrees of its elements and its index the sum of their indices. Let \(A_n(u,v)\) denote the number of permutations of \(\mathbb{Z}_n\), which have the index \(u\) and the degree \(v\). Then the Alter-Curtz-Wang conjecture (1974) states that \(A_n(u,v) = A_n(v,u)\). In this paper, among other results, the said conjecture is proved for \(u \leq 4\) and all \(v\). A generating function is obtained for \(A_n(u,v)\), with \(n = u + v\), for any given \(u\) and arbitrary \(v\). It is shown how \(A_n(u,v)\) can be computed without using any partition table, from the generating function alone. (Received April 24, 1978.)

C. J. MOZZOCHI, Mittag-Leffler Institute, Djursholm, Sweden. A remark on Goldbach's conjecture VII.

In Part II (Abstract 75T-A233, these Notices 22 (1975), A-620) I show that if one could improve the estimate on \(\int \varepsilon E_n(x,n) \cdot e(-nx) dx\) from \(O(n \log n)\) to \(O(n \log^2 n)\), then one could establish the asymptotic formulation of Goldbach's conjecture. Later \(E_n\) was slightly modified to \(E_n^*\). Remark. It is not possible to obtain this estimate improvement by simply trying to obtain the requisite estimate on \(\varepsilon f(x,n)\), for \(x\) in \(E_n^*\), in particular by trying to sufficiently improve Vinogradov's well known estimate. This observation was communicated to me by R.C. Vaughan. Here I first present his argument, and then I present one of my own to establish the above remark. (Received April 26, 1978.)

MICHAEL DOOB, University of Manitoba, Winnipeg, Manitoba, Canada. Graphs with a Small Number of Distinct Eigenvalues II.

Several characteristics of graphs with a small number of distinct eigenvalues are discussed in this paper. (1) Bipartite graphs. Theorem: The only bipartite graphs with four or fewer distinct eigenvalues are complete bipartite graphs and the element-block graph of a symmetric balanced incomplete block design. (2) Cartesian Product. Theorem: If a regular graph has five or fewer distinct eigenvalues and is not prime under the Cartesian product of graphs, then the factors must
be formed from $K_nK_{n,n}$, the Shrikhande graph, the Hoffman-Singleton graph, or the complement of
the Clebsch graph. (3) Seidel Switching. Theorem: Seidel Switching can be used to construct all regular
cospectral graphs with a small number of distinct eigenvalues bounded below by -2 except
when the graphs arise from designs with the same parameters. (Received May 1, 1978.)

Elliott Evans, University of Tennessee, Knoxville, Tennessee 37916. Prime atoms in atomic
lattices. Preliminary report.

Notations. For a complete lattice $S$ we label conditions. $\mathcal{S}$ denotes: $\forall x \in S$, $\exists x$ is pseudocomplemented. Suppose $S$ is pairwise atomic $(\mathcal{P})$. Greek letters are always atoms. $\mathcal{S}$ denotes: $(\alpha \leq \beta$ and
$x \alpha x \beta = x \beta x \alpha$ and $x$ a line or an atom)., a $\in S$, $\exists x \in S$, $\forall x \in S$, $\exists x \in S$, $\forall x \in S$. For
$S$ complete, $\mathcal{S}$-dense in $L$ imply $\mathcal{S}(L)$ (lattice of $\forall$-closed subsets under $\subseteq$) is $\mathcal{P}$, $\mathcal{S}$
and $\mathcal{S}(L)$ pseudocomplemented. So $c(L)$ (lattice of closure operators, pointwise order, dual to $\mathcal{S}(L)$)
is pseudocomplemented, $M$-symmetric, upper semimodular. For $L$ a power set these due to Ore (Ann. of
Math. (44) 1943, 514-526). 2. If $L$ continuous then sub $\mathcal{S}(L)$ (lattice of $\forall$-closed subsets under $\subseteq$)
is $\mathcal{P}$ and has $\mathcal{S}$, and so is dually $\mathcal{S}$ and $\mathcal{S}$. So $\mathcal{S}(L)$ (lattice of algebraic closure operators,
pointwise order) is $\mathcal{S}$, $M$-symmetric, upper semimodular. (Received May 1, 1978.)

SURJEET SINGH and AFZAL BEG, Guru Nanak Dev University, Amritsar-143005, India. Restricted
balanced rings. Preliminary report.

A ring $R$ is said to be restricted balanced if for every nonzero ideal $A$ of $R$, $R/A$ is a balanced ring in
the sense of Dlab and Ringal (Proc. Lond. Math. Soc. 26(1973), 446-462). All Dedekind prime rings are restricted
balanced rings. The following is proved: Let $R$ be a nonprime restricted balanced ring, then (i) $R$ is balanced
or (ii) $R$ is a matrix ring over local restricted balanced rings, with $\mathcal{J}(R) = (0)$ or (iii) $R = (D_1 \times M)$
where $D_1$ and $D_2$ are two simple artinian rings and $M$ is a simple $(D_1, D_2)$-bimodule. (Received May 3, 1978.)

DAVID ZEITLIN, 1650 Vine Ave., North, Minneapolis, Minn., 55411. Parametric solutions for two
equal sums of seven cubes (six identities)

$W_0$ and $W_1$ are integers; for $k = 0, 1, \ldots$, $W_{k+2} = W_{k+1} + W_k$ satisfies the following identities:

1. $W_{k+2}^3 + (5W_{k+3})^3 + (6W_{k+4})^3 + (7W_{k+5})^3 + W_{k+1}^3 + (7W_{k+1})^3 + W_k^3 = W_{k+3}^3 + (7W_{k+3})^3 + (2W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

2. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

3. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

4. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

5. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

6. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

7. $(7W_{k+2})^3 + (7W_{k+1})^3 + (2W_{k+2})^3 + (2W_{k+1})^3 + (2W_{k+1})^3 + (5W_{k+2})^3 + (6W_{k+2})^3 + (5W_{k+2})^3 + (6W_{k+1})^3 + (5W_{k+1})^3 + (6W_{k+1})^3$.

(Received February 3, 1978.)

MEERA N. KHAMBADKONE, University of Jos, Jos, Nigeria. On the structure of augmentation
ideals in group rings. Preliminary report.

Let $\mathcal{A}$ denote the augmentation ideal of the group ring $\mathcal{Z}$ of a group $G$. C. Lasure found the structure
of $A^2_G / A^1_G$ for any finitely generated group. In this paper, we investigate the structure of $A^G_H / A^G_G$ where $H$ is a finitely generated normal subgroup of $G$ where $G = H \lor K$. (Received May 11, 1978.) (Author introduced by Professor E. N. Chukwu).

78T-A138 SARADHA, K University of Madras, Madras-600005, India. On \[ \sum_{k=1}^{m} |e^{\pi i k^2} - \alpha_k| \] where $\alpha_k$ are algebraic numbers and $\gamma$ any complex number. Preliminary report. The object of this paper is to prove the following: Theorem: Let $G_0 (H)$ denote the set of 4-tuples $(\alpha_1, \alpha_2, \alpha_3, \alpha_4)$ of algebraic numbers where

(i) the heights of $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ do not exceed $H (\geq 1)$
(ii) the degree of the field generated by $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ over the field of rationals does not exceed $D$.
If $\gamma$ be a complex number different from zero and $\exp (-P(q)) = \min \{ \gamma + \nu \gamma + \nu \gamma + \nu \gamma \}$
where $P(q)$ is a positive real valued function tending to $\infty$ as $q \rightarrow \infty$, then we have an explicit function $\Psi (D, H, \gamma)$ defined in terms of $P$ such that
\[ \min \left( \sum_{k=1}^{m} |e^{\pi i \alpha_k} - \alpha_k| + |e^{\pi i \alpha_k} - \alpha_k| + |e^{\pi i \alpha_k} - \alpha_k| \right) > \Psi (D, H, \gamma) \]
(Received May 11, 1978.) (Author introduced by Dr. T.S. Bham Murthy).

Let $k$ be an integer $\geq 2$ and $R_k(n)$ denote the number of representations of $n$ as a sum of two $k$-free integers. In 1931, C. J. A. Evelyn and E. H. Linfoot found the asymptotic formula $R_k(n) = c_k p_k(n) + O(n^{\frac{2}{(k+1)}} \log \log n^{\frac{2}{(k+1)}})$ for each $\epsilon > 0$. In this paper, we improve the $O$-estimate to $O(n^{\frac{2}{(k+1)}} \log \log n^{\frac{2}{(k+1)}})$ which supersedes the earlier results due to E. Cohen; C. Pomerance and D. Suryanarayana; the authors. (Received May 12, 1978.) (Author introduced by Professor Bruce C. Berndt).

We prove, for example, the following result. Theorem: Let $A$ be a complex $n \times n$ matrix such that $A + A^*$ is positive definite. Then there exists a matrix $B$ such that $B^2 = A$ and such that $B + B^*$ is positive definite.

The two stages of the proof are sketched here. (i) Lemma: For $0 \leq t \leq 1$ let $S_t$ be a hermitian matrix depending continuously on $t$ such that $S_0$ is positive definite but $S_1$ is not. Then if $\tau = \inf \{ 0 \leq \tau \leq 1 : S_\tau$ is not positive definite $\}$, $S_\tau$ is singular. (ii) For $0 \leq t \leq 1$ write $A_t = 1 + t(A - I)$. Then $A_t + A_t^*$ is positive definite, so that $B_t = A_t^{1/2}$ exists. If $B = B_1$ is such that $B + B^*$ is not positive definite, the Lemma applied to $S_t = B_t + B_t^*$ shows that $S_\tau$ is singular for some $\tau$ with $0 \leq \tau \leq 1$. But since $S_\tau x = 0$ leads to $x^* A_\tau x = -x^* A_\tau^{1/2} T(x) A_\tau^{1/2} x$ such a conclusion contradicts the fact that $A_\tau + A_\tau^*$ is positive definite. (Received May 15, 1978.)

The labelled and unlabelled Hamiltonian circuits on three graphs have been computed and the numbers are given below. The terminology and methods are as in my paper "Enumerating unlabelled Hamiltonian circuits", Intern. Series on Numerical Mathematics, Vol. 29, Birkhauser, 1975, pp. 117-130. Briefly, $|A|$ is the order of the automorphism group $A$ of the graph, $|L|$ is the number of labelled circuits, 

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\[ \frac{|L/A|}{|L|} = \frac{|L|}{|A|} \] is the number of circuits modulo A, and |U| is the number of unlabelled circuits, i.e. circuits modulo the group generated by A and the dihedral group of circuit shifts and reversals. Waller's musical chord graph is described in "Some combinatorial aspects of the musical chords", Math. Gaz. 62 (Mar 1978) 12-15. (Received May 15, 1978.)

| A | L/A | |L| | U |
|---|---|---|---|---|
| Cubo-octahedron | 24 | 50 | 2400 | 5 |
| Icosidodecahedron | 120 | 19520 | 2342400 | 353 |
| Waller's graph | 24 | 124 | 2976 | 8 |

#78T-A142 RICHARD CRITTENDEN, Portland State University, Portland, OR 97207, and CHARLES VANDEN EYEND, Portland State University and Illinois State University, Normal, IL 61761. Completing partial Latin squares.

It is shown that if a partial Latin square of order \( n \) with fewer than \( n \) entries has all its entries in no more than \( \frac{n+3}{2} \) rows, then it can be completed. This extends results of Lindner (Canad. Math. Bull. 13 (1970), 65-68) and Wells (J. Comb. Th. Ser. A 22 (1977), 313-321). The number \( \frac{n+3}{2} \) is best possible for the method used, namely, completing one row at a time without regard for completing future rows. A lemma used is that a partial Latin square with the first \( r \) rows filled in and exactly one additional entry can be completed. The conjecture of Evans that any partial Latin square of order \( n \) with fewer than \( n \) entries can be completed is verified for \( n = 9 \). (Received May 15, 1978.)

78T-A143 WILLIAMS K. FORREST, University of Manitoba, Winnipeg, Manitoba, Canada. R3T 2N2 Some Basic Results in the Theory of Constructible Sets.

Let \( F \) be a field and \( \Omega \) a universal domain over \( F \). Theorem 1. If \( F \) is algebraically closed then a set \( Y \) is almost homogeneous in \( F^n \) iff it is almost homogeneous in \( \Omega^n \). Theorem 2. Projective constructibility is a local property of sets in \( F^n(\Omega) \). Theorem 3. If \( X \) is a constructible subset of \( \Omega^n \) there is a smallest field of definition \( F_0 \) of \( X \) in \( \Omega \). (Received May 18, 1978.)

#78T-A144 JAE KEOL PARK, University of Cincinnati, Cincinnati, Ohio 45221. Artinian Skew Group Rings.

Let \( R \) be a ring with identity and \( s \) be a group homomorphism from a group \( G \) to \( \text{Aut}(R) \), the group of automorphisms of the ring \( R \). We prove that the skew group ring \( R \ast G \) is right Artinian (resp. semiprimary, right perfect) if and only if \( R \) is right Artinian (resp. semiprimary, right perfect) and \( G \) is finite. Also semilocal skew group rings over fields are characterized. (Received May 19, 1978.)

78T-A145 José Meseguer, Mathematics, University of California at Berkeley, CA., 94720.

A Birkhoff variety theorem for continuous ordered algebras. Preliminary report.

The category \( \text{Pos}(\omega) \) of \( \omega \)-chain complete posets and \( \omega \)-continuous maps is cartesian closed. Epis are dense maps. A continuous theory is a finitary (Lawvere-Bénabou) theory \( T \), but enriched in \( \text{Pos}(\omega) \). Any such \( T \) is dense quotient of an ordinary free theory \( T_x \). \( T \)-algebras, \( \text{Pos}(\omega)_T \), are product-preserving \( \text{Pos}(\omega) \)-functors \( A: T \rightarrow \text{Pos}(\omega) \). Proposition: For any continuous theory \( H: T \rightarrow T' \), the functor \( H^*: \text{Pos}(\omega)_T \rightarrow \text{Pos}(\omega)_T' \) is \( \text{Pos}(\omega)_T \)-monadic and creates : coequalizers of \( H^* \)-pairs, and filtered colimits. \( \text{Pos}(\omega)_T \) is locally presentable. Birkhoff Variety Theorem: There is a bijection between dense quotients \( T_x \rightarrow T \) and classes of algebras closed in \( \text{Pos}(\omega)_T \) under : (i) products, (ii) dense quotients, (iii) full monos \( (m \rightarrow n) \rightarrow a \rightarrow b \), (iv) filtered colimits. If the algebras in the class have \( \bot \in \Sigma_\delta \) as bottom, (iv) can be
dropped $\Box$. In particular for $f: A \rightarrow B$ in $\text{Pos}(\omega)_T$, its extremal-epi-bimorphism-full-mono factorization in $\text{Pos}(\omega)_T$ lifts uniquely. The results are related to classes of interpretations in program semantics. Any dense $T \rightarrow T$ factors as $T \rightarrow T_1 \rightarrow T_2 \rightarrow T$ with $T_1$ ($T_2$) corresponding to inequations on $T_1$ ($T_2$), its algebras giving the best "finite tree" ("infinite") describable variety containing $\text{Pos}(\omega)_T$. (Received May 19, 1978.) (Author introduced by Professor E. Spanier).

KENST-AL46 ALLAN B. CRUSE, University of San Francisco, San Francisco, California 94117.
On removing prescribed vertices from a convex polyhedron. Preliminary report.

Given an $n$-by-$m$ matrix $A = (a_{jk})$ and an $n$-vector $b = (b_j)$, let $P(A,b)$ denote the convex polyhedral subset of $R^n$ consisting of all nonnegative $n$-vectors $x = (x_j)$ satisfying the linear system $Ax = b$. Let $E = \{ e_1, e_2, \ldots, e_r \}$ and $F = \{ f_1, f_2, \ldots, f_t \}$ be any partition of the set of all vertices of $P(A,b)$. For each vector $f_v$ in the set $F$, let $D_v$ be the set of all $n$-vectors $d = (d_j)$ defined by:
- $d_k = 0$ if $f_k > 0$.
- $d_k = 0$ if $f_k = 0$.
- $d_k = e_k$ if $f_k < 0$.
Let $D_v$ denote the blocking polyhedron for the set $D_v$; that is, let $D_v = \{ x \in R^n : d_k \geq 1 \}$ for $i = 1, 2, \ldots, r$. (Cf. D. R. Fulkerson, Math'l Programming, 1 (1971), pp. 168-194.) Let $C_v$ denote the set of all extreme points for the polyhedron $D_v$, and let $C = C_1 \cup C_2 \cup \cdots \cup C_t$. Finally, let $\hat{C}$ denote the blocking polyhedron for the set $C$.

Theorem. The intersection $P(A,b) \cap \hat{C}$ is a convex polyhedron having $E$ in its set of vertices. Note that for a bounded convex polyhedron whose vertices and facets are known, this theorem (by introducing "slack variables" if necessary) obtains the linear constraints needed to define the convex hull of any prescribed subset $E$ of the set of vertices. Its proof is based on the fundamental "duality" and "complementary slackness" principles of linear programming. (Received May 22, 1978.)

KENST-AL47 Alexander ABIAN, Department of Mathematics, Iowa State University, Ames, Iowa 50011.
A fixed-point theorem of image-intersecting mappings (revised).

The following is an improved version of Abstract *78T-A64, these Notices 25(1978), A-230.

THEOREM. Let $(S, \leq)$ be a nonempty simply ordered set in which every nonempty bounded above well ordered subset has a least upper bound. Let $f$ be a mapping from $S$ into $S$ such that:
1. $f$ is order reversing, i.e., $x \leq y$ implies $f(x) \geq f(y)$ for every $x, y \in S$, and
2. the open at $x$ and closed at $f(x)$ interval $H$ of $S$ has a nonempty intersection with its image $f[H]$ for every $x \in S$ for which $x \neq f(x)$.

Then $f$ has a fixed point.

It is shown also that (2) by itself does not imply the existence of a fixed point. In (2) it can be the case that $x < f(x)$ or $x > f(x)$. The result can be extended to partially ordered sets. (Received May 22, 1978.)

KENST-AL48 HARRY LAKSER, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.
The semilattice tensor product of projective distributive lattices.

In "The semilattice tensor product of distributive lattices", Trans. Amer. Math. Soc. 217(1976), 183-194, Grant A. Fraser defined the semilattice tensor product $A \otimes B$ of distributive lattices $A, B$ and showed that it is a distributive lattice. He proved that if $A \otimes B$ is projective then so are $A$ and $B$, that if $A$ and $B$ are finite and projective then $A \otimes B$ is projective, and he gave two infinite projective distributive lattices whose semilattice tensor product is not projective.

We prove THEOREM. Let $A$ and $B$ be distributive lattices with more than one element. Then $A \otimes B$ is projective if and only if both $A$ and $B$ are projective and both have a greatest element. -- This is a complete answer since the semilattice tensor product of $A$ and the one-element lattice is isomorphic to $A$. (Received May 22, 1978.) (Author introduced by G. Grätzer).
Let A and B be finite lattices and let $A \otimes B$ denote their tensor product in $\mathcal{S}_0$, the category of semilattices with 0. For a lattice $L$, denote by $\text{Con} L$ the lattice of congruence relations of $L$. Theorem. $\text{Con}(A \otimes B) \cong \text{Con} A \otimes \text{Con} B$. Corollary. $A \otimes B$ is simple/subdirectly irreducible iff both $A$ and $B$ are such. — If $B$ is distributive, then $A \otimes B \cong \text{A}[B] \cong A^P$ (where $P$ is the poset of join-irreducibles of $B$), thus the Theorem yields as a special case a result of E. T. Schmidt on $\text{Con} M_3 \cong \text{A}[B]$ and it also yields the uniqueness theorem of A. Mitchke and R. Wille for $M_3(B)$. It also provides a positive answer to a problem of E. T. Schmidt. (Received May 22, 1978.)

**Some radical properties of Jordan matrix rings II.** Preliminary report.

Let $A$ be a 3-torsion free alternative ring in which $2x = a$ is uniquely solvable. Let $j$ be an involution on $A$, $J_a$ the canonical involution on $A^3$ determined by a diagonal matrix $a \in A^3$ all of whose entries are invertible in the nucleus of $A$, and $H(A^3, J_a)$ the set of symmetric elements of $A^3$. Then if $SP$ denotes the strongly semiprime radical then $SP(H(A^3, J_a)) = H(A^3, J_a) \cap SP(A)^3$. In view of our earlier result regarding the prime radical (these Notices 25 (1978), A-65) it follows that the prime radical and the strongly semiprime radical coincide for Jordan matrix rings determined by rings $A$ with the characteristic conditions of above. (Received May 22, 1978.)

**Conjugates and nth roots in Mal'cev-Neumann sfields.**

Let $k$ be a field, $G$ an ordered group, and $k((G))$ the Mal'cev-Neumann sfield of formal power series with coefficients in $k$ and well-ordered supports in $G$ (P. M. Cohn, Universal Algebra, p. 276). We shall say $G$ has Centralizer Chain Condition (CCC) if every chain $G = G_0 \supset G_1 \supset \cdots$, such that $G_{i+1}$ is the centralizer of a noncentral element of $G_i$, is finite. If $n$ is a positive integer such that $\text{char } k \neq n$, we show that an element $1$ of $k((G))$ has an $n$th root (unique up to a factor of an $n$th root of 1 in $k$) if and only if its leading (= lowest) term does. If char $k = p > 0$ and all elements of $G$ and of $k$ have $p$th roots, and $G$ has CCC, then all elements of $k((G))$ have unique $p$th roots. These results are proved by showing that every element can be brought by an inner automorphism of $k((G))$ to a form to which commutative methods can be applied. An example shows that the second result is false without the CCC, but it is not clear whether it is existence or uniqueness, or both, that fail! (Received May 22, 1978.)

**The lattices of ideals of semigroups and inverse semigroups.**

Let $P$ be any partially ordered set in which every two elements have a common lower bound. A $P$-semilattice is a structure $E = (E, \wedge, \wedge)$ where $(E, \wedge)$ is a lower semilattice and $\lambda: S \rightharpoonup P$ such that (i) for all $e, f \in S$ with $e < f$, $\lambda(e) < \lambda(f)$, $E$ is full if (ii) for all $p, q \in P$ with $p < q$ there exist $e, f \in E$ with $e < f$, $\lambda(e) = p$ and $\lambda(f) = q$ and $E$ is uniform if (iii) for all $e, f \in E$ with $\lambda(e) = \lambda(f)$, the $P$-semilattices $E < e$ and $E < f$ are isomorphic. Theorem. There exists a full, uniform $P$-semilattice, $E$. Taking the inverse semigroup of all $P$-semilattice isomorphisms between principal ideals of $E$ gives Corollary 1. There is an inverse semigroup with no two comparable $\mathcal{J}$-related idempotents whose set of principal ideals partially ordered by inclusion is isomorphic to $P$. Corollary 2. A lattice, $L$, is isomorphic to the lattice of all ideals of a semigroup (including the empty set) iff $L$ is complete and distributive, every element of $L$ is a join of compact join-irreducible elements and every two nonzero elements of $L$ have a common, nonzero lower bound. If so, the semigroup may be chosen to be an inverse semigroup with no two comparable $\mathcal{J}$-related idempotents. (Received May 22, 1978.) (Author introduced by Professor John W. Rosenthal).
Inverse semigroup congruences on a standard regular semigroup.

We use the definitions and notation of Ronson J. Warne and Irene Loomis, "Standard regular semigroups", these Notices 24 (1977), A-523. Let \( S = (Y, V, T) \) be a standard regular semigroup, \( I = U(I_y : y \in Y) \), and \( J = U(J_y : y \in Y) \). Let \( N \) denote the collection of all finite products of elements of the form \( a^{-1} oa \) where \( a \in V \) and \( s \) or \( s^{-1} \in J \). Let \( N_y = N \cap Y \) for \( y \in Y \). Let \( \delta_N = \{(i, a, j), (p, b, q)\} \in SX: N_yoa = N_yob \) where \( y = aoa^{-1} = bob^{-1} \). Then, \( \delta_N \) is the minimum inverse semigroup congruence on \( S \).

(Received May 23, 1978.)

Analysis (26, 28, 30–35, 39–47, 49)

The continuity of monotone polynomial operators on ordered topological vector spaces.

The author has generalized the standard theorems of Nachbin, Namioka, and Schaefer on sufficient conditions for the continuity of positive linear maps of ordered topological vector spaces to monotone polynomial operators in the following form: Let \( E \) and \( F \) be ordered topological vector spaces with positive cones \( K_1 \) and \( K_2 \) respectively. If \( K_2 \) is normal, then each of the following is sufficient for a monotone polynomial operator \( P: E \to F \) to be continuous in (a) and (b) and hypocontinuous in (c):

(a). The cone \( K_1 \) of \( E \) has nonempty interior.

(b). \( E \) is a metrisable topological vector space of the second category and \( K_1 \) is a complete, generating cone.

(c). \( E \) is a sequentially complete bornological space, \( K_1 \) is closed, and \( F \) is locally convex. If in addition \( E \) is a (DF) space, \( P \) is continuous. (Received March 16, 1978.)

Splitting singly-generated \( W^* \)-algebras. Preliminary report.

Let \( N \) be a Von Neumann algebra, and let \( \text{Irr}_\sigma(N) \) denote the family of all \( \sigma \)-continuous irreducible representations of \( N \).

Let \( T_1, T_2 \) be operators on a Hilbert space, let \( N = W^*(T_1 \oplus T_2), N_i = W^*(T_i), i = 1, 2 \). For \( \sigma \in \text{Irr}_\sigma(N) \), define \( \sigma(T_1 \oplus T_2) = \sigma(T_1)^i, i = 1, 2 \). Let \( \text{supp} \sigma \) denote the central projection in \( N \) such that \( \ker \sigma = N(I - \text{supp} \sigma) \). Set \( S_i = \{ \text{supp} \sigma : \sigma \in \text{Irr}_\sigma(N_i), i = 1, 2 \} \).
Theorem. The following are equivalent:

1. \( W^*(T_1 \otimes T_2) = W^*(T_1) \otimes W^*(T_2) \).
2. \( S_1 \perp S_2 \) and \( \sup(S_1 \cup S_2) = I \).
3. If \( A \in B(H) \) satisfies \( AT_1 = T_2^*A \) and \( AT_2 = T_2^*A \), then \( A = 0 \).

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*78T-Bl20

More on weak estimates for oscillating kernels. Preliminary report.

In an earlier paper (see these Notices, 753-833, Feb. 1978) we announced weak \( L^p \) type estimates for a general class of kernels on \( IR^1 \). To show the power of the method we use it to solve an endpoint problem. For example, for \( 1 < p < 2 \) let \( \phi(t) = e^{it\log|t|^\gamma} (\log(2+|t|))^{-s} \), then set \( K_p(t) = |t|^{-1/p} \phi(t) \) and \( K_1(t) = (1+|t|)^{-1} \phi(t) \), \(-\infty < t < \infty \). Theorem 1. Let \( 0 < \gamma < 1, \delta = \frac{1}{2}(1-\eta) \) and \( 1 < p \leq \frac{2}{1+\eta} \). Then, \( \sup_{|t| \leq 1} ||K_p*f||_q \leq c_q \), for \( p < q < p' \) and for \( q = p \) we get for each \( \lambda > 0 \), (2) \( \prod_{|x| \leq \lambda} ||K_p*f(x)|| \leq c \lambda^p ||f||_p \) and (3) \( \sup_{|x| \leq 1} ||K_p*f||_p = +\infty \). \( X_p \) is the characteristic function of the set \( E \). Furthermore, for \( p = 1 \) we get, for each \( \lambda > 0 \), \( \prod_{|x| \leq \lambda} ||K_p*f(x)|| \leq c \lambda^p (\log(2+\lambda^{-1}))^{-\delta} ||f||_1 \). The constant \( c_q \) is independent of \( f \) and the constant \( c \) is independent of \( f \) and \( \lambda \). (Received April 14, 1978.)

*78T-Bl21

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Relations between fixed-point theory and numerical analysis.

Recall that Helly's Theorem for an arbitrary Minkowski space can be viewed as a very special kind of fixed-point theorem [These Notices 24 (1977), A-9; #77T-B1] for that Minkowski space; viz., a fixed-point-extension theorem for a system of families of continuous self-mappings. The present note applies this fixed-point generalization of Helly's Theorem to improve slightly on interesting results by Lev G. Snirel'man on uniform approximations of functions by polynomials of arbitrary degrees [0 ravnomenykh približeniyah, Izv. Akad.Nauk (Mat.) 2 (1938), 53-59]. As spin-off from this fixed-point approach, one has very brief, if not trivial, proofs of several geometric results such as Rolle's Theorem and its principal generalization. Fixed-point approaches to other aspects of classical uniform-approximation theory are discussed informally. (Received April 17, 1978.)

*78T-Bl22

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On divergence of Vilenkin-Fourier series. Preliminary report.

Given a Vilenkin system of functions with respect to the sequence of primes \( \{p_1, p_2, \ldots, p_k, \ldots\} \) with \( \sup_k p_k < \infty \), there exists no \( f \in L[0,1] \) whose Vilenkin-Fourier partial sums \( \{\sum f(x)\} \) are bounded divergent everywhere. This result is an analogue to trigonometric-Fourier series. (Received April 24, 1978.)

*78T-Bl23


Let \( 1 \leq k_1 < k_2 < \ldots < k_\ell \leq n \) be \( \ell \) integers, \( e_i = \pm 1 \) (\( i = 1, \ldots, \ell \)), and \( M_n \) be the set of polynomials \( p \) of degree \( n \) or less such that \( e_i P^{k_i}(x) \geq 0 \) for \( x \in [a,b] \). For \( f \in C[a,b] \), \( p^f_P \) denotes the unique best uniform approximation to \( f \) from \( M_n \). P. Yates and J. Roulier have shown that \( p^f_P \) need not be strongly unique. In this paper, we show that if \( \deg p^f_P \geq k_\ell \), then \( p^f_P \) satisfies a strong unicity condition of order \( 1/2 \); that is, for each \( K > 0 \) there is a constant \( \tau(f,K) \) such that \( ||p - p^f_P|| \leq \tau(f,K) \prod_{\ell} ||f_p^f - f||_1^{1/2} \) for all \( p \in M_n \) with \( ||p|| \leq K \). In addition, \( p^f_P \) satisfies a local Lipschitz condition of order \( 1/2 \) on bounded subsets of \( C[a,b] \). (Received April 24, 1978.)

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Second order linear partial differential equations (PDEs) in two independent complex variables and with holomorphic coefficients in a domain \( G \) admit representations of all holomorphic solutions in \( G \) by a pair of Bergman integral operators of the first kind. These representations are local, in principle. For obtaining global results, it is useful to introduce polynomial kernels. By definition, these kernels are polynomials in the variable of integration with coefficients depending only on the coefficients of the PDE. For these operators, the inversion problem is the determination of a pair of associated functions corresponding to a given solution holomorphic in \( G \). This problem is solved by reducing it to the investigation of an ordinary differential equation.

The PDEs admitting polynomial kernels form a proper subclass of the class of all PDEs of the above type. The authors have previously characterized that subclass by necessary and sufficient conditions, and have derived construction principles for those kernels and coefficients of corresponding representations of all holomorphic solutions in \( G \) by a pair of Bergman integral operators. By theoretic investigations of solutions can be based on those integral operators by Bergman or differential operators by Bauer or - in the self-adjoint case - on the complex Riemann-Vekua function and a Bergman kernel derived from it.

(Received April 25, 1978.)

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We consider complex separable infinite dimensional Hilbert space \( H \). If \( T \) is a contraction on \( H \), then the set of all translates of \( T \) is defined as the set \( \{ T^kU : U \in U \} \), the set of all unitaries. If \( T \) is the shift, Halmos proved that weak closure of this set is the set of all contractions, which suggests the question for arbitrary contraction. We prove the following. Theorem 1. For any contraction \( T \) on \( H \), the following are equivalent. a) Weak closure of \( \{ T^kU : U \in U \} \) = all contractions. b) The closure \( F(T) \) of the numerical range of \( T \) is the closed unit disc \( F \). c) The spectrum \( \sigma(T) \) of \( T \) contains the boundary \( \partial \) of the unit disc. d) The essential spectrum \( \sigma_e(T) \) contains \( \partial \). e) The contractive map \( \varphi \) from the disc algebra \( D \) into the algebra \( L(U) \) of all bounded linear operators on \( H \) defined by \( \varphi(f) = f(T) \) for any \( f \) in \( D \), is isometric.

Theorem 2. If \( T \) is a weighted shift with \( \{ a_k \} \), the weight sequence such that \( 0 < a_k \leq 1 \), \( k \in \mathbb{Z} \), then any of the above conditions is equivalent to \( f \) \( \forall M > 0, \exists M \) such that \( \sigma_M^1 > 1 - \epsilon \), \( \epsilon = 0, 1, \ldots, N \). Corollary. If \( T \) is a contraction that satisfies a) and if \( K \) is a compact operator such that \( \| T + K \| \leq 1 \), then \( T + K \) satisfies a) also. (Received April 26, 1978.)

The following theorem has been proved which extends a result of Gersberg (Izv. Vyss. Ucelin. Zaved Matematika, 1964 no. 4 (61), 39-46). Theorem. If the series \( \sum a_n \) is summable \( | R_p \) and, if, \( s_n = O(1) \), then it is also summable \( | A | \). (Received April 26, 1978.) (Author introduced by Dr. A. N. Siddiqi.)

Let each of \( E \) and \( F \) be a locally convex space. Definitions: i) \( E \) is multiply sequentially bounded (M.S.B.) if there exists a bounded subset \( B_0 \) of \( E \) so that \( E = \bigcup \{ B_0 \} \). ii) \( E \) is countably bounded (C.B.) if there is a nested sequence \( \{ B_j \} \) of bounded subsets of \( E \) so that if \( B \) is a bounded subset of \( E \), then there is a positive integer \( j \) so that \( B \subset B_j \). iii) \( E \) is multiply countably bounded (M.C.B.) if there is a bounded subset \( B_0 \) of \( E \) so that if \( B \) is a bounded subset of \( E \), then there is a positive integer \( j \) so that \( B \subset jB_0 \). We proved: Theorem 1. Let \( E \) be an M.C.B. locally convex Hausdorff space
and let $F$ be a normed space. Then $(L_c(E, F), \text{strong})$ is a normed space. \textbf{Theorem 2.} Let $E$ be a C.B. locally convex Hausdorff space and $F$ be a metrizable locally convex space, then $(L_c(E, F), \text{strong})$ is metrizable. \textbf{Remark 1.} $(E', \text{strong})$ is not necessarily normable when $E$ is only C.B. \textbf{Remark 2.} There does not necessarily exist a metrizable topology which can be placed on $E$ which is compatible with the duality $(E, E')$ when $E$ is M.S.B. or C.B. \textbf{Theorem 3.} If $E$ is an M.C.B. locally convex Hausdorff space, then there is a metrizable topology on $E$ which is compatible with the duality $(E, E')$. (Received April 28, 1978.)

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**78T-B128** JERRY JOHNSON, Oklahoma State University, Stillwater, Oklahoma 74074 and JOHN WOLFE, Oklahoma State University, Stillwater, Oklahoma 74074. \textit{Another Renorming of $c_0$.}

If $E$ is a Banach space, $P$ is the canonical projection of $E^{***}$ onto $E^*$. Given a number $t \in (1,2]$ and $x \in c_0$, let $\|x\| = \frac{1}{t-1} \sup_n |x_n|$. For this renorming of $c_0$ we have $\|I - P\| = t$. This answers a question posed to us by Fran Sullivan. (Received April 28, 1978.)

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**78T-B129** G. P. KAPOOR and K. GOPAL, V. V. Post Graduate College, Shamli 247776, India. \textit{On the mean value related to functions analytic in the unit disc.}

Let $f(z)$ be a function analytic in the unit disc and have order $\rho$. We consider the mean value $F(r) = \int_0^r (1-x)^{-k-1} (1 + \beta(x)) C(x) \, dx$, $(0 < k < \infty)$, where $\beta(x)$ is a proximate order of $f(z)$ (see e.g., Kapoor: A note on the proximate order of functions analytic in the unit disc, Istanbul Univ. Fen. Fak., Mec. Ser. A. 36(1971), 35-40) and $C(r)$ is a positive and increasing function on $(0,1)$. In particular, $C(r)$ can be the arithmetic mean value or the geometric mean value of $f(z)$ on $|z| = r$, $0 < r < 1$. In the present paper certain best possible inequalities depicting the rate of growth of $F(r)$ with respect to the proximate order $\beta(r)$ as compared to that of function $\alpha(r) = \int_0^1 (1 + \beta(x)) (1-x)^{-1} \, dx$ are obtained. (Received April 28, 1978.) (Author introduced by Professor P. Sharma).

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**78T-B130** ETHELBERT N. CHUKWU, University of Jos, Jos, Nigeria. \textit{An estimate for the Solutions of a certain functional differential equation of neutral type.}

In this paper we derive an estimate for the solutions $x(t_0, \phi)$ of functional differential equation of neutral type,

\[
\frac{dx}{dt} [x(t) - C x(t-h)] = f(t, x(t), x(t-h)), \quad t > t_0
\]

\[
x(t) = \phi \text{ in } [-h,0].
\]

which enables one to deduce the result $x(t,t_0,\phi) \to 0$ as $t \to \infty$.

The investigation uses an explicit Liapunov functional for the neutral equation. As a consequence of this and some basic results of Cruz and Hale, J. Diff. Equation Vol. 7 334-355 (1970), the stability of the equation is deduced. (Received April 28, 1978.)

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**78T-B131** DOMINGO A. HERRERO, I.V.I.C., Matemáticas, A.P.1827, Caracas 101, Venezuela. \textit{Closure of similarity orbits of FBQT operators.}

Let $S(T) = \{WTW^{-1} : W \text{ is invertible}\}$ be the "similarity orbit" of an operator $T$ acting on a complex separable Hilbert space and let $S(T)^{-}$ be its norm closure. A complete description of $S(T)^{-}$ (in terms of parts of the spectra of the operators in this set) is obtained for all $T$ such that $-\infty < \text{ind} (z-T) < +\infty$ for all complex $z$ such that $z-T$ is semi-Fredholm and the isolated points of the essential spectrum of $T$ are of a certain type (defined in terms of analytic functions and compact perturbations of $T$). Corollaries: 1) A complete characterization of those orbits such that $S(T)^{-}$ is maximal (with respect to inclusion); 2) If $X$ is a nonempty compact subset of the plane and $S_E(X) = \{T : A(T) (\ast \text{ spectrum of } T) \text{ coincides with } X\}$, then $S_E(X)^{-}$ is the set of all those
operators $A$ such that $A(A)$ contains $X$, every component of $A(A)$ intersects $X$, every $z$ such that $z-A$ is semi-Fredholm with $\text{ind}(z-A) \neq 0$ belongs to $X$ and every $z$ in the boundary of $X$ such that $z-A$ is semi-Fredholm of index 0 is an isolated point of $X$; 3) If $Y$ is a nonempty subset of the plane and $\mathcal{S}(Y) = \{ T: A(T) \subseteq Y \}$, then $\mathcal{S}(Y) = \bigcup \{ \mathcal{S}(T): T \in \mathcal{S}(Y) \}$. (Received May 22, 1978.)


The two-dimensional Vlasov-Poisson system is

$$\frac{\partial u}{\partial t} + v \cdot \nabla u + \frac{\partial}{\partial x} (u \psi) = 0;\quad u(x,v) = f(x,v)$$

where $\Delta = \frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2}$.

A global-in-time proof of classical solutions is given for $f$ an arbitrary continuously differentiable function with compact support. The proof is essentially that given in [2] with some additional ideas and estimates taken from [1].


Let $T_0$ be a non-negative regular matrix. A bounded function $f: \mathbb{N} \to \mathbb{R}$ is $T_0$-almost convergent if it is assigned the same value by every $T_0$-invariant mean.

Theorem. Assume (1) the space of $T_0$-almost convergent functions is equal to the bounded convergence field of some non-negative regular matrix $S_0$, (2) the operator $S$ on $C(\mathbb{N} \setminus \mathbb{N})$ induced by $S_0$ is "good". Then the operator $T$ induced by $T_0$ on $C(\mathbb{N} \setminus \mathbb{N})$ is uniformly ergodic, i.e., the averages $(1/n)(I + \cdots + T^{n-1})$ converge in the uniform topology.

(The class of "good" operators includes Markov projections, generalized averaging operators, etc. They have the following useful property: if $Tf \geq 0$, then there exists $g \geq 0$ with $Tg = T_k$.) (Received May 8, 1978.)

WILLIAM D. L. APPLING, North Texas State University, Denton, Texas 76203. An integrability preservation characterization theorem.

Suppose $N$ is a positive integer and $g$ is a function from $\mathbb{R}^{N+1}$ into $\mathbb{R}$ such that for some $(\omega_1, \ldots, \omega_N)$ in $\mathbb{R}^N$ and $d > 0$, $g(\omega_1, \ldots, \omega_N)$ is bounded on $(-d;d)$. Theorem. The following three statements are equivalent: 1) If $U$, $P$, $P_B$, $P_{AB}$ are as in previous abstracts of the author, each of $\lambda_1, \ldots, \lambda_N$ is in $P_B$ and $h$ is in $P_{AB}$ and each of $\sum_{\lambda\in\Lambda}(Ih)(I)$ exists, then $\sum_{\lambda\in\Lambda}(Ih)(I)$ exists. 2) If each of $E_1, \ldots, E_N$ is a function from the subintervals of $[0;1]$ into $\exp(R)$ with bounded range union and $k$ is a real-valued function of bounded variation on $[0;1]$ such that each of $\sum_{I\subseteq\Lambda}B_1(I)dk, \ldots, \sum_{I\subseteq\Lambda}B_N(I)dk$ exists, then $\sum_{I\subseteq\Lambda}B_1(I)dk, \ldots, \sum_{I\subseteq\Lambda}B_N(I)dk$ exists. 3) An elaborate continuity-sequence-convergence-type condition on $g$ too lengthy for this abstract. (Received May 8, 1978.)

C. J. HARMAN, Mitchell College, Bathurst, N.S.W., 2795, Australia. A model for analytic functions in the discrete polar plane.

A discrete model for analytic functions is constructed using lattice points of the complex plane arranged in polar form. The discrete analytic functions are defined as solutions of a finite-
difference approximation to the polar Cauchy-Riemann equations. An analogue of Cauchy's integral theorem follows and a pseudo-power \( z^{(n)} \) is derived. The polar lattice is chosen judiciously such that \( z^{(n)} \) exhibits a blending of some of the 'better' properties of monodiffric pseudo-powers and the author's \( q \)-analytic function \( z^{(n)} \). The resulting function has a very simple algebraic form (a direct analogue of \( r^n \exp(in\theta) \)) and has some surprisingly powerful properties (e.g.: \( z^{(n)} = 0 \Leftrightarrow z = 0 \); \( \lim_n z^n \) converges \( \Rightarrow \lim_n z^{(n)} \) converges; \( z^{(n)} \) forms a basis i.e. if \( f \) is discrete analytic in the polar sense then \( f(z) = \lim_n z^{(n)} \)). (Received May 9, 1978.)

*87T-B136 ROBERT C. DUNCAN and MATTHEW WITTEN, Department of Biometry, Medical University of South Carolina 29403. Problems arising from truncation and roundoff in iterative models.

In his article on generalized conjugacy theorems for iterative models, Witten has pointed out that the extention set \( f_\alpha(x) \) of \( f_\alpha(x) = ax(1-x) \), is dense with dense complement in \([0,1]\). In this paper we discuss various ramifications of the dense property with respect to computer simulation of iterative models. For values of \( b \) in the chaotic region \((b \geq 83)\) of the model \( f_\alpha(x) = bx(1-x) \) it is seen that an error in \( x \) can throw \( x \) onto a different trajectory. Finite computer representation of the reals involves truncation error in the beginning and this together with subsequent roundoff errors disturbs the (deterministic) path of the system. In particular, for \( f_4(x) \), it is impossible to recover certain points in \( \mathbb{C}(i) \). Thus, questions arise about tracing a trajectory from computer simulation. (a) How do we find cycles with some certainty, (b) How do we even trace the path of a trajectory. For \( f_2(x) \) a density function is known and gives correct density under computer simulation. However, even if the density looks as expected, if the simulation is not working correctly the implications are not clear. The behavior of \( f_4(z) \) is investigated under various levels of precision of the computer representation of \( x \) and for various values of the parameter \( b \). (Received May 10, 1978.)

*87T-B137 MARIA FRAKOULOPOLIOU, University of Athens, Math. Institute, 57 Solonos Str., Athens 143, Greece. Enveloping l.m.c. \( * \)-algebras. Preliminary report.

Let \( (E, (p_a)) \) be a l.m.c. \( * \)-algebra (locally \( m \)-convex algebra with an involution such that \( p_a(x^*) = p_a(x) \), \( x \in E \), \( a \in A \) with a b.a.i. (bounded approximate identity), and \((U_a)\) the local basis of \( E \) corresponding to \((p_a)\). Denote by \( B(E) (\leq E_S) \) the extreme points of \( (P(E) (positive linear forms \( f \) on \( E \) so that there exists \( a \in A \) with \( f \mid 1_{[0,1]}(U_a) \). The set \( R(E) \) of all equivalence classes of continuous topologically irreducible representations of \( E \) into Hilbert spaces is endowed with the final topology \( \tau_0 \) from \( B(E) \) and called the space of representations of \( E \). Now, if \( \Gamma = \bigcap \ker(p_a) (\Gamma = \text{supp}(f(x^x)\beta : f \in \mathbb{B}(E)), \mathbb{B}(E) = \{ f \in B(E) : \mid f \mid < 1_{[0,1]}(U_a) \}, \Gamma_0 = \Gamma \cap \Gamma_\sigma (\mathbb{B}(E)), \sigma \mathbb{B}(E) \sigma \mathbb{B}(E)) \), the completion of the l.m.c. \( * \)-algebra (with the \( C^* \)-property) \( (B(E) / 1_{[0,1]}(U_a)) \), denoted by \( \mathcal{E}(E) \), is called the enveloping algebra of \( E \). Theorem 1. Let \( E \), \( \mathcal{E}(E) \) be as above. Then, (i) \( \mathcal{E}(E) = \lim_{\tau_0} (E_{\sigma}) \) within topology isomorphism, where \( E_{\sigma} = \mathbb{E}(\ker(p_a), a \in A \).

(ii) If \( \mathcal{E}(E) \) is i.e. (locally equicontinuous), then \( B(E) = \mathbb{B}(\mathcal{E}(E)), \mathcal{R}(E) = \mathcal{R}(\mathcal{E}(E)) \) within homeomorphisms. Theorem 2. Let \( E \) be a Fréchet l.m.c. \( * \)-algebra. Then, (i) if \( E \) has the \( C^* \)-property, \( \tau_0 \) on \( \mathcal{R}(E) \), \( \tau_0 \) is initial topology on \( \mathcal{R}(E) \) from \( \mathcal{R}(E) \) (primitive ideals of \( E \) with the h.k.-topology). (ii) If \( E \) has a b.a.i. and \( \mathcal{B}(\mathcal{E}(E)) \) is i.e., the map \( \mathcal{B}(E) \rightarrow (\mathcal{R}(E), \tau_0) \) is open. (Received May 15, 1978.) (Author introduced by Professor A. Mallios).

*87T-B138 HUZOOR H., KHAN, Department of Mathematics, Aligarh Muslim University, Aligarh, India. On the degree of approximation by weighted \((L^p, \psi (h))\). class.

If \( f(x) \in \text{Lip}(\alpha, 0 < \alpha < 1) \) and \( S_n(x) \), the nth partial sum of its Fourier series, then \( f(x) - S_n(x) = O(1/n^{\alpha}) \) is not true in general but if \( f(x) \in \text{lip}(\alpha, p) \), then \( f(x) - S_n(x) = O(1/n^{\alpha - 1/p}) \). We define anew class names weighted \((L^p, \psi (h))\) and say that \( f(x) \in \text{Lip}(\alpha, \psi (h)) \) if \( \left[ \int_0^{2\pi} |f(x + h) - f(x)|^p \sin \theta dx/2 \pi \right]^{1/p} = O(\psi (h)) \) for \( p > 1 \) and \( h \neq 0 \) where \( \psi (h) \) is a positive increasing function. Our class weighted \((L^p, \psi (h))\) reduces to the class lip \((\alpha, p) \) when \( \beta = 0 \) and \( \psi (h) = h^{\alpha} \). For our new class, we proved a theorem \( f(x) - S_n(x) = O(\psi (1/n)^{\frac{p-1}{p}}) \), which generalizes the result due to Izumi (J. London Math. Soc. 25(1950), 40-42). (Received May 15, 1978.) (Author introduced by Professor A. H. Siddiqi).

*87T-B139 HUZOOR H., KHAN and SARFARAZ UMAR, Department of Mathematics, Aligarh Muslim University, Aligarh, India. On the degree of approximation by \( A_{\lambda} \)-means.

Let \( f(x) \) be a \( 2\pi \)-periodic function integrable \( L^p(p > 1) \) and \( f(x) = \sum_{n=0}^{\infty} (a_n \cos nx + b_n \sin nx) \) be its Fourier series. We define a new class \( \text{Lip}(\psi (t), p) \) and say that \( f(x) \in \text{Lip}(\psi (t), p), p > 1, \psi (t) \) -
f(x) = O(\psi(t)\tau^{-1/p})$, \tau \to 0$ where $\psi(t)$ is a positive increasing function. Given $\lambda > -1$, we say that the sequence $[S_n]$ is $A_\lambda$-summable to a finite sum $s$ if the series $(1-x)^{\lambda+1}\sum_{n=0}^\infty \epsilon_n \lambda S_n x^n$, where $\epsilon_n = n^{\lambda+1}$, is convergent for all $x$ in $(0,1)$, and tends to $s$ as $x \to 1$ in $(0,1)$. We define $t_n(x) = (1-x)^{\lambda+1}\sum_{n=1}^\infty \epsilon_n \lambda^n x^n S_n(x)$. In this paper we prove a theorem which gives the degree of approximation by $A_\lambda$-means. **Theorem.** If $f(x)$ is periodic and belongs to the class $\text{lip}(\psi(t), p)$ for $p > 1$, then under certain conditions $t_n(x) - f(x) = O(\psi(1-x)(1-x)^{-1/p})$. (Received May 15, 1978.) (Authors introduced by Professor A. H. Siddiqi).

78T-B140 HUZOOR H. KHAN and ABDUL WAFI, Department of Mathematics, Aligarh Muslim University, Aligarh, India. On the degree of approximation by matrix means.

Let $f(x)$ be a $2\pi$-periodic function integrable in the sense of Lebesgue over $(-\pi, \pi)$ and its Fourier series be given by $f(x) \sim a_0/2 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$. Let $(\lambda_{n,k})$ $(n = 0, 1, \ldots, k = 0, 1, \ldots, n; \lambda_{n,0} = 1)$ be a triangular matrix of real or complex numbers, and $\sum_{k=0}^{n} \lambda_{n,k} u_k = \sum_{k=0}^{n} \Delta \lambda_{n,k} S_k = \sigma_n(f, x)$, $S_k$ denotes the $k$th partial sum of the Fourier series. A series $\sum_{n=1}^{\infty} S_n$ with partial sum $S_n$ is said to be summable to a finite limit $s$ if the sequence $\sigma_n(f, x)$ tends to $s$ as $n$ tends to infinity. In this paper the following theorem has been proved which generalizes a result of G. Alexits (Math. Ann. 100(1928), 264–277) and Holland, Sahney and Taximbalaris (Acta Sci. Math. 38(1976), 69–72). **Theorem.** If $\{\lambda_{n,k}\}^n_{k=0}$ is a nonnegative and nondecreasing sequence with respect to $k$ and if $w(t)$ is the modulus of continuity of $f \in C^*([0, 2\pi])$, then the degree of approximation of $f$ by matrix means of the Fourier series for $f$ is given by $\max_{x \in I} |f(x) - \sigma_n(f, x)| = O\left(\sum_{k=1}^{\infty} \Delta \lambda_{n,k} w(1/k)\right)$. (Received May 15, 1978.) (Authors introduced by Professor A. H. Siddiqi).

78T-B141 ABDUL WAFI, ANWAR HABIB and HUZOOR H. KHAN, Department of Mathematics, Aligarh Muslim University, Aligarh, India. On generalized Bernstein polynomials.

If $f(x)$ is a function defined on $[0,1]$, the Bernstein polynomial $B_n(x)$ of $f$ is $B_n(f, x) = \sum_{k=0}^{n} \binom{n}{k} f(k/n) x^k (1-x)^{n-k}$. A small modification of the above due to Kantrovic (C. R. Acad. Sci. URSS 20(1930), 536–568, 595–600) makes possible to approximate Lebesgue integrable functions in $L_1$ norm by the modified Bernstein polynomials $P_n(f, x) = (n+1) \sum_{k=0}^{n} \left(\binom{n}{k} (1/k!)(f(k/n)) x^k (1-x)^{n-k}\right)$. In this paper we extend the theorem of Voronowskaja (C. R. Acad. Sci. URSS 4(1932), 79–85) by taking the modified Bernstein polynomial $P_n(f, x)$. **Theorem.** Let $f(x)$ be bounded Lebesgue integrable function with its first derivatives in $[0,1]$ and suppose that $f^{(1)}(x)$ exists at a certain point $x$ of $[0,1]$, then $\lim_{n \to \infty} n[f(x) - P_n(f, x)] = -f''(x)/8$. (Received May 15, 1978.) (Authors introduced by Professor A. H. Siddiqi).

*78T-BL42 LEONARD DOR, Department of Mathematics, University of Illinois, Urbana, Illinois 61801. On basis constants and duality in Banach spaces.

Let $(x_i)$ be a basis for a Banach space $X$, and let $(x_1^*)$ be the biorthogonal sequence to $(x_i)$ in $X^*$. Contrary to accepted belief, the basis constant of $(x_1^*)$ is not necessarily equal to the basis constant of $(x_i)$. Just the opposite is true:

**Theorem 1.** If $\text{span}(x_1^*) \neq X^*$, then $X$ can be renormed so that the basis constant of $(x_1^*)$ is less than 2 while the basis constant of $(x_i)$ is arbitrarily large.

**Theorem 2.** If $(x_i)$ is a basis for $X$, and if the unconditional constant of $(x_1^*)$ is $C < 2$, then the unconditional constant of $(x_i^*)$ is at most $C/(2-C)$. By the unconditional constant of $(x_i)$ we mean, as usual the quantity

$$\sup \{ \left\| \sum_{i=1}^{n} a_i x_i \right\|, \quad n \in \mathbb{N}, \quad \left\| \sum_{i=1}^{n} a_i x_i \right\| \leq 1 \}.$$ (Received May 19, 1978.)

78T-BL43 PAUL STEWART SCHNARE, University of Petroleum & Minerals, Dhahran Airport, P.O. Box 144, UPM No. 172, Dhahran, Saudi Arabia. The Bohr-Archbold Inequality is equivalent to the Cauchy-Schwarz Inequality in $c_0$.

Recently, the author rediscovered the Bohr-Archbold Inequality: Let $z_k$ be complex, $a_k$ be positive for $k = 1, \ldots, n$ and $a_1 + \ldots + a_n = 1$. Then,

$$\left| \sum_{k=1}^{n} z_k a_k \right| ^2 \leq \sum_{k=1}^{n} a_k \left| z_k \right| ^2.$$
with equality iff \( a_{ij} z_k = a_k z_j \) for all \( 1 \leq j, k \leq n \). (See Schnare, P. S., "Behrens-Fisher degrees of freedom inequalities," these Notices, to appear; also, Mitric, D. S., Analytic Inequalities, Springer, 1970, 312-313.) He showed that this inequality follows immediately from an appropriate application of the Cauchy-Schwarz inequality in \( \mathbb{C}^n \). He now proves that the converse is true, hence establishing the following **Theorem**: The Bohr-Archbold inequality is equivalent to the Cauchy-Schwarz inequality in \( \mathbb{C}^n \). (Received May 19, 1978.) (Author introduced by Dr. Harold O. Ladd).

**Notation:** \( I = [0,1] \), \( T \) the circle, \( K = I \) or \( T \), \( \sigma = \sigma_1 \) a * automorphism of \( C(K) \), \( \delta = \delta_0 \) a closed * derivation in \( C(K) \). A description is given of all \( \delta \) such that \( \sigma_1 \delta = \sigma_0 \delta \) for some \( \sigma \). The description involves "generalized Cantor functions" (gcf); \( f \in C_R(I) \) is a gcf if \( f \) is non-constant, monotone, and not 1-1 on any subinterval. A consequence of the description is that any such \( \delta \) admits closed proper extensions; this answers problems of Sakai [1, problem 1.5] and Bratteli-Robinson [2, p. 260]. All such \( \delta \) are quasi-well behaved. **Theorem.** Let \( \delta \) be the generator of a strongly continuous one-parameter group \( \sigma_t \) of * automorphisms of \( C_0(R) \). Suppose the corresponding group of homeomorphisms of \( R \) acts transitively. Let \( \delta_1 \) be a closed * derivation in \( C_0(R) \) such that \( \sigma_t \delta_1 = \sigma_t \delta \). Then \( \delta_1 \) is a gcf for some \( C \in R \). This answers a problem of Sakai [1, problem 1.6]. A solution was obtained independently by C. Batty. References: [1] S. Sakai, Theory of Unbounded Derivations in \( C^* \) Algebras, preprint. [2] Comm. Math. Phys., 42, p. 253ff. (1975). (Received May 22, 1978.) (Author introduced by Professor William G. Bade).

**Spectral theory and interpolation of operators.**

Let \((B^0, B^1)\) be an interpolation pair of Banach spaces, and let \( T: B^j \to B^j \) be a bounded linear operator, \( j = 0,1 \). We study \( \text{sp}(T, B) \), that is the spectrum of \( T \) on an intermediate Banach space \( B \). First, let \( B_{s,p}, 0 < s < 1, 1 < p < \infty \), denote the real interpolation spaces of Lions and Peetre. In a rather general context, we prove that \( \text{sp}(T, B_{s,p}) \) is independent of \( p \). An analogous program is then carried out for spaces between \( L_1 \) and \( L_\infty \). Specifically, let \( B_j = L^j_p, j = 0,1, \) let \( p_0 < p < p_1 \), and let \( X \) be a rearrangement invariant function space. Essentially, it is shown that if \( L_p \) and \( X \) enjoy similar interpolation properties, then \( \text{sp}(T, L^p) = \text{sp}(T, X) \). Examples of such \( X \) include the Lorentz spaces \( L^p_{1,q}, 1 < q < \infty \), and the Orlicz spaces \( L^p_{p} \left( \log^* L \right)^r, 1 < r < \infty \).

(Received May 22, 1978.)

**Homogeneity Structure of Distributions on Local Fields.**

Let \( K \) be a local field. For \( y \in K \setminus \{0\} \) let \( \sigma_y \) denote multiplicative translation on functions and distributions. Let \( \mathfrak{p} \) be a prime of the maximal ideal of the ring of integers \( R \) of \( K \), so that \( K = \{ \mathfrak{p}^j : j \in \mathbb{Z} \} \times D \), \( D \) the units of \( R \). A distribution \( u \) is **integrally**.
homogeneous of degree $\gamma$ if $\sigma^j \mu = \gamma(p^j) u$, $\gamma$ a multiplicative character. Several theorems are proved connecting integral homogeneity to singular integrals, the spirit being that homogeneous distributions "are" singular integrals.

"Basic Theorem. Every homogeneous distribution is the sum of $c_0$ and a distributional limit of singular integrals." Attention then centers on finding conditions under which the limit is itself a singular integral of a function or measure. "Representative Theorem: If $u$ is integrally homogeneous of degree $||^{-1}$, then $u$ is the singular integral of a measure $\mu$ if and only if its regularizations are $L_1$-bounded." Extensions exist to $L_2(K)$. (Received May 1, 1978.)

Applied Mathematics
(65, 68, 70, 73, 76, 78, 80-83, 85, 86, 90, 92-94)

78T-C30 MATTHEW WITTEN, Department of Biometry, Medical University of South Carolina, Charleston, South Carolina 29403. A new method for uniquely classifying $n$-dimensional, $m$-color rectangular patterns.

By making use of a simple construction, we demonstrate that it is possible to map an $n$-dimensional $m$-color rectangular pattern into a unique number $G(P)$. It is shown that $G(P)$ is the Goedel number of the pattern $P$ and it is also shown that $G(P)$ carries all of the information of the relative positions of the various colors in the cells of pattern $P$. Using this construction, we attempt to see if there is any relationship between the $G(P)$'s and various pattern configurations in different cellular automata games such as the game of life. (Received December 20, 1977.)

78T-C31 ERWIN O. KREYSZIG, University of Windsor, Windsor, Ontario, Canada

On an application of the binomial distribution in numerical analysis

J. Reinkenhof (J. Num. Meth. Engng. 11, 1977, 1627-1630) has proposed a method of numerical integration based on the use of Bernstein polynomials. It is shown that this method is about of the quality of a composite trapezoidal rule. Furthermore, extending that approach, one arrives at the closed Newton-Cotes formulas and can represent their coefficients in terms of column sums of the inverse of an $n+1$-rowed square matrix whose elements are probabilities corresponding to the binomial distribution. (Received April 4, 1978.)


The idea of duality is now well established in the theory of concave programming. The basis of this duality is the concave conjugate transform. This has been exemplified in the development of generalised geometric programming. Much of the current research in duality theory is focused on relaxing the requirement of concavity. Here we develop a duality theory for mathematical programming with a quasiconcave objective function and explicit quasiconcave constraints. Generalisations of the concave conjugate transform are introduced which pair quasiconcave functions as the concave conjugate transform does for concave functions. Optimality conditions are derived relating the primal quasiconcave program to its dual. This duality theory was motivated by and has implications in certain problems of mathematical economics. An application to economics is given. (Received April 17, 1978.) (Authors introduced by Professor Robert G. Jeroslow).
In a recent paper Atias, Wofshstein and Israeli have compared efficiency of various Navier-Stokes solvers. In particular, they studied a second order upwind scheme (USO) for discretizing the convective terms in the vorticity transport equation. This paper presents convergence and stability properties of the second order upwind scheme when applied to a linearized one-dimensional form of the vorticity transport equation. Comparisons are carried out with the existing central difference scheme (CC) and the first order upwind difference scheme (UFO) and it is found that the second order upwind scheme is no better than the central difference scheme for small Reynolds numbers and is no better than the upwind difference scheme of first order for large Reynolds numbers. Even when the accuracy of the USO is comparable to the accuracy of CC, it is computationally more complex.


The network flow method originated by Karzanov [Determining the maximal flow in a network by the method of preflows, Soviet Math. Dokl. 15 (1974) 434-437] and elaborated on by S. Even [The max flow algorithm of Dinic and Karzanov, Lecture notes, M.I.T., 1976] is modified to operate with array space in the amount of 5N + 4E, where N is the number of vertices, and E twice the number of undirected edges. (An edge pq may have positive capacity in both the directions p → q and q → p but both must be supplied even if only one is positive.) The use of push-down stacks associated with each vertex, to register incoming flow, is entirely avoided by determining precise instants when accumulated pre-flow, is "old" (i.e., not to be changed again) and transferring it to previously accumulated flow. The "new" pre-flow is easily accommodated in other parts of the array space. Details are to appear elsewhere [A. Nijenhuis and H. S. Wilf, Combinatorial Algorithms, 2nd Ed. (1978), Academic Press, New York]. (Received May 10, 1978.)

In this game of R. Isaacs, the players are a hider and a searcher. The payoff is the time until capture. The hider is assumed to be mobile within a bounded set D. The searcher has an arbitrarily small detection radius. There is incomplete information in that neither player knows the present or past location of the other. For various sets D, the value of the game is demonstrated by the presentation of ε-optimal strategies. Specifically, the game is solved in case D is convex or is the finite union of convex sets in $\mathbb{R}^n$ with $n \geq 2$. Also the game is discussed in the case where D is a network. The results settle two conjectures of S. Gal. (Received May 16, 1978.)

Let G be an acyclic digraph. A source is a node with no incoming arcs. The Topological Sort algorithm can be formulated as follows:

1. do while (nonempty G)
   1.1. Find a source S.
   1.2. Output S.
   1.3. Delete S from G.

We define Data and Control Structure transformations on T to get: standard nonrecursive versions of preorder and postorder tree traversals, radix linked sort algorithm and a game tree evaluator. The used processes can be automated and the described inference of the algorithms from the Topological Sort algorithm has methodological virtues.


A-494
ANDREW M. OLSON, University of Puerto Rico, Río Piedras, Puerto Rico, 00931.

Computable Series Representations of Nonlinear Operators.

This paper concerns a class of computational methods arising from the use of series representations in solving nonlinear operator equations, in particular, methods in which the operator equation is reduced to a system of ordinary equations. The reduction is accomplished during a symbol manipulation phase, whereas the resulting system is solved during a numerical phase. The basic question addressed is which types of operators and series lend themselves to this reduction in such a way that both phases of the method can be effected on a computer. It is shown that an analytic operator, represented by a power series, can be reduced to such a system if and only if its domain is what is termed a weakly nilpotent algebra. Analogous results are proved for operators represented by series of analytic operators. The theory is extended to implicit representations of operators and, by way of example, is applied to rational and differential representations. The results obtained here generalize to simultaneous systems of operators. (Received May 17, 1978.)

MATTHEW WITTEN, Department of Biometry, ARMAND GLASSMAN, and BETH BENNETT, Department of Laboratory Medicine, Medical University of South Carolina, 171 Ashley Avenue, Charleston, S.C. 29403. A Kinetics Study of an Abrin Single Pulse Experiment.

Glassman et al have demonstrated that the mitogenic agent Abrin effectively reduces metabolic uptake of radioactive thymidine. In this paper, we demonstrate that this process can be effectively modeled by the kinetics equation

$$X + Y \xrightarrow{k_1} XY \xrightarrow{k_3} X' + Y'$$

We discuss the asymptotic behavior of the abrin and transformed cell populations, showing that the equation gives excellent results in comparison to experimental results. (Received May 22, 1978.)

Geometry (50, 52, 53)

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Polar Reciprocal Convex Bodies.

Let $K^*$ be the polar of a convex body $K$ in $\mathbb{R}^n$ relative to a point in $\text{int } K$. Theorem: For proper, symmetric convex bodies in $\mathbb{R}^n$, the volumes satisfy $V(K)V(K^*) = \frac{4^n}{n!}$. Equality holds only if $K$ is a direct product $K = P \times Q$ or the convex hull $K = \text{conv}(P,Q)$ of symmetric bodies in complementary $p$- and $q$-spaces through the center of $K$, $p + q = n$, and $V(P)V(Q^*) = \frac{4^p}{p!}$, $V(Q)V(P^*) = \frac{4^q}{q!}$. The second part corrects a result of the author (Israel Journal of Math. 14(1973) 109-116) where only $p = n-1$ was considered. (Received May 1, 1978.)

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Equidistance Relations in Geometry and Metric Spaces.

Section 1 recounts Arthur Cayley's use of "equidistance" in "A Sixth Memoir on Quantics" and contains a short sidelight on making this rigorous using non-standard analysis. Section 2 characterizes equidistance in general, investigates two metrics having the same equidistance relation, their topologies, the functions relating the metrics, and especially the case of "most stringent metrics". These include normed linear spaces of two or more dimensions. Section 3 investigates equidistance and isometries. The principle result shows that equidistance can be used as a foundation for metric geometries. Section 4 shows how to recover a metric from its equidistance relation for those relations which are "triangle complete". (Received August 13, 1978.)
A convex manifold is a compact, smooth Riemannian manifold $M^n$ with smooth boundary $\partial M$ such that there is a Riemannian manifold $\tilde{M}^n$ without boundary and an isometric embedding $i: M \to \tilde{M}$ with $i(M)$ a convex subset of $\tilde{M}$ in the sense of Cheeger and Gromoll, Ann. Math., 96. A point on the boundary of $M$ where the second fundamental form of an outward normal is positive definite is a point of strict convexity. We prove:

**Th. 1** - If $M$ is strictly convex, positively curved, it can be imbedded isometrically into a complete open manifold of positive curvature.  
**Th. 2** - If $M$ is a strictly convex surface (or a convex surface with $K_{M} = 0$) of non-negative curvature, it can be $C^2$ imbedded into a complete open surface of non-negative curvature.

**Th. 3** - If $M$ is a convex surface of non-negative curvature with at least one point of strict convexity and no conjugate points along any boundary geodesics, then again the preceding result holds.  
**Th. 4** - If $M$ is a convex surface of non-negative curvature whose boundary is a geodesic, it can be $C^2$ imbedded into a compact surface homeomorphic to the sphere.  

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### Logic and Foundations (02, 04)


In Ann. Math. Logic(1977) the authors sketched the theory of the lattice $L(V_{\omega})$ of re subspaces of an $\omega$-dimensional recursively presented (rp) vector space with a recursive base, subsequently
developed by Kalantari, Remmel, Retzlaff, Shore, TeKolste in a dozen papers. This suggests investigation of \( \mathcal{A}(F_{\omega}) \), the lattice of \( \omega \) algebraically closed subfields of an \( n \)-dimensional \( \mathbb{F} \) algebraically closed field with a recursive transcendence base. But the modularity of \( \mathcal{A}(F_{\omega}) \) was heavily used. At our request C.Ash and J.Rosendahl developed many intricate examples of the non-modular character of \( \mathcal{A}(F_{\omega}) \). So some new wrinkles were needed. One is dependence state; given \( F \in \mathcal{A}(F_{\omega}) \), \( a_1, \ldots, a_n \in F_{\omega} \), \( \omega_1 \subseteq F_{\omega} \) the \( e \)-state of \( a_1 \) has as its \( i \)th coordinate \( 0 \) or \( 1 \) as \( a_1 \) is in the algebraic closure of \( a_1, a_0, \ldots, a_{i-1} \). With this maximality and supermaximality proofs become very short. Another is that the proper analogue of recursive set is not complemented element, but an \( A \) with a complement \( B \) such that the union of an independent set from \( A \) with one from \( B \) is always independent. Then one gets elements recursive as sets but not as members of \( \mathcal{A}(F_{\omega}) \), etc. Also, there are no recursively homogeneous universal fields. (Received December 2, 1978.)


By defining new conditions on forcing preserved by iteration, we get, e.g., the consistency of:
1) If \( P \) has power \( \aleph_1 \), and forcing by it does not destroy any stationary subsets of \( \omega_1 \), then for any \( \aleph_1 \) dense subsets of \( P \) there is a generic subset \( G \) of \( P \).

2) G.C.H. and an axiom implying the Souslin hypothesis. The proof seemed to us simpler than Jensen's proof of the consistency of SH + G.C.H.

3) There is a set \( A \subseteq 2^\omega \), \( |A| = \aleph_1 \), of the second category, and if \( A, B \subseteq 2^\omega \) are everywhere of the second category, \( |A| = |B| = \aleph_1 \), then \( A_n \in \mathcal{E}_n \iff B_n \in \mathcal{E}_n \) where \( a_n \iff a \cap \mathcal{E}_n \).

4) Not CH, but there is a universal order of power \( \aleph_1 \). (Received March 6, 1978.)

78T-E59 ROBERT A. DI PAOLA, Queens College, The City University of New York, Flushing, New York 11367. The Theory of partial \( \alpha \)-recursive operators Preliminary report.

Let \( \alpha \) be an arbitrary admissible ordinal. A set \( A \) is \( \alpha \)-enumeration reducible to a set \( B \) (A \( \leq_{\alpha} \) B) if there is a \( \alpha \)-enumerate \( \phi \in \mathcal{E}_{\alpha} \) such that for all \( e \in \alpha \), \( \phi(e) \leq_{\alpha} \mathcal{E}_{\alpha} \) (in general, \( \mathcal{E}_0 \) is the \( \alpha \)-finite set with canonical index). Each index \( e \) thus defines a mapping \( \phi(e) \) from \( 2^\alpha \) to \( 2^\alpha \). If \( A \leq_{\alpha} B \) via \( e \) we write \( \phi(e) = A \) and refer to \( \phi \) as the \( \alpha \)-enumeration operator with index \( e \). Partial \( \alpha \)-recursive, \( \alpha \)-recursive, and general \( \alpha \)-recursive operators and functionals are defined from \( \alpha \)-enumeration operators as in Rogers' book for the \( \omega \)-case. (Theory of recursive functions and effective computability, Mc-Graw Hill Book Co., New York, 1967). Theorem 1. For all total functions \( f \) and \( g \), \( f \) is \( \alpha \)-recursive in \( g \) if \( \exists \phi \in \mathcal{E}_{\alpha} \).

Theorem 2. The recursion theorem relative to \( \alpha \)-recursive operators (as in Rogers', op. cit., p. 194).

A mapping \( F \) from a subclass \( M \) of the class of all partial \( \alpha \)-recursive functions is an \( \alpha \)-effective enumeration operator if \( F \) is a partial \( \alpha \)-recursive function that agrees with no \( \alpha \)-recursive function. Theorem 3. The Myhill-Shepherdson Theorem (Rogers, op. cit. p. 196). Theorem 4. The Kreisel-Laconne-Shoenfield Theorem (Rogers, op. cit., p. 362). Measured in terms of difficulty of distribution, our principal results is a lift of a theorem of Friedberg: Theorem 5. Let \( \alpha \leq \beta \) be \( \beta \)-projection of \( \alpha \). Let \( A \) be the \( \mathcal{E}_2 \) cofinality of \( \alpha \) and assume \( \lambda \leq \beta \). Then there is a Banach-Mazur \( \beta \)-functional that agrees with no \( \alpha \)-recursive functional on the class of \( \alpha \)-recursive functions. Theorem 6. Let \( \alpha \) be \( \mathcal{E}_1 \). Then of course it is not the case that \( \lambda \leq \alpha \). Friedberg's theorem holds for \( \omega \alpha \omega_1 \), the metarecursive case. (Note that what Friedberg calls a partial recursive functional Rogers terms a recursive functional.) (Received April 24, 1978.)


We show that under conditions generally satisfied by reducibility orderings, \( R \), that the first order theory of the associated degrees under \( \leq_R \) is recursively isomorphic to second order arithmetic. All the usual reducibilities from 1-1 through arithmetic are included. (The case of Turing degrees is due to Simpson [Ann Math 105 (1977)].) Indeed under mild set theoretic assumptions so is the ordering of constructibility degrees of reals. This answers a question of Sacks' [Proc. Symp. Pure Math 13 (1971), p. 340]. The methods also give results on automorphisms and definability. Thus for example every automorphism of the Turing degrees is the identity on a cone and predicates such as arithmetic, hyperarithemetic and constructible are definable from a parameter (e.g. \( \chi_\beta \)). (Received May 8, 1978.)
Probability models and the logic $L_{\mathcal{U},\mathcal{P}}$ were discussed in the author's paper "Probability logic" (see these Notices v.24 no.5 p.A-438). Let $(\mathcal{M}, \mathcal{A}) = (\mathcal{M}, \mathcal{A})_n \prec \omega$ be a probability model. Let $\mathcal{M}_n \prec \omega$ be the smallest measure on $\mathcal{A}_n$ extending each $\mathcal{M}_n(\mathcal{A}_n)$ to $\mathcal{A}_n$. A set $E \in \text{dom}(\mathcal{M}_n)$ is uniform iff $\mathcal{M}_n(E) = \mathcal{M}_n(F)$ for every $F \in \text{dom}(\mathcal{M}_n)$. Then there is a sentence $\phi$ of $L_{\mathcal{A}, \mathcal{P}}$ such that for any probability model $(\mathcal{M}, \mathcal{A})$, $E \in \text{dom}(\mathcal{M})$, $E$ is uniform iff $(\mathcal{M}, \mathcal{A}) \models \phi$. Now let $\mathcal{V}$ be an $\omega_1$-saturated nonstandard universe. Then $(\mathcal{M}, \mathcal{A})$ is hyperfinite in $\mathcal{V}$, where $\mathcal{V}_n$ is the internal uniform measure on $\mathcal{A}_n$, $n \prec \omega$. Then in the uniform measure on subsets, almost every internal subset of $\mathcal{A}_n$, $n \prec \omega$, is uniform (of measure $\frac{1}{2}$). Cor 3: If $\mathcal{M}(\mathcal{A}, \mathcal{P})$ is an internal probability model in $\mathcal{V}$ and not all of $\mathcal{P}$ is concentrated on point masses, then $\mathcal{P}$ properly extends $\mathcal{M}_n \prec \omega$. Cor 4: Let $(\mathcal{B}_n, \mathcal{P})$ be a probability space, and let $(\mathcal{B}_n, \mathcal{P})$ be a family of pairwise independent, identically distributed, random variables on some probability space such that the finite dimensional distributions of $(\mathcal{B}_n, \mathcal{P})$ are $\mathcal{V}_n$-measurable for suitable $n$. Then for $\mathcal{V}_n$-almost all sequences $(\mathcal{B}_n)_{n \prec \omega}$, $(\mathcal{B}_n)_{n \prec \omega}$ are (totally) independent. (Received May 15, 1978.)

Statistics and Probability (60, 62)

Let $\nu_1, \ldots, \nu_k$ be real numbers in some numerical scale, and let $e = \{e_1, \ldots, e_k\}$ be a set of elements endowed with the value vector $\nu = (\nu_1, \ldots, \nu_k)$. Let $\nu$ denote the vector $(1, 2, \ldots, k)$. $G(M)$ the group of permutation matrices of order $k$, and $P = \{p = (p_1, \ldots, p_k) : \forall j \exists P = 1\}$ a family of probability distributions defined in $G(M)$. For a random selection $\nu_1, \ldots, \nu_k$ from $G(M)$, let $p_{a_1}^{b_1}$ be the probability of the mapping $v(e) + M_{a_1}^b v$, and let $R$ be the random variable $L_p (v)$. For an arbitrary distribution $p$ of $P$, the following topics are discussed: (a) the characteristic function $\phi_R$, (b) a set of moments of $R$, (c) the probability distribution of $R$; special attention is given to properties of moments as functions of distributions in $G(M)$. Let $g$ be a relation defined on the support $D(R)$ of $\phi_R$. For specific structures of $g$, the probability distributions of the mappings $g: R \rightarrow v(e)$ are investigated. Also studied are the relationships between $D(R)$ and $G(M)$. (Received May 17, 1978.)

Topology (22, 54, 55, 57, 58)

Theorem 1: Let $k \subset S^3$ be a tame link. There exists a torus knot $t \subset S^3$ such that $t \cap k = \phi$ and $k \subset F$, where $F$ is a minimal spanning surface for $t$. Corollary 1: Let $f = \bigcup_{i=1}^n f_i$ be a link of $n$ components, and assign to each component $f_i$ an integer $s_i$. There exists a torus knot $t \subset S^3 - f$ such that $\#(t, f) = s_i$, $1 \leq i \leq n$. If $s_i \neq 0$, $f_i$ meets each fiber of $C(S^3 - N(t))$ exactly $|s_i|$ times. Corollary 2: If $f \subset S^3$ is any link, then there exists a torus knot $t \subset S^3 - f$ such that $C(S^3 - N(f \cup t))$ is fibered over $S^1$. Theorem 2: Let $S \subset S^3$ be an orientable, nonseparating and nonsingular surface, possibly disconnected. There exists a torus knot $t$ with mirror image $t^\prime$ such that $(t \# t^\prime) \cap S = \phi$, $S \subset F$, where $F$ is a fiber for $t \# t^\prime$, $F - S$ is connected, and $S$ is incompressible in $S^3 - (Bd(S) \cup (t \# t^\prime))$. Corollary 4: (Gonzalez-Acuna, Myers). Every closed orientable 3-manifold $M$ has an open book decomposition with a connected binding. (Received April 14, 1978.)
For each positive integer $i$, let $X_i$ denote a copy of the universal Menger curve, or for each positive integer $i$, let $X_i$ denote a copy of the universal Sierpiński curve. **Theorem.** Suppose $h$ is a homeomorphism from $\prod_{i=1}^n X_i$ onto itself where $n$ is a positive integer greater than 1 or the first infinite ordinal. Then there are (1) a one-to-one function $F$ from $\mathbb{N}$ (positive integers) onto $\mathbb{N}$, and (2) a collection $H = \{ h_i \}_{i=1}^n$ such that for each $i$, $h_i$ is a homeomorphism from $X_{F(i)}$ onto $X_i$; and for each $x = (x_1, x_2, \ldots)$ in $\prod_{i=1}^n X_i$, $h(x) = (h_{F(1)}(x_{F(1)}), h_{F(2)}(x_{F(2)}), \ldots)$. (That is, each homeomorphism from $\prod_{i=1}^n X_i$ onto itself is trivial in the sense that it is simply a product of homeomorphisms from $X$ onto $X$ with appropriate "switches".)

**Corollary.** If for each $i$, $X_i$ denotes the universal Sierpiński curve, then $\prod_{i=1}^n X_i$ is not homogeneous.

(K. Kuperberg, W. Kuperberg and W. W. Transue proved this and the above theorem for $n = 2$. This corollary answers one of their questions.) A space is 2-homogeneous means that if $\{ A, B \}$ and $\{ C, D \}$ are both subsets of the space containing 2 points, then there is a space homeomorphism $h$ such that $h(\{ A, B \}) = \{ C, D \}$.

**Corollary.** If each $X_i$ denotes the universal Sierpiński curve, then $\prod_{i=1}^n X_i$ is not homogeneous.
Bounded functions which do not extend. Preliminary report.

If $X$ is a dense subset of $Y$, we write "$Y \cap \not X = X"$ as shorthand for the statement "for each $p \in Y - X$, there is an $f_p \in C^*(X)$ such that $f_p$ does not extend to an element of $C^*(X \cup \{p\})". If a single function $f$ serves as every $f_p$ (so there is an $f \in C^*(X)$ which extends to no point of $Y - X$) we write "$Y \cap \not X = X(singly)." It is easy to see, for example, that $\mathbb{R} \cap \not \mathbb{Q} = \mathbb{Q}$ but it is not the case that $\mathbb{R} \cap \not \mathbb{Q} = \mathbb{Q}$ (singly). Theorem: If $Y$ is a compact metric space and $X$ is a dense subset of $Y$, then $Y \cap \not X = X(singly)$ if and only if $X$ is completely metrizable. Example: There is a (scattered) compactification $Y$ of the (locally compact metric) space $\mathbb{N}$ of natural numbers such that $Y \cap \not \mathbb{N} = \mathbb{N}$ but such that it is not the case that $Y \cap \not \mathbb{N} = \mathbb{N}$ (singly). (Received May 8, 1978.)

Topologically hyperbolic critical points. Preliminary report.

An isolated equilibrium of a dynamical system $\phi$ on $\mathbb{R}^{2n}$ is said to be topologically hyperbolic if it admits an isolating block [cf. Wilson and Yorke, J.D.E. 15(1973), 106-123] $B = D^m \times D^n$ with the following structure:

- $b_+ = D^m \times D^n$
- $b_- = D^m \times D^n$
- $A_+ = \mathbb{R}^n \times \{0\}$
- $A_- = \{0\} \times D^n$

It has been conjectured by C. Coleman [Fifth International Conference on Nonlinear Oscillations, Kiev, 1970] that such a system is locally topologically equivalent to a system with a differentially hyperbolic (generic) equilibrium. We construct a $\mathbb{C}^0$ counterexample to this conjecture on $\mathbb{R}^2 \times \mathbb{R}^2$.

C-R structures on f-manifolds. Preliminary report.

Let $M$ be a $C^\omega$ real manifold and $TM\otimes\mathbb{C}$ the complexified tangent bundle. A C-R structure on $M$ is an involutive subbundle $HM$ of $TM\otimes\mathbb{C}$ so that $HM \cap \overline{HM} = 0$. A $C^\omega$ real manifold $M$ carrying a linear transformation field $f \neq 0$ of class $C^\omega$ satisfying the algebraic condition $f^3 + f = 0$ is called an $f$-manifold provided the $f$-structure $f$ is of constant rank $r$ on $M$.

Now we consider a normal globally framed $f$-structure


Theorem Every normal globally framed $f$-manifold carries a C-R structure.

Corollary Every normal almost contact manifold carries a C-R structure (see D. Blair, Lecture Notes in Mathematics 509, Springer-Verlag, 1976)

Some examples are given. (Received May 12, 1978.)

Analytic continuation of the principal series, I. $SO(1,n)$.

This paper applies Weyl's unitary trick to harmonic analysis on $SO(1,n)$. Two non-Hilbert space representations related to the principal series are introduced and used to obtain the Plancherel measure for $SO(1,n)$ from the Peter-Weyl theorem for $SO(n+1)$. The first, constructed on function spaces of $SO(1,n+1)$, is used to construct Green's functions for the Casimir operator. The second, called the meromorphic series, contains the discrete series among its quotients when $n$ is even.
Matrix coefficients of the meromorphic series are seen to generate the Green's functions, which, in turn, generate the spherical functions. The spherical functions for all irreducible representations of $SO(n)$ are treated. (Received May 22, 1978.) (Author introduced by George M. Bergman).


Consider the following property on a topological space $X$.

$(\ast)$: If $U$ is any well-ordered open cover of $X$ there is an open refinement $G = \cup G_n$ of $U$ such that if $x \in X$ there is some $n \in \mathbb{N}$ with $St(x,G_n) \subseteq F(x,U)$ and $\text{ord}(x,G_n) = 1$. ($F(x,U)$ denotes the first element of $U$ containing $x$.)

Theorem 1. A space $X$ is quasi-developable if and only if $X$ satisfies $(\ast)$ and has a primitive base.

Theorem 2. If $f: X + Y$ is a perfect mapping and $X$ satisfies $(\ast)$ then $Y$ satisfies $(\ast)$.

Combined with the author's previous result about the preservation of a primitive base under a perfect map, Theorems 1 and 2 solve the corresponding problem concerning the preservation of a quasi-development under a perfect map.

Corollary 3. If $f: X + Y$ is a perfect mapping and $X$ is a Hausdorff quasi-developable space then so is $Y$. (Received May 22, 1978.)

*78T-G105 TEODOR C. PRZYMUSİNSKI, Institute of Mathematics, Polish Academy of Sciences, 00-950 Warsaw, Śniadeckich 8, Poland. Paracompactness of Pixley-Roy hyperspaces. Preliminary report.

Let $X$ be a subspace of some space of ordinals or, more generally, a space with a Sorgenfrey-type topology.

Theorem 1. The Pixley-Roy hyperspace $F[X]$ of $X$ is paracompact. Theorem 2. The following statements are equivalent: (i) the space $F[X]$ is hereditarily paracompact, (ii) the space $F[X]$ is hereditarily normal, (iii) characters of all nonisolated points of $X$ are equal, (iv) the space $F[X]$ is $\lambda$-metrizable, for some cardinal $\lambda$.

Theorem 1 answers a question of Bennett and Lutzer. (Received April 25, 1978.)

Miscellaneous

78T-III DAGMAR HENNEY, GEORGE WASHINGTON UNIVERSITY, WASHINGTON, D. C. 20052. ON A CONJECTURE BY RICHARD BELLMAN.

When Richard Bellman was approached and asked to submit his favourite unsolved problem for publication in "Open Questions in Mathematics" (A collection of problems submitted by foreign and American academicians) - he proposed the following among others: Concerning Dynamic Programming:

2. Use this theory to treat multidimensional variational problems.

A possible approach towards a solution to Richard Bellman's problem is explored. (See also R. Bellman "Open Questions" Ed. D. Henney pg. 119/161.). (Received May 22, 1978.)

LATE PAPERS | Presented at past meetings

753-B55 LYNN R. ZIEGLER, The Ohio State University, Columbus, OH 43210. Intermediate Norm Behavior for Orthogonal Polynomials. Preliminary report.

Let $\mu$ be a probability measure on $[-1,1]$ with the property that $0 < C = \inf_{\mu(E) = 1} C(E) < C = \sup_{E \in S(\mu)} C(E)$ where $C(E)$ is the logarithmic capacity of $E$, $S(\mu)$ is the smallest closed set of $\mathbb{R}$. Theorem 1 answers a question of Bennett and Lutzer. (Received May 22, 1978.)
μ-measure 1, and the sup on the right runs over all compact subsets of S(μ) which are regular for
for the Dirichlet problem. (Note that if S(μ) is regular, as in the case S(μ) = [-1,1], then C_R
is just the logarithmic capacity of S(μ).)

We construct a measure μ' with the same sets of measure 1 as μ and such that if N_n is the
L_2(μ') norm of the nth monic orthogonal polynomial associated with μ', then the interval [C_R,]
is a subset of the limit points of (N_n). This can be used to show that there are infinitely many
possible weak limits of the zero measures for these orthogonal polynomials. (Received May 1, 1978.)
The proportion theory in Euclid's Elements V, impressive for its rigorous formal structure, has conventionally been attributed to Eudoxus (mid-fourth century B.C.) and his efforts to place geometry on a sound basis after the discovery of incommensurable (irrational) magnitudes. In the present discussion Archimedes's proof of the principle of the balance (Plane Equilibria I, prop 6-7) is shown to apply the methods, not of the Euclidean proportion theory, but of another. On the basis of this and other examples from ancient sources we can retrieve the technical procedures characteristic of this alternative theory of proportion and recognize it to be pre-Euclidean in origin, closely associated with the Eudoxean method of "exhaustion." A reconsideration of passages from Aristotle and others reinforces the view that this was the theory which Eudoxus introduced and that the Euclidean theory we know of was a later revision and refinement of it. (Received May 30, 1978.) (Author introduced by Professor Raymond G. Ayoub).

The mathematics of infinitesimal analysis and the mechanics of central forces both originated from separate sources outside the Paris Academy of Sciences in the late 17th century, yet it is there during the 18th century that they flourished most brilliantly. They did so hand in hand, in a style determined at the outset by Pierre Varignon's (1654-1722) transformation of the geometrical presentation of the Principia into the algebraic language of Leibniz's calculus. From then on, the two disciplines offered each other mutual support. Despite attacks on the calculus' lack of rigor, it deepened and generalized Newton's mechanics, making its application simpler and its conceptual structure clearer. By the same token, the picture of bodies held in curvilinear motion by central forces provided an intuitive model for the basic concepts of the calculus, a model on which mathematicians fell back when pressed to unravel the seeming paradoxes of infinitesimal quantities. Mechanics needed the calculus to realize its possibilities; the calculus used mechanics to establish the validity of its methods. This paper is a study of that symbiosis. (Received May 30, 1978.) (Author introduced by Professor Raymond G. Ayoub).

During the late 1820's Cauchy deduced an equation of motion in finite differences for propagation in a point lattice system. To solve current problems in optics, Cauchy initially transformed the equation into a linear, partial differential equation, which he solved generally. In 1835 he retrieved the discrete character of the original equation by using Fourier analysis. Further optical difficulties led him back to partial differential equations, for which he introduced both an operator calculus and the concept of 'isotropy'. In addition, Cauchy allowed the coefficients of these equations to be periodic functions of the coordinates, yielding finally a series of n-th order linear partial differential equations in operator form and with periodic coefficients. These equations solved a critical problem in contemporary optics and were subsequently analysed by Charles Briot and Emile Sarrau. Sarrau combined the equations with lattice theory, recently developed by Bravais, to produce a general account of periodic differential equations in 1867. (Received May 30, 1978.) (Author introduced by Professor M. S. Mahoney).
Some applications of model theory to universal algebra.

Theorem 1. i) A residually countable variety has either countably many or $2^\aleph_0$ countable subdirectly irreducible algebras ii) (GCH) If a residually small variety has an uncountable subdirectly irreducible algebra it has $2^{\aleph_1}$ subdirectly irreducible algebras of power $\aleph_1$. Using the known structure of models of $\text{Th}(\omega, S)$ we obtain Theorem 2. There is a locally finite variety of finite type which has exactly one infinite subdirectly irreducible algebra. (Received May 19, 1978.)

Recursively saturated nonstandard models of arithmetic.
The bearing of recursive saturation on more traditional questions about nonstandard models is discussed: 1. We characterise recursive saturation in terms of the standard system of a model. 2. We give criteria for the existence of recursively saturated elementary cofinal and end extensions of a given nonstandard model. 3. (In the non-elementary case) a nonstandard model $M$ has a recursively saturated end extension modelling a given theory $T$ iff i. $T$ is consistent with the diagram of $M$, and ii. $T$ is in the standard system of $M$. Our results overlap with those of George Wilmers and his student Haald Lessan. (Received May 10, 1978.)

On the relation $2ab \leq a^2 + b^2$ for regressive isols.

Since it is always true within $\omega$ that $2ab \leq a^2 + b^2$ it is also true in the isols that $2ab \leq a^2 + b^2$. We present some results about the following relation, $2ab \leq a^2 + b^2$, within the regressive isols. Throughout, let $a$ and $b$ be regressive isols. Thm.0. If $a \leq b$ or $b \leq a$ then $2ab \leq a^2 + b^2$. Thm.1. If $2ab \leq a^2 + b^2$ and $a \neq^* b$ then $a \leq b$. Thm.2. If $a + b$ is regressive, then $2ab \leq a^2 + b^2$ if and only if $\min(a, b) \leq \max(a, b)$. Cor.3. (Based on a theorem of M. Hassett) There will exist regressive isols $a$ and $b$ with a sum regressive, yet with $2ab \leq a^2 + b^2$ not being true. Thm.4. There exist isols $a$ and $b$ regressive, and isol $r$ non-regressive, with $2ab + r = a^2 + b^2$. The value of $r$ here is representable as a sum of two regressive isols. (Received May 11, 1978.)

Structure and elementary theory of r.e. sets. Preliminary report.

If $D$ is any set, let $\mathcal{E}(D) = \{\mathcal{M} \in D | \mathcal{M}$ r.e.}. Let $\mathcal{E}^*(D)$ be $\mathcal{E}(D)$ modulo the ideal of finite sets. Theorem 1. Suppose $A$ is a major subset of $B$ ($A \subseteq^m B$). Then the $\forall \exists$-theory of $\mathcal{E}^*(B-A)$ is decidable and independent of the choice of $A$ and $B$. The proof is an extension of Lachlan's proof of the decidability of the $\forall \exists$-theory of the lattice of r.e. sets. A key observation is: Theorem 2. Suppose $A \subseteq^m B$ and $f$ is a 1-1 recursive enumeration of $B$. Let $\hat{A} = f^{-1}(A)$. Then there is a $C$ such that $\hat{A} \subseteq^m C$. (Received May 11, 1978.)
For any set \( B \) let \( P_B(n) \) = the \( n \)-th element of \( B \). A coinfinite r.e. set \( A \) is hypersimple (Post) if \( P_A \) is not dominated by any recursive function and dense simple (D. A. Martin) if \( P_A \) dominates every recursive function. (Clearly, dense simple sets are hypersimple.) Martin shows in a finite injury argument that there is an automorphism, \( \varphi \), of the lattice of r.e. sets and a hypersimple set, \( A \), such that \( \varphi(A) \) is not hypersimple. We show, by extending the automorphism machinery of Soare, that \( A \) can be made dense simple. Thus dense simplicity is not invariant under automorphisms of the lattice of r.e. sets. (Received May 24, 1978.)


- Nineteenth century mathematics was highly constructive, early 20th century mathematics much less so. Mathematicians like Kronecker and Gordan refused to accept "nonconstructive methods", later ones like Hilbert, Artin, Hahn embraced them. Earlier constructive, computationally clear, proofs were replaced by later less constructive, conceptually clear, proofs utilizing indirect reasoning and choice. Field theory began wholly constructively in finite dimensions (Lagrange, Kronecker) and progressed to a less constructive theory of abstract fields (Steinitz, Artin). Linear algebra began with finite matrices (Cayley, Sylvester) and progressed to abstract spaces. Galois theory began with constructive determination of groups of finite extensions and progressed to profinite groups of infinite extensions (Kronecker). Ideal theory began with the wholly constructive theory of Kummer, Kronecker, and progressed via Dedekind to the axiomatic theory of Noether and Krull. Existence theorems for ordinary differential equations began with successive approximations and progressed to the less constructive theory of Ascoli, Peano. Similar stages occur in the evolution of Hahn–Banach and the separation theorem. We and colleagues have used methods from recursion theory to demarcate the limits of constructivity in these and other areas. We wish to determine for each of the important "constructions" of classical mathematics, the extent to which that construction is effective in the sense of recursion theory. For example, to what extent is Steinitz' theorem that fields have transcendence bases effective? To the recursion theorist a field is effectively presented if its domain, operations, and equality are recursive. All of Kronecker's finite dimensional fields are effectively presented and have finite (hence recursive) transcendence bases, as was proved by Kronecker. But by recursion theory one can construct an infinite dimensional effectively presented (even algebraically closed) field for which there is no effective list of any infinite algebraically independent set (Metakides-Nerode). So "giving" a field does not "give" a transcendence base or any nontrivial part thereof. We present such analyses for theorems in all the areas mentioned above. These are due to a number of workers. We also discuss the connections with Brouwer and Bishop. (Received May 26, 1978.)

758-02-6 RICHARD A. SHORE, Cornell University, Ithaca, New York 14853. On exact pairs for ideals of r.e. degrees. Preliminary report.

We show that in the upper semi-lattice of r.e. degrees such as weak truth table or many-one an ideal \( I \) has an exact (i.e. minimal) pair over it if and only if the r.e. sets with degrees in \( I \) are simultaneously recursively enumerable. This answers a question of Ladner and Sasso [Ann. Math. Logic 8 (1975) 429-448] though we note that a simple counting argument suffices to show that in any of the usual countable degree structures there are ideals without exact pairs. The main theorem allows us to code models of true first order arithmetic in the r.e. \( m \)-1 degrees using techniques developed with A. Nerode [see abstract in this issue of these Notices] which in fact had these results on the r.e. degrees as their starting point. Applications to other countable degree structures such as the arithmetic sets with Turing degree may also be discussed. Sample results are that with jump (or parameters) their theory is recursively isomorphic to true arithmetic and that the \( T \)-degrees of arithmetic sets with \( m \) jump are not elementarily equivalent to these degrees with \( n \)-jump for \( m \neq n \). This answers a question of Selman [Proc. London Math. Soc (3) 25 (1972)]. (Received May 30, 1978.)
758-02-7  E. KLEINBERG, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139. On measurable cardinals and partition relations.

Assume that \( \kappa \) is an uncountable cardinal satisfying the strong partition relation \( \kappa \rightarrow (\kappa^\lambda)^\Lambda, \forall \lambda < \kappa \). Then it is known that \( \kappa \) is measurable. Theorem 1. If \( \kappa \) is a limit of regular cardinals then there exists a set \( A \) of measurable cardinals greater than \( \kappa \) such that \( \kappa \equiv \bigcup A \). To this point all normal measures on \( \kappa \) produced by partition relations, or by AD, were generated by single sets and as such they concentrated on singular cardinals.

Theorem 2. If \( \kappa \) is Mahlo then there exists a normal measure on \( \kappa \) concentrating on regular cardinals.

Theorem 3. If there exist at least as many normal measures on \( \kappa \) as the least measurable cardinal greater than \( \kappa \), then there exists a normal measure on \( \kappa \) generated by no single set. (Kechris has since derived some of our assumptions from AD.) (Received May 30, 1978.)

758-02-8  MANUEL LEMANS, University of Connecticut, Storrs, CT 06268. Initial segments of the degrees below \( \mathcal{O}' \). Preliminary report.

Theorem: Let \( L \) be a \( \mathcal{O}' \)-presentable uppersemilattice. Then \( L \) is isomorphic to the degrees below \( g \) for some \( g \) less than \( \mathcal{O}' \). Furthermore, if \( L \) is \( \mathcal{O}' \)-presentable, then we can choose such a \( g \) for which \( \mathcal{O}' = g' \). Corollary: The elementary theory of the ordering of the degrees below \( \mathcal{O}' \) is undecidable. (This corollary has been obtained independently by F. Epstein, using different methods.) (Received May 30, 1978.)

758-02-9  WILLIAM H. WHEELER, Indiana University, Bloomington, Indiana 47401. Model Theory of Fields.

Some recent results on the model theory of fields, in particular, results on model-completeness and amalgamation, will be discussed. (Received May 30, 1978.)

758-02-10  BRUCE I. ROSE, University of Notre Dame, Notre Dame, Indiana 46556. Model Completeness and Nonassociative Algebras. Preliminary report.

In what follows, all algebras are finite-dimensional central simple algebras with unity element over a field, although they are not necessarily associative.

An algebra \( G \) is said to have the center extension property if whenever \( S \) and \( C \) are elementarily equivalent to \( G \) and \( S \subseteq C \), then the center of \( S \) is contained in the center of \( C \).

THEOREM 1. Let \( G \) be a finite-dimensional central simple algebra over a field \( \mathfrak{q} \). Then the theory of \( G \) is model complete if and only if \( G \) has the center extension property and the theory of \( \mathfrak{q} \) is model complete.

THEOREM 2. Let \( A \) be a finite-dimensional associative (alternative) division algebra over a field \( \mathfrak{q} \). Then the theory of \( A \) is model complete if and only if the theory of \( \mathfrak{q} \) is model complete.

One can define a center extension property for classes of algebras. For classes with this property one can deduce as an application of Theorem 1, a Nullstellensatz-like result. (Received May 30, 1978.)

758-02-11  VLADIMIR LIFSCHITZ, Brigham Young University, Provo, Utah 84602. Semantical completeness theorems in logic and algebra.

The Nullstellensatz is an easy corollary to the completeness of Robinson's hyper-resolution method. Let \( f, f_1, \ldots, f_\ell \) be polynomials such that \( f \) vanishes at all common zeroes of \( f_1, \ldots, f_\ell \). Then \( f = 0 \) is derivable from \( f_1 = 0, \ldots, f_\ell = 0 \) and basic computational laws in the calculus of hyper-resolutions. A representation \( f^\mathfrak{q} = h_1f_1^\mathfrak{q} + \ldots + h_\ell f_\ell^\mathfrak{q} \) can be extracted from the derivation. This method gives also proof-theoretic proofs of some other algebraic theorems, including a form of the duality theorem of Farkas-Minkowsky. (Received May 30, 1978.)
Infinite exponent partition relations and forcing.

We use the technique of forcing to prove relative consistency results concerning infinite exponent partition relations. Theorem 1. It is consistent for the partition relation $N_1 \rightarrow (\alpha)^\omega_0$ to hold for all countable $\alpha$ assuming the consistency of a measurable cardinal of high order. Theorem 2. AD cannot be proven from $ZF + N_1 \rightarrow (\omega_1)^\omega$ assuming the lattice theory is consistent. Theorem 3. Countable choice for sets of reals cannot be proven from $N_1 \rightarrow N_1$ assuming the consistency of $ZF + AD + DC$. (Received May 30, 1978.)
Let \( G \) be an undirected graph without multiple edges and with a loop at every vertex -- the set of edges of \( G \) corresponds to a reflexive and symmetric binary relation on its set of vertices. Then every edge-preserving map of the set of vertices of \( G \) to itself fixes an edge \([f(a), f(b)] = (a, b)\) for some edge \((a, b)\) of \( G \) if and only if (i) \( G \) is connected, (ii) \( G \) contains no cycles, and (iii) \( G \) contains no infinite paths. The proof is concerned with those subgraphs \( H \) of a graph \( G \) for which there is an edge-preserving map \( f \) of the set of vertices of \( G \) onto the set of vertices of \( H \) and satisfying \( f(a) = a \) for each vertex \( a \) of \( H \).

(Received April 25, 1978.)


We have \( n \) companies in \( n \) different cities. Each company sends out exactly \( r \) salesmen at the same time and each day for \( n \) consecutive days each of the \( n \) cities is occupied by exactly \( r \) salesmen. For \( n \) consecutive days each salesman must visit each one of the \( n \) cities where the companies reside exactly one time. During the \( n \) days each salesman must be paired with each one of \( n(r-1) \) salesmen exactly once. No two salesmen are ever to be together in the same city more than one time. We include the day of departure of each salesman from his respective company in the problem and consider his day of departure as the first day of the \( n \) consecutive days. Thus for the following \( n-1 \) days (after the first day) no two salesmen of the same company may be together in the same city.

In this paper we give a solution of the difficult problem where \( n = 10 \) and \( r = 2 \). In addition we generalize the \( n = 10 \) problem as follows: we let \( r = 2 \) for nine of the ten companies and for the tenth company we let \( r = 3 \). This author thanks Professor E.G. Straus for his patience and advice and his enduring my infinite phone calls. (Received May 3, 1978.)

Christopher Landauer, Systems & Intelligence Group, Pattern Analysis & Recognition Corporation, Rome, NY 13440. Perfect Codes in Association Schemes.

This paper shows that the author's polynomial proof of Lloyd's theorem on the existence of perfect block codes can be carried through in the framework of association schemes. The method used in the earlier proof is applied with little change.

The main feature of the proof is a detailed examination of the matrices involved in the MacWilliams equations for linear codes. As before, the coefficients of the "transformed" distance enumerator can be related to the zeros of the analogue of the Lloyd polynomial.

In fact, the conditions under which the proof can be successfully completed are precisely those that force a certain matrix algebra to be the Bose-Mesner algebra of the association scheme. (Received May 5, 1978.)


Let \( G \) be a group of finite order \( s \), \( H = [h_{ij}] \) be a square matrix of order \( r \) with entries from \( G \). Then \( H \) is a GH-matrix (group Hadamard matrix) of type \( r/s \) over \( G \) provided: (1) for \( i \neq j \), the sequence \( [h_{1x}h_{2x}^{-1}] \) contains every element of \( G \) equally often; (2) \( H^t \), the transpose of \( H \), also satisfies (1). Butson has proved the existence of GH-matrices of order \( 2^{n}p \) over the cyclic group \( C_p \) where \( p \) is prime, \( k \geq \min(1,n) \), \( m \geq 0 \). We construct GH-matrices of order \( p^{i+j} \) over the elementary abelian group of order \( p^i \) for \( p \) prime,
j ≥ 0, and prove: **THEOREM.** Let N be an odd order normal subgroup of G such that G/N is cyclic of even order. Then there is no GH-matrix of odd type t over G (except when G = C_2, t = 1). **CONSTRUCTION.** Every GH-matrix of order r ≥ 3 over an abelian group of order s may be used to construct a symmetric Hanani dual transversal design D: D has rs points and r parallel classes, each containing s lines of equal cardinality r; non-parallel lines have r/s common points. (Received May 8, 1978.)

758-05-5 Stanley E. Payne, Miami University, Oxford, Ohio 45056. Spreads and Ovoids of the Known Finite Generalized Quadrangles

Recent results on spreads and ovoids of the classical finite polar spaces are surveyed, with special emphasis on the generalized quadrangles. **Theorem.** Let S be a G.Q. of order (s, s). If x is a regular point of S belonging to an ovoid N, then S\(\setminus\{x\}\) is an ovoid of the G.Q. S\(^a\) of order (s-1, s+1) obtained by expanding S about x. **Theorem.** Let S be a G.Q. of order \(q^2, q^2\) having an ovoid N (i.e. a set of \(1+q^4\) pairwise noncollinear points). Then any subquadrangle S' of S with order \(q,q\) must meet N in exactly \(1+q\) points. These results aid in a study of the geometry of all ovoids in GQ of small order. (Received May 15, 1978.)

758-05-6 ROBERT ROTH AND D. K. RAY-CHAUDHURI, The Ohio State University, Columbus, Ohio 43210. Commutative Moufang 3-loops. Preliminary report.

It is proved that for \(1 ≤ m ≤ n - 3\), there exists a commutative Moufang 3-loop of size \(3^n\) and (associative) center of size \(3^m\). Commutative Moufang 3-loops are equivalent to Steiner triple systems in which every 3 noncollinear points generate an affine plane of order 3. Marshall Hall, Jr. first studied these systems. (Received May 30, 1978.)

*758-05-7 Kenneth P. Bogart, Dartmouth College, Hanover, NH 03755. Eulerian posets and Reed Muller codes.

In this paper we give an elementary method of showing that the \(r^{th}\) order Reed Muller code of length \(2^n\) has the sum of the first \(r\) binomial coefficients as its dimension and has minimum distance \(2^{n-r}\). Although it is no more elementary than the typical textbook constructions, it has two advantages. First, it gives codes with these parameters over any field. Second, the same method can be used to construct codes from Eulerian posets with the least upper bound property. For each order ideal of the poset we obtain a code whose dimension is the number of elements in the order ideal, whose length is the number of points in the poset, and whose minimum distance is the minimum size of any principal dual ideal generated by an element of the ideal. This gives rise to a large family of apparently new codes with majority logic decoding. (Received May 30, 1978.)

*758-05-8 ALLEN J. SCHWENK, U. S. Naval Academy, Annapolis, Maryland, 21402. Removal-cospectral sets of vertices in a graph.

The concept of cospectrally rooted graphs (also called graphs with cospectral points) was introduced by the author in an earlier work. We now extend this concept to allow subsets of vertices containing more than one vertex. In this new view, cospectrally rooted graphs are graphs containing
removal-cospectral sets of vertices which happen to be singletons — namely, the roots of the respective graphs.

This extension yields numerous constructions of cospectral graphs, including one discovered by Godsil and McKay. It also provides an explanation of the phenomenon of unrestricted substitution of vertices discovered by Herndon and Ellzey. Finally, there are some interesting examples using graphs first studied in connection with the reconstruction conjecture. (Received May 30, 1978.)

758-05-9 JACK EDMONDS and ARNALDO MANDEL, University of Waterloo, Waterloo, Ontario, N2L 3G1.
Topological Oriented Matroids. Preliminary report.

The span of an oriented matroid is shown to be a piecewise linear ball complex with shellable cells, whose polyhedron is a sphere. As a consequence, the Upper Bound Theorem holds for oriented matroids, as conjectured by Las Vergnas. As another application, we extend the Sylvester Gallai Theorem to oriented matroids, a result conjectured by U.S.R. Murty. (Received May 30, 1978.)

758-05-10 VÁCLAV CHVÁTAL, Université de Montréal, Montréal, Québec, Canada. Cutting planes in combinatorial arguments.

Many combinatorial problems may be stated as zero-one linear programming problems. In this setting, many common sense arguments may be formalized in terms of Comory-type cutting planes. We provide several illustrations, including Deza’s proof of the Erdős-Lovász conjecture on weak delta-systems. (Received May 30, 1978.) (Author introduced by Professor Louis J. Billera).

758-05-11 ROBERT E. HIXSON, Northwestern University, Evanston, Illinois 60201 and WILLIAM H. CUNNINGHAM, Carleton University, Ottawa, Canada K1S 5B6. Converting linear programs to network problems.

We describe an algorithm which converts a linear program min{cx|Ax = b, x ≥ 0} to a network flow problem, using elementary row operations and nonzero variable-scaling, or shows that such a conversion is impossible. If A is in standard form, the computational effort required is bounded by O(rn), where r is the number of rows and n is the number of nonzero entries of A. A method for determining whether a "binary matroid" is "graphic" plays an important role in the algorithm. (Received May 30, 1978.) (Author introduced by Professor Louis J. Billera).

758-05-12 JEFF KAHN, Department of Mathematics, Ohio State University, Columbus, Ohio 43210. Finite inversive planes with bundle theorem.

A finite inversive plane of order n is a 3-(n² + 1, n + 1, 1) design. In the present paper it is proved that an inversive plane of odd order satisfying the bundle theorem [1, p. 255] is "egglike" (i.e. the circles are plane sections of an ovoid in PG(3,n)). [1] P. Dembowski, Finite geometries, Springer-Verlag, 1968. (Received May 30, 1978.) (Author introduced by Professor D. K. Ray-Chaudhuri).


Let L(m,n) denote the set of all integer sequences l<a_1≤a_2≤...≤a_m≤n+1. Define a partial ordering on L(m,n) by setting (a_1,...,a_m)≤(b_1,...,b_m) if a_i≤b_i for 1≤i≤m. Every maximal chain of L(m,n) has length ℓ = mn. Let L_1 denote the set of elements of L(m,n) of rank i, 0≤i≤ℓ, and let w_i = |L_i| (so w_i = w_{i-1}).

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Theorem. For each \( i \) such that \( 0 < i \leq \frac{1}{2} \), there exist \( w_i \) pairwise disjoint saturated chains (of length \( \ell - 2i \)) of \( \text{L}(m,n) \) between \( \text{L}_i \) and \( \text{L}_{\ell - i} \).

Corollary. \( \text{L}(m,n) \) has the Sperner property, i.e., the cardinality of the largest antichain of \( \text{L}(m,n) \) is equal to \( \max w_i = w_{\ell/2} \).

The proof uses Menger's theorem, Pieri's formula from the Schubert calculus, and a result from Hodge theory applied to the Grassmann variety \( \text{G}_{m+n,m} \). (Received May 30, 1978.)

08 ▶ General Mathematical Systems

N. Sauer and M.G. Stone, University of Calgary, Calgary, Alberta. Subalgebra and Endomorphism Structure of Algebras.

An abstract monoid \( M \) and an abstract lattice \( L \) are jointly algebraic provided they can be jointly represented as the endomorphism monoid and the subalgebra lattice of some universal algebra \( \mathfrak{U} \), viz. \( M \cong \text{End} \mathfrak{U} \) and \( L \cong \text{Sub} \mathfrak{U} \).

Theorem 1. If \( M \) and \( L \) are jointly algebraic then there is a universal algebra \( \mathfrak{J} \) with \( M \cong \text{End} \mathfrak{J} \) and \( L \cong \text{Sub} \mathfrak{J} \) in which every finitely generated subalgebra of \( \mathfrak{J} \) is singleton generated.

Theorem 2. If \( M \) and \( L \) are jointly algebraic and one of them is finite then \( N \) and \( L \) are jointly algebraic for every submonoid \( N \subseteq M \). (Received May 8, 1978.)

10 ▶ Number Theory

Daniel S. Kubert, Cornell University, Ithaca, N.Y., 14853 and Serge Lang, Yale University, New Haven, Conn., 06520. Independence of Modular Units on Tate Curves.

Let \( k \) be a number field, let \( A \) be an elliptic curve defined over \( k \), and let \( k(A/\ell) \) be the field extension of \( x \)-coordinates of \( N \)-torsion points. Let \( p \) be a prime of \( k \) lying above the prime number \( p \). Let \( V \) be the multiplicative group of elements of \( k(A/\ell) \) such that \( \text{ord} v \) is independent of the prime \( F \) of \( k(A/\ell) \) dividing \( p \). Let \( C(N)(\ell) \) be a non-split Cartan subgroup of \( GL(\mathbb{Z}/N\mathbb{Z}) \). Let \( U(\ell) \) be the group of modular units specialized at \( j(A) \). Then one has

Theorem

Assume

1) \( \text{Gal}(k(A/\ell)/k) \) contains \( C(N)(\ell) \)
2) \( j(A) \) has negative valuation at \( p \)

Then \( \text{rank} U(\ell) V/V = [C(N)(\ell)]^{-1} \). (Received May 17, 1976.)

Residue Classes of \( p(n) \) (mod \( 5^k \)) have been computed for

\( 1 \leq k \leq 6 \), \( n \leq 19,000 \). \( p(n) \equiv 0 \) (mod \( 5^k \)) for 6907 (resp. 1992, 724, 172, 57, 5) values of \( n \leq 19,000 \) if \( k = 1 \) (resp. 2, 3, 4, 5, 6). The Conjecture:
\[ p(5^k + 599) \equiv 0 \pmod{5^5} \] if \( k \equiv 2, 3, \) or \( 4 \pmod{5} \) has been verified for \( k \leq 29 \). If \( k \equiv 3 \pmod{5} \) this is a special case of the Ramanujan congruences for \( p(n) \pmod{5^k} \). (Received May 30, 1978.)

\( \ast 758-10-3 \) MICHAEL J. RAZAR, University of Maryland, College Park, Maryland 20742. Eichler cohomology and Eisenstein series.

The non-cuspidal cohomology of congruence subgroups of the modular group is computed using the techniques developed in the author's paper Dirichlet Series and Eichler Cohomology (preprint). Some connections with the special values of nonanalytic Eisenstein series are discussed. Also discussed are associated \( p \)-adic interpolations. (Received May 30, 1978.)

\( \ast 758-10-4 \) GREGORY WULCZYN, Bucknell University, Lewisburg, Pennsylvania 17837. Real Quadratic Identities for evaluating \( \sum_{x=1}^{n} P(x) P_{x+s}^{r} \)

Let \( \frac{a+b\sqrt{D}}{2} \) be a Type I real quadratic field fundamental unit, \( \left( \frac{a+b\sqrt{D}}{2} \right)^n = \left( \frac{1+n\sqrt{D}}{2} \right) \). The evaluation of \( \sum_{x=1}^{n} P(x) P_{x+s}^{r} \) can be accomplished by using the following closed form formulas.

(a) \[ \frac{b}{x+1} \prod_{x=1}^{n} (x+1) F_{x+s}^{r} \]

(b) \[ \prod_{x=1}^{n} (-1)^{x+1} x (x+1) F_{x+s}^{r} \]

(c) \[ \prod_{x=1}^{n} x \prod_{x=1}^{n} F_{x+s}^{r} \]

(d) \[ \prod_{x=1}^{n} (-1)^{x+1} x \prod_{x=1}^{n} F_{x+s}^{r} \]

(e) \[ \prod_{x=1}^{n} x \prod_{x=1}^{n} F_{x+s}^{r} \]

(f) \[ \prod_{x=1}^{n} (-1)^{x+1} x \prod_{x=1}^{n} F_{x+s}^{r} \]

These results are then extended to Type II, Type III, and Type IV real quadratic fields. (Received May 3, 1978.) (Author introduced by Professor Raymond Ayoub).

12 > Algebraic Number Theory, Field Theory and Polynomials

\( \ast 758-12-1 \) BENEDICT H. GROSS, Princeton University, Princeton, New Jersey 08540. Tamagawa numbers of abelian varieties with complex multiplication. Preliminary report.

Let \( A \) be an abelian variety of dimension \( g \), defined over a number field \( k \). Let \( \omega \) be a non-zero differential in \( H^0(A, \mathcal{O}_A^g) \). When \( A/k \) has complex multiplication by an abelian field of degree \( 2g \) we will show how the local integrals \( \int_{A(k)} |\omega|_v \) are related to rational values of the classical and \( p \)-adic gamma functions. (Received May 3, 1978.)

\( \ast 758-12-2 \) NICKOLAS HEEREMA, Florida State University, Tallahassee, Florida 32306. Higher Derivation Galois Theory of Fields.

A Galois correspondence for finitely generated field extensions \( k/h \) is presented for the case characteristic \( h = p \neq 0 \). A field extension is Galois if and only if it is modular and separably algebraically closed. Galois groups are direct limits of groups of rank \( p^n \) higher derivations for \( n \geq 0 \). Galois groups are characterized in terms of abelian iterative generating sets obtaining a theory which includes both the finite rank and the infinite rank theories of Heerema and Deveney. Certain of Deveney's intermediate field theorems of the finite rank Galois theory are extended to the general theory. (Received May 22, 1978.)

A-512
The Axiomatic Approach to Class Field Theory of Artin-Tate assumes the existence of an invariant map which, in turn, implies the existence of a norm residue symbol \( f_{L/K} \) for \( L/K \) a normal extension. The Axiomatic Approach of G. Whaples assumes the existence of a norm residue symbol for each finite extension of the ground field. It can be shown that assuming the norm residue symbol of G. Whaples, one can construct an invariant map in the sense of Artin-Tate. This paper proves a preliminary result to this construction. The paper shows that for extensions \( L/K \) for which \( f_{L/K} \) is defined, \( H^2(L/K) \) is cyclic of order dividing the order of the extension. Finally, the result is generalized for \( L/K \) a normal extension. (Received May 26, 1978.)

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Some recent joint work with Bruce Ferrero on \( \mathbb{Z}_p \)-extensions will be discussed. Let \( k \) be a number field, \( K/k \) a \( \mathbb{Z}_p \)-extension of \( k \), and \( h_n \) the class number of \( k_n \) (the \( n \)-th intermediate field). If \( p^n \) is the exact power of \( p \) dividing \( h_n \) then Iwasawa has shown that there exist integers \( \lambda_n, \mu, v \) independent of \( n \) such that \( e_n = \lambda n + \mu p^n + v \) for all sufficiently large \( n \).

**Theorem 1.** \( \mu = 0 \) for the cyclotomic \( \mathbb{Z}_p \)-extension of an abelian number field. **Theorem 2.** Let \( \ell \neq p \) be another prime and let \( f_n^\ell \) be the exact power of \( \ell \) dividing \( h_n^\ell \). If \( k \) is abelian over \( \mathbb{Q} \) and \( K/k \) is the cyclotomic \( \mathbb{Z}_p \)-extension of \( k \) then \( f_n^\ell \) is bounded independent of \( n \). (Received May 30, 1978.)

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Let \( K/k \) be a finite purely inseparable field extension. The set of all degree \( p^m \) subextensions of \( K/k \) is a Zariski closed subset of the Grassmann variety of all \( p^m \)-dimensional subspaces of the \( k \)-vector space \( K \). Examples are constructed that show that these algebraic sets of subextensions are usually reducible. It is shown that if \( (e_1, \ldots, e_r) \) are the Pickert exponents of \( K/k \), i.e., if \( K \otimes_k K \cong k[x_1, \ldots, x_r]/(x_1^{e_1}, \ldots, x_r^{e_r}) \) and if \( (e'_1, \ldots, e'_s) \) are those of a deformation of \( K \), then for every \( i \) we have \( e'_1 + \ldots + e'_i \geq e_1 + \ldots + e_i \). Bounds are given on the Pickert exponents of intermediate fields. (Received May 30, 1978.)

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Let \( k \) be a complex, abelian extension of the field \( \mathbb{Q} \), of rational numbers. Let \( p \) be a prime such that \( p-1 \) is divisible by the exponent of the Galois
group, $\text{Gal}(k/Q)$, and consider $\mathbb{Z}_p$-extensions $K$ of $k$ such that $K$ is normal over $Q$. If $X$ is the (inverse) limit of the ideal class groups of the sub fields of $K$, then $X$ contains a subgroup $A = \prod_{i=1}^{r} \mathbb{Z}_p$ where $A$ is the power series ring $\mathbb{Z}_p[[T]]$ over the ring $\mathbb{Z}_p$ of $p$-adic integers. We compute the invariants $a_1, \ldots, a_r$ for certain $\mathbb{Z}_p$-extensions $K/k$. (Received May 30, 1978.) (Author introduced by Professor Larry J. Goldstein).

13 ▶ Commutative Rings and Algebras

758-13-1 JAMES K. DEVENEY, Virginia Commonwealth University, Richmond, Virginia, 23284 and JOHN N. MORDESON, Creighton University, Omaha Nebraska, 68139. On Pencil Galois Theory. Preliminary report. This talk will survey some recent results concerning the inseparable Galois theory of pencils of higher derivations developed by N. Heerema. Topics covered will include invariant subgroups and modular extensions. (Received May 30, 1978.)

758-13-2 RAYMOND T. HOOSLER, City College of New York, New York, New York 10031. Extension's of Chase's modular Galois theory. Preliminary report. Theorem: Let $L/k$ be a ring extension such that $k = L^G$ for some group scheme $G$ defined over $k$. Then, for an appropriate topology, there is a one-to-one correspondence between $\mathbb{H} \leq \text{Aut}(L/k)$ such that $\mathbb{H}$ is a subgroup sheaf of the Aut scheme with $\mathcal{S}(\mathbb{H}) = \mathbb{H} \leq \text{Aut}(L/k)$ and intermediate sheaves $\mathcal{X} = \text{Spec}(L)/\mathbb{H}$. If $L/k$ is a field, there is a one-to-one correspondence between subgroup schemes $\mathbb{H}$ satisfying the above conditions and intermediate field extensions $k \leq K \leq L$ such that $K = L^\mathbb{H}$. If in addition we require $L/k$ to be modular, then we get the one-to-one correspondence between truncated subgroup schemes satisfying the above condition and intermediate fields $K$ with $L/K$ modular that Chase describes. If we require $L/k_\mathbb{H}$ to be modular and $k_\mathbb{H}/k$ to be Galois where $k_\mathbb{H}$ is the separable closure of $k$ in $L$, then $k = L^\mathbb{H}$ for an appropriate group scheme. In this case we get a generalization of both Chase's theory and classical Galois theory. This case also generalizes work of M. Takeuchi. The situation for rings is more complicated and will also be discussed. (Received May 30, 1978.)

14 ▶ Algebraic Geometry

758-14-1 SPENCER BLOCH, University of Chicago, Chicago, Illinois 60637. On the geometry of algebraic cycles.

Various elementary examples in the theory of algebraic cycles of codimension greater than one on an algebraic variety will be discussed. Emphasis will be on pleasing exposition and discussion of interesting open problems rather than profound or thorough scholarship. Consequently there will be no written text. (Received April 7, 1978.)

758-14-2 WALTER L. GRIFFITH, JR., University of Missouri - St. Louis, St. Louis, Mo. 63121. A Vanishing Theorem for $H^*(\text{SL}/B, L')$. A general vanishing theorem for line bundles on the flag variety $\text{SL}/B$, valid over an algebraically closed field of arbitrary characteristic, is given. A certain weight constructed from highest weights of irreducible submodules of $H^0(\text{SL}/B, L')$, where $L'$ is explicitly associated to $L$, is
dominant iff $H^q(SL/B,L) \neq 0$. The proof is based on a formula for $H^q(L)$ not involving derived functors. All previously known vanishing theorems follow readily as corollaries. (Received April 19, 1978.)

**758-14-3** BRUCE A. DODSON, Universita Degli Studi, Florence, Italy 50134. New examples of quasi-Abelian varieties, and complete reducibility.

A quotient $X = C^n/L$, where $L$ is a lattice of rank $n + m$, $0 < m < n$, is called a quasi-Abelian variety if it has a Hodge metric. A new example is constructed from certain number fields $K$, via the real and complex imbeddings of $K$. The required Hermitian form is given by the trace $\text{Tr}_{K/Q}$ and a characterization is given of such fields. Conditions on an extension field $K'/K$ are given so that $K'$ provides a quasi-Abelian variety isomorphic to $[K':K]$ copies of that associated to $K$. Further results on complete reducibility are also available. (Received May 17, 1978.)

**758-14-4** WILLIAM L. HOYT, Rutgers University, New Brunswick, New Jersey 08903. Meromorphic 2-forms on elliptic surfaces. Preliminary report.

Let $V + X$ be the Neron model for $y^2 = x(x-1)(x-t)$ relative to some finite algebraic extension $K$ of $\mathbb{C}(t)$, let $D_a$ be the space of meromorphic 2-forms on $V$ with poles only on some fixed non-singular fiber $V_a$, and let $I_a$ be the set of $\xi \in D_a$ with $\int_\sigma \xi \in \mathbb{Z}$ for all 2-cycles $\sigma$ on $V$ with $V_a \cap \sigma = \emptyset$. Theorem. There is an exact sequence $0 \to W_a \to D_a/I_a \to U_a \to 0$ where $W_a = H^1(V_a,C)/H^1(V_a,\mathbb{Z})$ is the universal vector extension of $V_a$ and $U_a = H^1_p(r,C^2)/H^1_p(r,\mathbb{Z}^2)$ is the quotient of parabolic cohomology groups determined by $V + X$. Question. Is there a natural structure of algebraic variety on $D_a/I_a$ relative to which $D_a/I_a + U_a$ is a rational map? Examples. If $K = \mathbb{C}(t)$, then $W_a = 0$ and the answer is trivially yes. However if $K = \mathbb{C}(\sqrt{t-c})$, then $W_a = \mathbb{C}^*$ and there are too many structures unless some further restriction is imposed. (Received May 24, 1978.)

**758-14-5** JAMES A. CARLSON, University of Utah (Sloan Fellow), Salt Lake City, Utah 84112. Extensions of Mixed Hodge Structures. Preliminary report.

The cohomology of a singular projective variety carries a mixed Hodge structure $H$. If $H$ is isomorphic to a sum of mixed Hodge structures, it splits over $\mathbb{Z}$. The obstructions to splitting form a complex torus $\text{Ext}(B,A)$: it is the set of congruence classes of extensions $0 \to A + H \to B + 0$. An extension $\phi$ defines a one-motive $\phi_u$: a homomorphism from a lattice to a generalized Jacobian. The crucial point is to identify $\phi_u$ with a geometrically defined motive (the trace): (1) Let $X$ be a singular curve; $\Sigma$ its singular locus, $\tilde{X}$ its normalization, and $\tilde{\Sigma}$ the lift of $\Sigma$ to $\tilde{X}$. The trace determines the position of $\tilde{\Sigma}$ on $\tilde{X}$ if $\tilde{X}$ is connected and nonhyperelliptic. (2) Let $X = D_1 \cup D_2$ be a normal crossing surface, $F$ a divisor on $X$ whose intersection with $\Sigma = D_1 \cap D_2$ is a zero-cycle homologous to zero. The trace determines this cycle modulo linear equivalence. Next, we show that certain varieties are determined by their polarized mixed Hodge structure ("Torelli theorem"): (a) curves as in (1); (b) the union of two quadrics, or of a cubic surface and a plane (degenerate K-3's). For pencils of hypersurfaces in $P_3$ we show that the limiting mixed Hodge structure determines the points cut out by the base locus on the double curve of the singular fiber ("infinitesimal moduli"). We also describe a classifying space for polarized mixed Hodge structures. (Received May 26, 1978.)

**758-14-6** BORIS MOISHEZON, Columbia University, New York, New York 10027. Global problems in the singularities theory.

- One of the central questions of algebraic geometry and complex analysis is the question of the existence of algebraic functions of several complex variables with given discrete (or topological) invariants. This question motivates some new and essentially global problems about singularities of complex algebraic varieties. Using stable maps and projections we can assume that individual singularities are not complicated and ask questions about the global coexistence of such simple singularities. This coexistence is very intimately connected with the
existence of some remarkable relations and formulas in such noncommutative groups as braid groups and mapping class groups. From this point of view, the existence of regular elliptic surfaces is essentially due to the relation $(XY)^6 = 1$ in $\text{SL}(2, \mathbb{Z})$ where $X = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$, $Y = \begin{pmatrix} 1 & -1 \\ 0 & 1 \end{pmatrix}$. Also, the existence of so-called Severi stratification of the space of plane curves of given degree with ordinary double points is due to some classical formulas for the generator of the center in groups of braids. In the talk, we will discuss results and problems of a similar nature. (Received May 26, 1978.)


In order to make an explicit computation of the period matrix of the Fermat surface, we require a convenient basis for its second homology group. In the present paper we determine such a basis, as well as a decomposition of the Fermat surface as a CW-complex, by making a careful study of a suitable pencil of hyperplane sections. This, in turn, is based in part on an algorithmic procedure previously introduced by the second author for calculating the intersection matrix of arbitrary branched coverings of Riemann surfaces. (Received May 30, 1978.)


Let $H_i$ (1 ≤ i ≤ n) be hypersurfaces in $\mathbb{P}^n$ which intersect improperly. By moving the $\{H_i\}$ in algebraic families $\{(H_i)_t\}$ which intersect properly for $t \neq t_0$, Severi was led to propose a method for assigning multiplicities to certain "distinguished subvarieties" $Z_j$ of $\bigcap H_i$ in such a way that these multiplicities add up to $\text{Id}(H_i)$. Unfortunately, Severi's procedure does not in general work. But Fulton and MacPherson have recently constructed by different methods a refined intersection class $[H_i \cdots H_n] \in \bigoplus \mathbb{A}_0(Z_j)$ which does have the expected degree. We will discuss conditions under which the Fulton-MacPherson class can be obtained by a limiting process in the spirit of Severi. (Received May 30, 1978.) (Author introduced by William Fulton).

758-14-9 WILLIAM FULTON and ROBERT MACPHERSON, Brown University, Providence, Rhode Island 02912. Intersection theory and enumerative geometry. Preliminary report.

The writers have given a formula for the intersection cycle of subvarieties $V_1, \ldots, V_k$ on a non-singular variety as a sum of rational equivalence classes on the connected components of $\bigcap V_i$, which satisfies a "continuity principal" when the $V_i$ vary in algebraic families. This can be applied to classical enumerative problems, such as finding the number of plane curves in a $k$-dimensional family which are tangent to $k$ fixed curves in general position; the 3264 conics tangent to 5 given conics is a standard example. (Received May 30, 1978.)


We give a presentation for the group $H^2(X \times S, K_2)$ when $X$ is a smooth surface and $S$ is artinian. The generators are modules on $X \times S$ which are finite and free over $S$, and the relations are analogous to those for the group of 0-cycles.
on $X$ modulo rational equivalence. The major tool is a localization theorem for flat modules similar to Quillen's localization theorem for abelian categories. (Received May 30, 1978.)

758-14-11 SPENCER J. BLOCH, University of Chicago, Chicago, IL 60637. Torsion algebraic cycles.

A theorem of Roitman relating torsion in the Chow group to torsion in the Albanese variety will be described. (Received May 30, 1978.)

758-14-12 JOHN W. MORGAN, Columbia University, New York, New York 10027. Hodge theory for the algebraic topology of nonsingular varieties.

Classical Hodge theory concerns the cohomology of nonsingular, algebraic varieties. This talk presents an extension of Hodge theory to encompass additional algebra-topological invariants, in particular, the fundamental group. We find that the fundamental groups of nonsingular varieties have mixed Hodge structures (in the sense of Deligne). The results derive from joining two distinct theories. One is the theory of Hodge, as expanded by Deligne, concerning the differential forms on an algebraic variety. The other is the theory of de Rham, as expanded by Sullivan, relating algebra topology (e.g. the fundamental group) and differential forms. One of the main consequences of our extension is a purely group-theoretic restriction on the fundamental groups of nonsingular varieties. For projective varieties, the work of Lefschetz and Hodge shows that there are restrictions on the cohomology rings and a fortiori on the fundamental groups. The extended Hodge theory gives even stronger restrictions. In the case of affine varieties, the extended theory gives the first known restrictions. (Received May 30, 1978.)


Consider an n-dimensional abelian variety $A$ together with an (orientation-preserving) isomorphism $H^1(A,\mathbb{Z}) \cong \mathbb{L} = \mathbb{Z}^n$. We think of the period map as associating with each such $A$ a point $p(A) \in G(n,2n)$ representing the n-dimensional subspace $H^{1,0} \subseteq L \otimes C$. Given a cohomology class $\varphi \in H^{2k}(A,\mathbb{Z}) = \mathbb{L}^{2k}$, we describe those abelian varieties $A$ on which $\varphi$ is a Hodge $(k,k)$ class. When $n = 2k$, $\varphi$ determines a hyperplane-section $H_{\varphi}$ of $G(n,2n)$; our observation here is that $\varphi$ is perpendicular to $H^{1,0}$ on $A$ iff $p(A) \in H_{\varphi}$; and further, $\varphi$ is perpendicular to $H^{0,0} \oplus \cdots \oplus H^{n-r+1,r-1}$ iff $p(A)$ is an $r$-tuple point of $H_{\varphi}$. For $k = 1$, $\varphi$ determines a line-complex in $H^{2n-1}$ for which $p(A)$ is a maximal isotropic subspace iff $\varphi$ is of type $(1,1)$ on $A$. (The obvious generalization holds for arbitrary $k,r,n$.) When $k = 1$ this is nothing but Riemann's bilinear relations for a complex torus to be an abelian variety. However the case $k = 2, n = 4$, together with an analysis of the action of $H(8)$ on singular hyperplane sections $H_{\varphi}$ of $G(4,8) \subset H^2$, allows to determine the maximal families of abelian fourfolds carrying a non-trivial Hodge class. (Received May 30, 1978.)

15 ▶ Linear and Multilinear Algebra; Matrix Theory (finite and infinite)


Let $G = \prod_{i=1}^{k} \langle e_i \rangle$ be a factorization of a finite abelian group $G$, having order $n$, into cyclic subgroup $\langle e_i \rangle$, having order $n_i$ and $n = n_1 \cdots n_k$. Define $0 \leq \sigma_i(j) \leq n_i - 1$ for $i = 1, \ldots, k$, $j = 0, \ldots, n_i - 1$ by the equation $j = \sigma_1(j)n_2 \cdots n_k + \cdots + \sigma_k-1(j)n_k + \sigma_k(j)$. Define $\sigma = (0, \ldots, n-1) \rightarrow G$ by $\sigma(j) = \prod_{i=1}^{k} e_{\sigma_i(j)}$. Let $[y_{\alpha\beta}]$ be an $n \times n$ matrix such that $y_{\alpha\beta} = y_{\beta\alpha}$ if $\sigma(\alpha-1) = \sigma(\beta-1) = (\sigma(\gamma-1) = (\sigma(\delta-1)$ . Then, up to a constant factor, $\det[y_{\alpha\beta}] = R(f_0, f_1, \ldots, f_k)$ where $f_0(x_1, \ldots, x_k) = \prod_{\alpha=1}^{k} y_{\alpha1}^{\sigma_1(\alpha-1)}$, $f_i(x_1, \ldots, x_k) = x_i^{n_i-1} - 1$ for $i = 1, \ldots, k$, and $R(f_0, \ldots, f_k)$ is the resultant. (Received May 26, 1978.) (Author introduced by Professor Richard Randell).
In this paper, we discuss the elementary properties of F-rings with unit (for definitions see these Notices, # 696-16-1, August, 1972). Among other results, we conclude that in an F-ring with unit, every element is either invertible or a two-sided divisor of zero. Since every finite ring is an F-ring, this result also holds for finite rings with unit. (Received May 16, 1978.)

If \( R \) is a commutative ring and \( G \) is a finite, abelian group, then the isomorphism classes of (not necessarily commutative) Galois \( R \)-algebras with Galois group \( G \) form an abelian group \( A(R,G) \) and \( A(R,G) \) is functorial in \( R \) and \( G \). Henceforth, assume \( R \) has prime characteristic \( p \).

Theorem: If \( G \) is a \( p \)-subgroup of the group \( G \), then the sequence \( 0 \rightarrow A(R,G_1) \rightarrow A(R,G) \rightarrow A(R,G/G_1) \rightarrow 0 \) is exact. Corollary 1. If \( G \) is the direct product of a finite, abelian \( p \)-group \( G_1 \) and a finite, abelian group \( G_2 \), then \( A(R,G) \) is isomorphic to the direct product of \( A(R,G_1) \) and \( A(R,G_2) \). Corollary 2. If \( G \) is an extension of a finite, abelian \( p \)-group be a finite cyclic group, then every Galois \( R \)-algebra with Galois group \( G \) is commutative. Corollary 3. If \( G \) is a cyclic group of order \( p^n \), then \( A(R,G) \) is isomorphic to the quotient of the additive group \( W_e(R) \) of Witt vectors of length \( e \) over \( R \) modulo the subgroup of Witt vectors of the form \( P(x)-x \), \( x \) in \( W_e(R) \), where \( P \) is the Frobenius endomorphism. (Received May 22, 1978.)

In a recent paper VanLeeuwen and Heyman constructed a supernilpotent radical class using the class of almost nilpotent rings. Using a similar construction, for any class \( C \) satisfying the following four properties we obtain a supernilpotent radical class containing \( C \).

1. \( C \) contains the class \( Z \) of all zero rings.
2. \( C \) is hereditary.
3. \( C \) is homomorphically closed.
4. If \( A \) and \( A/I \) are elements of \( C \) for some ideal \( I \) of a ring \( A \), then \( A \in C \).

Every supernilpotent radical class \( P \) clearly satisfies these conditions. For any such radical class we define the class of almost radical rings and use these to construct a new radical class \( P_2 \) which contains the given one. (Received May 30, 1978.)

This paper investigates the chain conditions on ideals for certain classes of Lie algebras. Much work has already been done on chain conditions on subideals but the problem considered here is complicated by the fact that the conditions will not, in general, be inherited by the various substructures of the algebra. The development and results are analogous to those for infinite groups except in those instances where the theorems from group theory do not have valid lie theoretic analogues. (Received May 30, 1978.)
This paper explores the relationship between Hochschild's additive cohomology theory and Sweedler's multiplicative cohomology theory. Given an algebra \( C \) over a commutative ring \( k \) and a Sweedler two-cocycle \( \sigma \), one may form a new \( k \)-algebra \( C^0 \) and obtain a change of rings functor \( (\cdot)^0 \) from the category of \( C \)-bimodules to the category of \( C^0 \)-bimodules [cf. D. Riffelmacher, Pacific J. Math., 71, No. 1 (1977), 139-157]. \( (\cdot)^0 \) induces a map \( H^i(C,M) \to H^i(C^0,M^0) \), \( i \geq 0 \), on Hochschild cohomology for any \( C \)-bimodule \( M \). Several properties of this map are derived in this paper, including:

**Theorem.** Let \( C \) be a finite dimensional algebra over a field \( k \). Then \( \text{Hom}^1(C,M) \to \text{Hom}^1(C^0,M^0) \) is injective. (Received May 17, 1978.)

**20 ▶ Group Theory and Generalizations**

**758-20-1** Anthony M. Gaglione, U.S. Naval Academy, Annapolis, Maryland 21402. **A Commutator Identity.** Preliminary report.

The purpose of this note is to establish a group theoretical identity. Suppose \( F \) is the free group generated by \( a,b \). Let \( F_n \) be the nth subgroup of the lower central series of \( F \). Let \( p \) be a prime. Let \( c_3 < c_4 < \cdots < c_d \) be the basic commutators of weight \( >1 \) but \( < p+2 \). Let \( F_1 = (a,b), F_n = (F_{n-1},b) \) for \( n > 1 \). Then \( (a,b)^{(c_1)} \equiv \prod_{i=3}^{d} c_i^{e_1} \mod F^{p+2} \) where \( \alpha > 1 \). Moreover, it is shown that the exponents \( e_1 \) are divisible by \( p \) except for the exponent of \( p \) which is congruent to \( p^{a-1} \mod p^a \).

(Received May 10, 1978.)

**758-20-2** Michael E. Mays, West Virginia University, Morgantown, West Virginia 26506. **Groups of square-free order are scarce.**

Let \( T(n) \) be the number of non-isomorphic groups of order less than \( n \) and let \( B(n) \) be the number of non-isomorphic groups of square-free order less than \( n \).

**Theorem 1.** There is a positive constant \( c \) such that \( T(n) \gg n \log^2 n \).

**Theorem 2.** \( B(n) \ll ((\log \log n)^{\log n/\log \log n})^{(\log n/\log \log n)^2 + 1} \log n \).

The title theorem is that \( B(n) = o(T(n)) \). (Received May 25, 1978.)
A finite group $G$ is called a generalized Sylow tower group if it has a complete Sylow system $(P_1, P_2, \ldots, P_n)$ with the property that for each $P_i$, $P_j \in \pi(G)$, either $P_i \leq N_G(P_j)$, or $P_j \leq N_G(P_i)$. For such a group $G$ we construct a directed graph whose vertices are the primes $p_i$, $i = 1, \ldots, n$, and there is an arrow from $p_i$ to $p_j$ if $P_i \leq N_G(P_j)$. Some of the properties of this graph related to the structure of $G$ are studied. (Received May 23, 1978.)

Polyhedra of solutions to semigroup problems are discussed including a subadditive characterization of facets. This result leads naturally to a duality theorem. (Received May 30, 1978.)

Let $S$ be a semigroup of $2 \times 2$ fuzzy relation matrices over a finite subset $F$ of the unit interval $[0, 1]$ of the real line. Then the number of $D$-classes of $S$ is given by

$$m \cdot \sum_{t=1}^{m-1} t^2 + \sum_{t=1}^{m-1} \sum_{t=2}^{m-1} t \cdot (t+1) \cdot (m-t)^2 + \sum_{t=1}^{m-1} \sum_{t=2}^{m-1} t \cdot (t+1) \cdot (m-t+1),$$

where $m = |F| - 1$.

($|F|$ denotes the cardinal number of the set $F$). (Received May 30, 1978.)

Let $gdG$ denote the geometric dimension of a group $G$.

Theorem: Suppose $1 + N + G + Q + 1$ is an extension of groups. If $gdG \leq 2$ and $N$ is a stably free $G$-crossed module, then $gdQ \leq 2$; moreover, if $G$ is a free group, then $gdQ \leq 2$ only if $N$ is a stably free $G$-crossed module.

We remark that Dunwoody's presentation of the trefoil group is an example of an extension in which $G$ is a free group, $gdQ = 2$, and $N$ is a stably free but not a free $G$-crossed module. (Received May 30, 1978.)

The ideas of C. Jordan, O. Hölder, O. Dedekind, O. Schreier converging to the lemma on 4 subgroups of a group and its unfolding into lattice and category theory are presented. E. Noether's ideas are confronted with the isomorphy problem of the theory of algebraic structures. (Received May 30, 1978.)

22 ▶ Topological Groups, Lie Groups

We first calculate the von Neumann kernel, $\mathcal{V}(G)$, of an arbitrary connected Lie group. We conclude easily from this calculation that the closed, characteristic, subgroup $\mathcal{V}(G)$ is also connected. Using our calculation of $\mathcal{V}(G)$ we give various characterizations of minimally almost periodic for a connected Lie group. Among the characterizations is the following: A connected Lie group $G$ with radial $R$ is minimally almost periodic (m.a.p.,) if and only if $G/R$ is semisimple without compact factors and $G = [G,G]$. We prove in the special case where $R$ is also simply connected that $G = [G,G]$. This has the corollary that a simply connected radical of a connected m.a.p. Lie group is nilpotent. Using techniques established early in this paper together with a theorem of Tits we prove that a connected m.a.p. Lie group has no nontrivial automorphisms of bounded displacement. As a consequence we prove if $G$ is a m.a.p. connected Lie group, $H$ is a closed subgroup of $G$ such that $G/H$ has finite volume and $d_{H,x}$ is bounded, then $\langle H \rangle$ is trivial. Using a decomposition due to Y. Matsushima and projective limits of Lie groups, we extend most of our results on the characterization of m.a.p. Lie groups to arbitrary locally compact topological groups, and get a relatively simple proof of the Freudenthal-Weil theorem. (Received May 30, 1978.)
Equip $H^m$, the group of Lebesgue measure-preserving homeomorphisms (m.p.h.) of $R^n$ onto itself, with the topology of uniform convergence on compact sets. We obtain the following infinite measure-preserving extension of the Ornstein-Ulam theorem (Ann. of Math. 42 (1941), 874-920):

**Theorem 1** In the Baire space $H(R^n)$, $n \geq 2$, the ergodic m.p.h. of $R^n$ form a nonempty $G$-set. If in addition, $m\set$, the ergodic m.p.h.'s are shown to be a dense $G$-subset of $H(R^n)$. (Received May 9, 1978.)

**Theorem 2** In the Baire space $SH(R^n)$, $n \geq 2$, the ergodic measure-preserving stable homeomorphisms, form a dense $G$-subset of $SH(R^n)$. (Received May 9, 1978.)

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**Functions of a Complex Variable**

**758-30-1** CARL PRATHER, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061. *Zeros of successive derivatives of some entire functions. Preliminary report.*

We compute the zeros of the $n$-th derivative of $e^{m(e^z - 1)}$ [resp. $e^{m(e^{iz} - 1)}$], for $m$ real, in terms of the roots of the polynomial $P_n(t) = S(n, 1)t + \ldots + S(n, n)t^n$, where the coefficients $S(n, k)$ are Stirling numbers of the 2nd kind. By analyzing the roots of the polynomials $P_n(t)$ as a function of $n$, we obtain information about the asymptotic location of zeros of the individual derivatives. When $m = \pm 1$, these functions are $e^{\pm(e^z - 1)}$ (resp. $e^{\pm(e^{iz} - 1)}$). By using known congruences modulo primes for the $P_n(s)$, $s$ an integer, it is shown that for more than 97% of the $n \geq 3$, the zeros of $d^n/e^n [e^{\pm(e^z - 1)}]$ (resp. $d^n/e^n [e^{\pm(e^{iz} - 1)}$] are not purely imaginary (resp. real). The roots of $P_n(t)$ are computed for $n \leq 21$. (Received April 12, 1978.)


The results which will be presented concern properties of a class of Riemann surfaces which occurs in a natural way in the study of bounded holomorphic functions. (Received May 30, 1978.) (Author introduced by Professor Jerry Goldman.)
James Ernest Miller, West Virginia University, Morgantown, West Virginia 26506. Convex starlike meromorphic functions.

Let \( S(p) \), \( 0 < p < 1 \), denote the class of univalent meromorphic functions \( f \) in the unit disk \( E \) with a simple pole at \( z = p \) and with the normalization \( f(z) = z + a_2 z^2 + \ldots \) for \( |z| < p \). In this paper we study the subclasses of \( S(p) \) which map the unit disk onto the exterior of a convex set or the exterior of a starlike set. We show that the set of points omitted by the class of convex functions is \( \{ -\pi/(1 + p^2) \} \). The coefficients of convex and starlike meromorphic functions are also studied. (Received May 30, 1978.)

WITHDRAWN


A presentation of some number theoretic consequences which follow from properties of the Hecke operators on spaces of modular forms. There will be a discussion of problems arising in finding an analogue for the Hecke operators when the relevant group is of infinite index in the classical \((2 \times 2)\) modular group. (Received May 30, 1978.)

Edward J. Moulis, Jr., United States Naval Academy, Annapolis, Maryland 21402. Two classes of analytic functions depending on three real parameters. Preliminary report.

Let \( U^k_\alpha(p) \) denote the class of regular functions \( f(z) \) in \( E = \{ z : |z| < 1 \} \), normalized so that \( f(0) = f'(0) = 1 = 0 \) in \( E \) and
\[
\int_0^{2\pi} \left| \frac{\text{Re} e^{i\alpha} zf'(z)/f(z)}{1 - \rho} - \rho \cos \alpha \right| d\theta \leq k \pi \cos \alpha,
\]
\( k \geq 2, 0 \leq \rho < 1, \alpha \text{ real}, |\alpha| < \pi/2, z = r e^{i\theta}, 0 \leq r < 1 \). \( U^k_\alpha(0) \) is the class of functions with bounded argument rotation and functions in \( U^2_\alpha(0) \) are \( \alpha \)-spirallike in \( E \). Functions in \( U^2_\alpha(p) \) are starlike of order \( \rho \) in \( E \). Representation theorems are obtained for the class \( U^k_\alpha(p) \). Let \( V^k_\alpha(p) \) be the class of normalized analytic functions in \( E \) determined by the condition that \( f \in V^k_\alpha(p) \) iff. \( zf' \in U^k_\alpha(p) \). We obtain bounds on the radius of convexity of the class \( V^k_\alpha(p) \) and the radius of starlikeness of \( U^k_\alpha(p) \). (Received May 30, 1978.)

32 ★ Several Complex Variables and Analytic Spaces

Carlos A. Berenstein, University of Maryland, College Park, Maryland 20742 and B.A. Taylor, University of Michigan, Ann Arbor, Michigan 48109. Interpolation by entire functions of exponential type. Preliminary report.

Let \( F(z,w) \) be an entire function of exponential type on \( \mathbb{C}^2 \). Let \( M = \{(z,w) \in \mathbb{C}^2 : F(z,w) = 0 \} \) and assume that \( \nabla F \neq 0 \) on \( M \), so that \( M \) is a submanifold. If for some \( \varepsilon > 0 \) and \( A > 0 \) and all \( z \in M \) we have \( |\nabla F(z,w)| \geq \varepsilon \exp(-A|z| + |w|) \), then a standard argument shows that every analytic function \( \lambda \) on \( M \) of exponential type is the restriction to \( M \) of an entire function of exponential type. Problem: Does the converse hold? In this talk, we will discuss some results and open questions which arise in trying to solve this problem. (Received May 8, 1978.)

Thomas Bloom, University of Toronto, Toronto, Canada M5S 1A1. \( C^\infty \) Peak Functions

Let \( U \) denote a bounded pseudoconvex domain in \( \mathbb{C}^n \) with smooth boundary \( \partial U \) and \( P \) a point of \( \partial U \). Theorem: If \( \partial U \) satisfies a strict type condition...
at \( P \) then there exists a function \( F \) analytic on a neighborhood \( V \) of \( P \) in \( \mathbb{C}^n \) such that the maximum of \( |F| \) on \( \overline{U} \cap V \) is assumed only at \( P \). **Example**

We exhibit a \( U \) which has an analytic support manifold at \( P \) but for which there is no function \( F \), analytic on \( U \) and \( C^\infty \) on \( \bar{U} \) such that \( |F| \) peaks at \( P \). (Received May 23, 1978.)

**758-32-3** FRANK BEARDSMORE, Tulane University, New Orleans, Louisiana 70118, and Rice University, Houston, Texas, 77001. Holomorphic Approximation in Weakly Pseudoconvex Domains. Preliminary report.

We construct a solution operator for the equation \( \overline{\partial} u = \alpha \) in weakly pseudoconvex domains which admits uniform and H"{o}lder estimates when the form \( \alpha \) vanishes near the set of boundary points where the Levi form degenerates. These estimates yield Mergelyan type approximation theorems and provide information concerning generators of maximal ideals in boundary value algebras. (Received May 25, 1978.)

**758-32-4** L.R. HUNT, Texas Tech University, Lubbock, Texas 79409 and MIKE KAZLOW, Rice University, Houston, Texas 77001. Silov boundaries of algebras of CR-functions. Preliminary report.

Let \( K \) be the closure of a relatively compact open subset (with smooth boundary) of a \( C^\infty \) real CR-submanifold \( M \) of \( \mathbb{C}^n \), \( n \geq 1 \). The spectrum and the Silov boundary of the algebra of the \( \mathbb{C}^\infty \) solutions to the tangential Cauchy-Riemann equations to \( M \) on \( K \) are examined. If \( \overline{CR}(K) \) denotes the completion of this algebra under the sup norm, then the following two problems are considered:

1) Find necessary and sufficient conditions on \( K \) so that \( K \) equals the Silov boundary of \( \overline{CR}(K) \).

2) Find necessary and sufficient conditions so that \( \partial K \) equals the Silov boundary of \( \overline{CR}(K) \).

(Received May 25, 1978.)


If \( S \subset \mathbb{C}^n \) is a pseudo-convex hypersurface then for \( x \in S \) we associate a doubly indexed sequence \( r^q_k(x) \) of ideals of germs of functions. These ideals measure the order of contact that \( q \)-dimensional varieties through \( x \) can have with \( S \). These ideals also control the boundary behaviour of the \( \overline{\partial} \)-Neumann problem and the \( \overline{\partial} \)-problem. (Received May 30, 1978.)

**758-32-6** Eric Bedford and John Erik Fornaess, Princeton University, Princeton, New Jersey 08540. A counterexample to regularity for the complex Monge-Amp\'{e}re equation.

We consider the following Dirichlet problem for a domain \( \mathbb{N} \subset \mathbb{C}^n \):

\[
(*) \quad \text{det} \left( \frac{\partial^2 u}{\partial \bar{z}_i \partial z_j} \right) = f \quad \text{on} \quad \mathbb{N}
\]

\[ u = \varphi \quad \text{on} \quad \partial \mathbb{N}. \]

It is shown that if \( \mathbb{N} \) is the unit ball in \( \mathbb{C}^n \), \( \varphi = 0 \), and \( f \geq 0, f \in C^\infty(\mathbb{N}) \), then the (unique) generalized solution of (*) need not belong to \( C^2(\mathbb{N}) \). We also consider the case where \( \mathbb{N} = \mathbb{N}_1 \setminus \mathbb{N}_2 \) and \( \mathbb{N}_2 \subset \mathbb{N}_1 \) are strongly pseudoconvex. It has been shown that there is a unique generalized solution to (*) with \( f = 0 \), \( \varphi = 1 \) on \( \partial \mathbb{N}_2 \), \( \varphi = 0 \) on \( \partial \mathbb{N}_1 \).

We show that in general \( u \notin C^2(\mathbb{N}) \), even when \( \partial \mathbb{N} \) is smooth. (Received May 30, 1978.)

**758-32-7** MICHAEL FREEMAN, University of Kentucky, Lexington, KY 40506. Existence of Complex Submanifolds of a Real Submanifold. Preliminary report.

Given a point \( z \) on a real CR submanifold \( M \) of a complex manifold, with \( k = \text{codimension of the space} \ H_z M \) of complex tangent vectors to \( M \) at \( z \), when
does there exist a $k$-dimensional complex submanifold of $M$ through $z$? A foliation of $M$ by such submanifolds is not required; just one through $z$. Necessary conditions are given which are also sufficient when $M$ is real-analytic. (Received May 30, 1978.)

*758-32-8 S. M. Webster, Princeton University, Princeton New Jersey, 08540. On mapping an $n$-ball into an $(n+1)$-ball in complex space.

A boundary preserving holomorphic mapping $f$ of a strictly pseudo-convex domain $D$ in $\mathbb{C}^n$ into the unit ball $B^{n+1}$ in $\mathbb{C}^{n+1}$ is studied. An extension theorem is proved under the assumption that $D$ has real analytic boundary and $f$ is $C^3$ to the boundary. If in addition $D = \mathbb{B}^n$ and $n \geq 3$ $f$ is shown to be (fractional) linear. (Received May 30, 1978.)

34 ▲ Ordinary Differential Equations

758-34-1 STEVEN MINSKER, Rutgers University, Camden, New Jersey 08102. Area-splitting centroids. Preliminary report.

Let $f: [0, r) \to \mathbb{R}$ be continuous, with $f > 0$ on $(0, r)$. Fix $0 < a < 1$. For each $x \in (0, r)$, let $c(x)$ denote the $x$-coordinate of the centroid of the area $A(x)$ under the graph of $f$ on the interval $[0, x]$. We seek functions $f$ such that $A(c(x)) = dA(x)$ for all $x \in (0, r)$. This problem is essentially equivalent to solving the unusual functional differential equation

$$c'(c(x)) = (c(x) - c(c(x)))/(x - c(x)), \quad x \in (0, r).$$

Solutions of this problem will be discussed. The analogous "two-sided" area-splitting problem will be solved completely. (Received April 6, 1978.)


Although the Jacobian Problem in algebraic geometry (discussed by O. H. Keller 1939, E. W. E. Jung 1942, W. van der Kulk 1953, M. Nagata 1972, and S. S. Abhyanker 1977) is not the same as the Jacobian Problem in the stability theory of differential equations (discussed by M. A. Aizerman 1949, N. N. Krasovski 1954, L. Markus and Hidehiko Yamabe 1960, J. P. LaSalle 1960, and P. Hartman and C. Olech 1961--66), nevertheless there may be some useful interaction. Analysis of the first problem reveals the detailed structure of the members $T$ of a large group $\mathcal{G}$ of one-to-one maps $T: \mathbb{R}^2 \to \mathbb{R}^2$ satisfying $\det J(T) = \text{constant} \neq 0$. This group $\mathcal{G}$ contains the group $\mathcal{P}$ of all those $T$ for which the components of both $T$ and $T^{-1}$ are polynomials. Theorems of Markus and Yamabe, Olech, Hartman, and LaSalle determine complete stability or the extent of stability for the corresponding vector systems $\dot{x} = T(x)$, which include Liénard's scalar equations of the form $\ddot{x} + \mu [f(x) - 1] \dot{x} + \nu x = 0$, with $f(0) = 0$, which in turn include van der Pol's equation $\ddot{x} + \mu [x^2 - 1] \dot{x} + x = 0$. (Received May 10, 1978.)


The LaSalle Invariance Principle is extended to the context of nonautonomous functional differential equations. The concept of a limiting equation of a differential equation is the chief tool used in establishing this extension. Results on uniform asymptotic stability, total stability, and eventual stability are given. Examples are included. (Received May 16, 1978.)
Writing Legendre's Differential Equation, \( \gamma'f := -(1-x^2)f'' = (\lambda - 1/4)f, ~x \epsilon (-1,1) \), in the "regularized form"

\[
\frac{du}{dx} = \frac{(\lambda - 1/4)}{2} \begin{pmatrix}
\frac{\text{Arctanh } x}{2} & \frac{(\text{Arctanh } x)^2}{2} \\
-1 & \frac{\text{Arctanh } x}{2}
\end{pmatrix} y
\]

we apply the limit circle theory given in C. Fulton, TRANS. AMER. MATH. SOC. 229(1977), 51-63, to obtain transcendental equations for the eigenvalues (and then the eigenfunction expansions) associated with the SELF-ADJOINT BOUNDARY VALUE PROBLEM determined by the boundary conditions

\begin{align*}
(1) & \quad B_1(f) \cos \alpha + B_2(f) \sin \alpha = 0, \quad \alpha \in [0, \pi] \\
(2) & \quad C_1(f) \cos \beta + C_2(f) \sin \beta = 0, \quad \beta \in [0, \pi]
\end{align*}

for all values of the parameters \( \alpha, \beta \) here \( \{B_1(f), B_2(f)\} \) and \( \{C_1(f), C_2(f)\} \) are linearly independent 'boundary values for \( \gamma' \) at \(-1\) and \(+1\) respectively, cf. D.-S., LINEAR OPERATORS, II., p. 1302. The well known LEGENDRE POLYNOMIAL EXPANSION arises as a special case when the Friedrich's B.C.'s are posed at either endpoint. Our more general LEGENDRE FUNCTION EXPANSIONS (involving Legendre functions of 1st. and 2nd. kinds) are alluded to in Achieser & Glazman, THORIE DER LINEAREN OPERATOREN IM HILBERTRAUM, Akademie Verlag (1968), pp. 467-471, but the details do not seem to have been worked out in any of the standard textbook references. (Received May 22, 1978.)

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**758-34-5**

RICHARD F. DATKO, Georgetown University, Washington, D.C. 20057.


The structure of Lyapunov functionals, the Perron condition and the Popov criteria for absolute stability are extended to linear differential-difference equations in a Hilbert space. (Received May 24, 1978.) (Author introduced by Professor H. T. Banks)

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**758-34-6**

TERRY L. HERDMAN, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

Behavior of noncontinuable solutions of a retarded differential equation.

We consider the retarded differential equation \( x'(t) = q(t, x(t - \tau(t))) \) where the functions \( q: [0, \infty) \times \mathbb{R}^n \rightarrow \mathbb{R}^n \) and \( \tau: [0, \infty) \rightarrow [0, \infty) \) are continuous. In particular, we discuss the behavior of \( ||x(t)|| \) as \( t \rightarrow T^* \) where \( T \) is the right hand endpoint of the maximal interval of existence for the solution \( x(t) \). (Received May 25, 1978.)

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**758-34-7**

R. D. DRIVER, University of Rhode Island, Kingston, RI 02881.

Can the future influence the present?

One widely accepted model of classical electrodynamics assumes that a moving charged particle produces both retarded and advanced fields. This formulation first appeared at least 75 years ago, and was popularized in the 1940s by work of Wheeler and Feynman. But the most basic question has remained unanswered: When does the associated two-body problem have a unique solution?

The present paper gives an answer in one special case. Imagine two identical charged particles alone in the universe moving symmetrically along the x-axis. One is at \( x(t) \) and the other is at \(-x(t)\). Their motion is then governed by a system of functional differential equations involving state dependent delays and advances. This system together with the Newtonian "initial" data \( x(0) = x_0 > 0 \) and \( x'(0) = 0 \) has a unique solution for all time provided \( x_0 \) is sufficiently large. (Received May 30, 1978.)

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**758-34-8**

A. MANITTIUS, Centre de Recherches Mathématiques, Université de Montréal, Montréal, Québec C.P. 6128, H3C 3J7.


The paper gives general necessary and sufficient conditions for completeness of eigenfunctions associated with systems of linear autonomous retarded functional differential equations (FDE), in the Hilbert space \( \mathbb{R}^n \times L_2([-h,0],\mathbb{R}^n) \). The eigenfunctions are elements of the nullspaces of \( (I-A)^{m} \), where \( A \) is the infinitesimal generator of a \( C_0^- \)-semigroup of bounded linear operators on
$R^n \times L_2([-h,0],R^n)$ corresponding to the FDE in question. In addition to the usual notion of completeness, a new concept of F-completeness is introduced and its significance is explained. In particular, it is shown that the F-completeness is related to the absence of solutions of the transposed equation that vanish in finite time. The results are obtained entirely via the $C_0$-semigroup theory, which results in simplicity of the proofs. As a by product, some new results on the adjoint semigroup are obtained. The main results are expressed in an operator form. A general criterion of completeness, expressed in terms of the original system matrices, is given. For systems with one delay, the F-completeness criterion is translated into matrix type conditions. (Received May 30, 1978.)

(Author introduced by Professor H. T. Banks.)

35 ▶ Partial Differential Equations


Let $\Omega$ be a bounded domain in $R^n$ with smooth boundary $\partial \Omega$. Consider the quasilinear elliptic boundary value problem $Lu = G(x,u,Du)$ in $\Omega$, $u = 0$ on $\partial \Omega$, where $G(x,s,p)$ grows at most quadratically in $p$, i.e. there is an increasing function $c(\cdot)$ such that $|G(x,s,p)| \leq c(|s|)(1 + |p|^2)$, where $Lu = -\sum_{ij} a_{ij}(x)u_{ij} + \sum_i b_i(x)u_i$ is uniformly elliptic in $\Omega$ and where the coefficients $a_{ij}$ and $b_i$ are smooth in $\Omega$. Criteria for the existence of a solution $u$ to the BVP are obtained. These criteria have the desirable feature that they are invariant under changes of variable $v = Q(u)$. In case $G$ does not depend on $Du$ the criteria reduce to the sharp criteria of Kazdan and Warner for semilinear elliptic boundary value problems. As a corollary to our general existence theorem we obtain a generalization to the P.D.E. case of a classical existence theorem of S.N. Berstein who proved it for second order ordinary differential equations. The assertion is that if $G(x,s,p)$ satisfies the quadratic growth condition in $p$ and if $G(x,s,p) \leq \text{const.} < 0$ for all large $|s|$ then a solution of the Dirichlet problem for $Lu = G(x,u,Du)$ exists. Moreover the result is sharp in that if $G_s \leq 0$ a solution may or may not exist. (Received April 27, 1978.)

758-35-2  Charlie H. Cooke, Old Dominion University, Norfolk, Virginia 23508.

On The Sufficiency Of A Numerical Downstream Continuation.

The numerical boundary conditions applied in closing the flow problems of fluid dynamics at downstream locations are often of higher order than are the equations of the physical model. In this paper an investigation of the sufficiency of such conditions for existence and uniqueness of solution is performed, for a particular boundary value problem of this bizarre type. An unconventional Hilbert space problem setting allows the insight that the existence question is equivalent to the completeness question for the eigenfunctions of an essentially self adjoint linear differential operator, whose outcome is well known. (Received May 4, 1978.) (Author introduced by Professor James L. Sclwing.)

#758-35-3  S. ALINHAC and M. S. BAOUENDI, Purdue University, West Lafayette, IN 47907. Uniqueness results for the characteristic Cauchy problem and strong unique continuation for higher order P.D.E's. Preliminary report.

Let $M$ be a $C^\infty$ compact manifold. Uniqueness results via Carleman type estimates are obtained for $m$th order operators of the form $P(t,\theta, t_\theta, D_\theta)$, where $P$ is a polynomial in $t_\theta$, whose coefficients are pseudo-differential operators on $M(t \in [0,T], \theta \in M)$. Applications to strong unique continuation yields results for second and fourth order elliptic differential inequalities (including the Arouszajn-Cordes theorem), and for hyperbolic equations. (Received May 18, 1978.)

A-526
We study the regular single-valued solutions of the equation
\[ a^2 u_{xx} + a^2 u_{yy} + a(x,y)u_{x} + b(x,y)u_{y} + c(x,y)u = 0 \]
whose real analytic coefficients are entire functions on \( \mathbb{C}^2 \). Let \( \Omega \) be a multiply-connected plane domain such that each component of the complement intersects the real axis and whose closure intersects the real axis in a collection \( \Lambda \) of finite compact intervals. Let \( f \) be a complex valued function with domain \( \Lambda \). Classes \( \mathcal{R}_n \), \( n = 0,1,2, \ldots \) of regular multi-valued "rational" function solutions are constructed on \( \Omega \) over which the Chebyshev norms
\[ e(f, \mathcal{R}_n; \Lambda) = \inf \{ \sup \{ |f(x) - r(x)| : x \in \Lambda \} : r \in \mathcal{R}_n \} \]
are defined. Properties of these norms characterize those \( f \) that are analytic on \( \Lambda \) and are the restriction to \( \Lambda \) of regular single-valued solutions on \( \Omega \) satisfying the Neumann condition \( \partial u/\partial y = 0 \) on \( \Lambda \). In this case, a uniformly convergent "rational" function expansion is given, representing \( u \) on compacta of \( \Omega \). Integral Operator Methods and the theory of Cayley inner functions are used extensively. (Received May 19, 1978.)

### Scattering of Sound Waves

In wave propagation problems, where waves are scattered by localized irregularities in the medium, the scattering matrix, a meromorphic (operator-valued) function, was introduced to isolate the essence of the interaction. The aim of this talk is to survey results relating properties of the scattering objects to properties of the scattering matrix. These results and related conjectures will be discussed for waves governed by linear perturbations of the classical wave equation \( \square u = 0 \) in \( \mathbb{R} \times \mathbb{R}^3 \), i.e. for sound waves in a medium of variable density and waves in the presence of reflecting obstacles. (Received May 22, 1978.)

### Propagation of Singularities for Operators with Non-Involutive Characteristics

Let \( \Omega \subset \mathbb{R}^{n+1} \) be an open set. Assume \( P_1, P_2 \) and \( Q \) are classical pseudodifferential operators on \( \Omega \) of orders \( m_1, m_2 \) and \( m_1 + m_2 - 1 \) with principal symbols \( p_1, p_2 \) and \( q \). Assume the \( p_j \) are real valued. We are concerned with operators \( P = P_1 P_2 + Q \) such that the Poisson bracket \( \{ p_1, p_2 \}(z_0) \neq 0 \), if \( p_1(z_0) = p_2(z_0) = 0 \). By constructing microlocal parametrices for \( P \) near \( z_0 \), we are able to study the propagation of singularities. Some results are independent of the lower order terms; other facts depend on the subprincipal symbol. (Received May 25, 1978.)

### A Global Theory of Steady Waves in Continuously Stratified Fluids

We study two dimensional wave motions in a heterogeneous, inviscid, incompressible fluid confined between two horizontal planes. Using Yih's version of Long's equation we show the existence of steady, periodic, wave trains and of a steady, single-crested wave. We treat the case of fixed energy and fixed velocity using a variational characterization of solutions which obviates any need to restrict amplitudes. By using Steiner symmetrization in the characterization of periodic waves we are able to obtain the single-crested wave as the limit of periodic waves, uniformly on bounded sets. (Received May 26, 1978.)

### The Confinement Problem for Solenoidal Vector Fields

We seek continuous vector fields \( A \) defined on a domain \( \Omega \) of \( \mathbb{R}^N \) with boundary \( \partial \Omega \) such that
1. \( A \) decomposes \( \Omega \) into two disjoint sets, a bounded set \( \Omega_1 \) (disjoint from \( \partial \Omega \)) on which \( A \) is solenoidal and the complement \( \Omega - \Omega_1 \) on which \( A \) is irrotational. (ii) \( A \) is the critical
point of an appropriate action functional. We discuss (a) a topological classification of such
vector fields with associated existence results, (b) new bifurcation phenomena (bifurcation from
Green's function), and (c) relationship to Euclidean Yang-Mills theory and other physical
problems. (Received May 30, 1978.)

*758-35-9 AVRON DOUGLIS, University of Maryland, College Park, Maryland 20742 and EUGENE FABES,
University of Minnesota, Minneapolis, Minnesota 55455. The Layering Method for the

We consider the initial value problem for the Navier-Stokes equations with data in $L^p(\mathbb{R}^n)$, $n < p < \infty$. A unique weak solution is constructed in a small interval of time through a layering procedure used previously by A. Douglass for certain systems of quasi-linear parabolic equations.

The technique consists of dividing $\mathbb{R}^n \times (0,\infty)$ into the strips $S_m = \mathbb{R}^n \times ((m-1)h, mh)$, $m = 1, 2, \ldots$, and in each of these strips constructing an "approximate" solution, $u_m$, of the equation

$$Du_m = \sum_{k=1}^{n} D_x u_m^i \cdot \xi^k + D_x F_m, \quad i = 1, \ldots, n$$

satisfying the conditions

$$\text{div } u_m = 0, \quad u_m(x, (m-1)h) = S_{m-1}(u((m-1)h))x$$

where $S_x(f)$ is a fixed regularization of the function $f$. We define $u^h$ on each $S_m$ as $u_m$ and the family so constructed will converge, in a small interval of time, to a solution of the Navier-Stokes equations. (Received May 30, 1978.)


It is shown that for certain $m$th order linear partial differential operators $P(t,x,D_t, D_x)$ of principal type an iterated boundary value problem is well-posed on a domain of the form $(0,T) \times \mathbb{R}^n$. More precisely, if $P_m(t,x,T,\xi) = (\sum_{k=1}^{n} (\tau - \tau_k)(t, x, \xi))$ then corresponding to each strictly real $\tau_k$ we may assign data at $t=0$ or $t=T$, and corresponding to each $\tau_k$ with $\text{IM}(\tau_k) > 0 (< 0)$ we may assign data at $t=0$ ($t=T$). The data will be iteratively assigned so that the $L_2$-inequalities used to prove existence and uniqueness will follow by iterating $L_2$-inequalities for certain elementary factors of $P_m$. (Received May 30, 1978.)

*758-35-11 LINDA PREISS ROTHSCIDLD, University of Wisconsin, Madison, Wisconsin 53706. Local solvability of differential operators on nilpotent Lie groups.

Let $X_1, X_2, \ldots, X_n$ generate a free two-step nilpotent Lie algebra, and put $L = \sum_{k=1}^{n} X_i^2 + \sum c_{jk} [X_j, X_k]$, $c_{jk}$ complex constants. Then $L$ is locally solvable iff the operator $\pi(L)$ has no zero eigenvalue for almost all irreducible unitary representations $\pi$. (Received May 30, 1978.)

758-35-12 HERBERT AMANN, Ruhr-Universität Bochum and MICHAEL G. CRANDALL, University of Wisconsin, Madison, Wisconsin 53706. On some existence theorems for semi-linear elliptic equations.

Let $A$ denote a strongly elliptic second order differential operator and $B$ be a first order boundary operator acting on functions $u$ defined on $\Omega \subset \mathbb{R}^n$. Let $f: \bar{\Omega} \times \mathbb{R} \times \mathbb{R}^N \rightarrow \mathbb{R}$ satisfy

$$|f(x, \xi, \eta)| \leq c(|\xi|)(1 + |\eta|^2).$$

Under suitable assumptions, it is shown how the set of solutions of problem

$$(1) \begin{cases} Au = f(x, u, Du) & \text{in } \Omega \\ Bu = 0 & \text{on } \partial \Omega \end{cases}$$

satisfying $\bar{u} \leq u \leq \hat{u}$ where $\bar{u}$ and $\hat{u}$ are, respectively, sub- and super- solutions of (1) can be naturally identified with the fixed point set of a self-mapping $T$ of the order interval $[\bar{u}, \hat{u}]$. Moreover, $T$ has many desirable properties from which existence and multiplicity theorems are obtained. (Received May 30, 1978.)
Local real analyticity of solutions to two types of problems in differential equations is proved; located (interior) regularity for certain non-elliptic (subelliptic) operators $P = \sum_{i,j=1}^{n} a_{ij}(x)X_iX_j + \sum_{i=1}^{n} a_i(x)X_i + a_0(x)$, for $i,j = 1, \ldots, 2n-2$, on a manifold of dimension $2n-1$ where the real analytic vector fields $X_j$ have a non-degenerate Levi form (if $X_1, \ldots, X_{2n-2}$ span the tangent space then the matrix $c_{jk}$ given by $[X_j, X_k] \equiv c_{jk}T$ (mod $X_j$) should be non-singular) and which satisfies the a priori estimate $\|X_jX_kv\|_{L^2} \leq C\|v\|_{L^2} + \|v\|_{L^2}$ (the prototype of such operators is the "boundary Laplacian", $\square_b$, under Kohn's condition $Y(q)$, on $(p,q)$ forms (differentiation acting on the coefficients)), and regularity up to the boundary, in the real analytic category, for the $3$-Neumann problem whenever the Levi form is non-degenerate and the problem satisfies the standard subelliptic estimate (condition $Z(q)$ on $(p,q)$-forms). (Received May 30, 1978.)

Solutions of the tangential Cauchy-Riemann equations on a real submanifold of complex $n$-space of codimension $k$ can be identified with the $k$th Dolbeault cohomology group with supports on the real submanifold. This is used to generalize the Mayer-Vietoris sequence for differential operators of the authors, A. Andreotti, and S. Lojasiewicz. This can be used to prove a local unique continuation theorem for solutions of the tangential Cauchy-Riemann equations. (Received May 30, 1978.)

A characterization of neutral linear difference-differential equations which are asymptotically globally in the delays.

In the difference-differential equation
\[ \frac{d}{dt} [x(t) + \sum_{k=1}^{m} A_k x(t-t_k)] = B_0 x(t) + \sum_{k=1}^{m} B_k x(t-t_k), \]
with $\{A_k\}_{k=1}^{m}$, $\{B_k\}_{k=1}^{m}$ $n \times n$ constant matrices and $\{t_k\}_{k=1}^{m}$ non-negative real numbers, a theorem is proven that characterizes the class of matrices such that the solutions of such equations are exponentially asymptotically stable for every set of $\{t_k\}$. Examples are presented to illustrate the application of the result. (Received May 23, 1978.)

Positivity of some Cotes numbers.

Fejér and Szegő proved the positivity of the Cotes numbers for certain quadrature schemes dealing with Jacobi polynomials. Vietoris and others have added to these examples. Some further examples will be given. (Received May 15, 1978.)

An exponential approximation operator $S_\lambda(f,t)$ is an integral operator whose kernel $W(\lambda, t, u)$ satisfies $\frac{dW}{dt} = \lambda(u-t) \frac{p(t)}{p(u)} W$, $\lambda > 0$, and $\int_0^\infty W du = 1$. Ismail and May; J. Math. Anal. Appl. (1978), to appear; showed how to solve the partial differential equation satisfied by $W$ in the space of generalized functions. The domain of $t$ is the closure of a component in $\{t \mid p(t) > 0, p(t)$...
analytic}. In the present paper we show that if \((A, B)\) is the domain of \(t\), either \(A\) (or \(B\)) is finite and \(A\) (or \(B\)) is a simple pole of \(1/p(t)\) then

\[
S_\lambda(f, t) = \exp\{-\lambda(\eta(\xi) - \eta(0))\} \sum_{k=0}^{\infty} \psi_k(\lambda) \frac{f^{(k)}(\xi)}{k!},
\]

where \(\xi\) and \(\eta\) are functions of \(t\) that can be computed explicitly, and \(\{\psi_k(\lambda)\}\) is a sequence of polynomials of binomial type. We will also briefly outline Ismail and May's results. (Received May 17, 1978.)

*758-41-3* I. BOROSH and C. K. CHUI, Texas A&M University, College Station, Texas 77843.
Characterization of functions by their Gauss-Chebyshev quadratures. Preliminary report.

If \(p\) is a polynomial, then all but a finite number of the Gauss-Chebyshev quadrature formulae are exact. The main purpose of this paper is to establish a converse to this property. Let \(f \in C[-1,1]\) and let \(f(x) = \frac{1}{2}a_0 + \sum_{k=1}^{\infty} a_k T_k(x)\) be its Chebyshev expansion. Assume that

1. \(\sum_{k=1}^{\infty} |a_k| < \infty\)
2. \(2^n \sum_{k=1}^{\infty} a_k 2^{nk} > 0\).

If all Gauss-Chebyshev quadrature formulae for \(f\) are zero, then \(f\) is an odd function. In addition we give two examples showing that neither of the conditions (1) and (2) is sufficient by itself. (Received May 25, 1978.)

*758-41-4* A. S. CAVARETTA, JR., Kent State University, Kent, Ohio 44242. A Refinement of Kolmogorov's Inequality.

For any \(n\)-times differentiable function \(f\) with uniform bounds on \(f\) and \(f^{(n)}\), we study the pair of values \(f^{(j)}(t), f^{(j+1)}(t)\) for an arbitrary real \(t\) and a prescribed \(j = 0, \ldots, n-1\). A given value of \(f^{(j)}(t)\) determines admissible values for \(f^{(j+1)}(t)\). These values are exactly determined in terms of the Euler spline \(s_n(t)\). Special differentiation formulas of cardinal interpolation type are developed to solve the problem. (Received May 24, 1978.)

*758-41-5* D. L. BARROW and P. W. SMITH, Texas A&M University, College Station, Texas 77843.
Efficient \(L_2\) approximation by splines.

Let \(s_N^k(t)\) be the linear space of \(k\)-th order splines on \([0,1]\) having the simple knots \(t_i\) determined from a fixed function \(t\) be the rule \(t_i = t(i/N)\). In this paper we introduce sequences of operators \(\{Q_N^{(k)}\}_{N=1}^{\infty}\) from \(C^k[0,1]\) to \(s_N^k(t)\) which are computationally simple and which, as \(N \to \infty\), give essentially the best possible approximations to \(f\) and its first \(k-1\) derivatives, in the norm of \(L_2[0,1]\). Precisely, we show that \(N^{-(k-1)} \|f - Q_N^k f\|_2 - dist_2(f^{(1)}, s_N^1(t)) + 0\) for \(i = 0, 1, \ldots, k-1\). Several numerical examples are given. (Received May 22, 1978.)

*758-41-6* CHARLES K. CHUI and PHILIP W. SMITH, Texas A&M University, College Station, Texas 77843.
An application of spline approximation with variable knots to optimal estimation of the derivative. Preliminary report.

In studying the optimal estimation of \(f'\), or more generally some mixed derivatives of \(f\), at \(t_n\) say, from the data \(f(t_1), \ldots, f(t_n)\), \(t_1 < \ldots < t_n\), one naturally arrives at the problem of best approximation from the linear span of the normalized B-splines \(\{N_{i,k}^n(t)\}\) with knots at \(\{t_i\}\). Hence, the problem of choosing the data to give the best estimation of the derivative, or mixed derivatives, at \(t_n\) is a variable knot problem in spline approximation. In particular, we prove that in approximating \(N_{n-k+1,k}\) from the span of \(\{N_{i,k}^{n-k}\}_{i=1}^{\infty}\) it is best to choose the knots closest to \(t_n\). This again, as in the problem of approximation of \(x^n\) by span\((x^1, \ldots, x^k)\), agrees with the general conjecture of G. G. Lorentz, namely, "like best approximates like." (Received May 26, 1978.)
Let $p_n(w,x)$, $(n = 0,1,\ldots)$, be the sequence of orthonormal polynomials (OP in short) to the weight $w$ which has support $(-1,1)$. We say that $w$ is Steklov in $(a,b)$ if the OP's are uniformly bounded in every proper subinterval of $(a,b)$. Let $x_{kn}$, $(k = 1,2,\ldots,n)$, be the zeros of $p_n(w,x)$ arranged in decreasing order. Let

$$t_{kn,n-1} = t_{kn}x_{kn-1,n} + (1 - t_{kn})x_{kn},$$

so that $t_{kn} \in (0,1)$. We say that the zeros of the OP's are uniformly separated in $(a,b)$ if to every proper subinterval $(c,d)$ of $(a,b)$ we have all the numbers $t_{kn}$ which are associated to zeros inside $(c,d)$, are situated in a proper subinterval of $(0,1)$.

Theorem. Let $(a,b)$ be a proper subinterval of $(0,1)$ which does not contain the point 0 and let $w(x) \geq m > 0$ for $x \in (a,b)$. Then $w$ is Steklov in $(a,b)$ if and only if the array of zeros $x_{kn}$ of the OP's is uniformly separated in $(a,b)$.

In the lecture, consequences of uniform boundedness of the OP's will be indicated. (Received May 30, 1978.)

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A Korovkin result will be presented for positive, linear operators which act on functions valued in the compact and convex subsets of $\mathbb{R}^d$. Particular aspects of Bernstein approximation will be discussed. (Received May 30, 1978.)

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The object of this note is to extend a result of Schoenberg about polynomial splines on the circle to a class of discrete splines of degree $n$ with the $k$-th roots of unity as knots $k = 1,2,\ldots,n$. The unique solution except in the following cases: Case I. $\epsilon = 0$, $n = 2m$, $\beta = 0$, $k = 2h$

For $\alpha = 1$, we get the result of Schoenberg (Proc. Conference on Constructive Theory of Functions 1969, Budapest, p. 403-418). (Received May 30, 1978.)

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Let $f$ be defined on $\mathbb{T}^n$ and have an absolutely convergent Fourier series $f(e^{i\sigma}) = \sum_m e^{im\sigma}$. Set $\|f\| = \sum |f_m|$. In this paper sufficient conditions for $\|f^k\| = o(1)$, $k \to \infty$, are obtained.

Theorem. Let $f$ be defined on $\mathbb{T}^n$, have an absolutely convergent Fourier series and satisfy $|f(e^{i\sigma})| \leq 1$ for all $\sigma$. If for each $\sigma$ such that $|f(e^{i\sigma})| = 1$ there exists a rotation $\lambda$ of $\mathbb{R}^n$, a polynomial $\rho$ such that $\Re \rho(\tau) > 0$ for all $\tau \neq \overline{\sigma}$, an $n$-tuple $p$ of positive integers such that $\rho(p^{1/2} \tau) = r^p(\tau)$ for all $r > 0$, and a function $\gamma$ in $C_0(\mathbb{R}^n)$, $m = \max(n+1,p_1,p_2,\ldots,p_n)$, such that $\gamma(\tau) = o(\rho^m)$, $\tau \to \overline{\sigma}$, and if for all $\tau$ in some $\mathbb{R}^n$-neighborhood of $\overline{\sigma}$ $f(e^{-i(\sigma + \lambda)(\tau)}) = c \exp(\beta \gamma(\tau))$ where $|\sigma| = 1$, $\beta \in \mathbb{R}^n$, then $\|f^k\| = o(1)$, as $k \to \infty$. (Received May 30, 1978.)

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A semigroup $S$ is said to be left amenable if it has a left invariant mean, i.e. a positive linear functional of norm one on the Banach space of bounded real-valued functions on $S$ with the sup norm,
which is invariant under all left translations by the elements of $S$.

A left amenable semigroup has a finite dimensional set of left invariant means if and only if it has a finite two-sided ideal, and in this case the dimension equals the number of disjoint left ideals of the semigroup which are finite groups. The dimension of the set of invariant means of a semigroup $S$ which does not contain a finite two-sided ideal, is

$$2^{\kappa(S)}$$

where $\kappa(S) = \min\{|B| : B \in S \text{ and } \mu(B) = 1 \text{ for every left invariant mean } \mu \text{ of } S\}$.

Analogous results hold for the dimension of the set of two-sided invariant means of an amenable semigroup. (Received May 15, 1978.)

### 45 ▶ Integral Equations

**#758-45-1 W. R. Madych, Iowa State University, Ames, Iowa 50011. On certain solutions of $g \tau = f$. Preliminary report.**

Suppose $g$ is a bounded solution of $g \tau = f$, where $\tau$ is a tempered distribution for which the convolution makes sense. (i.e. $\tau \phi$ is a summable on $(-\infty, \infty)$ for every $\phi$ in $S$.) Furthermore, suppose (i) $g$ satisfies a certain "Tauberian" condition at $\infty$, (ii) $f = f_1 + f_2$, where $f_1$ is bounded, satisfies a moment condition at $\infty$, and $\lim f_1(t) = 0$ as $t \to \infty$, and $f_2$ is almost periodic with $\exp f_2$ isolated, and (iii) the zeros of $\tau$ are isolated. Then $g = g_1 + g_2$ where $\lim g_1(t) = 0$ as $t \to \infty$ and $g_2$ is almost periodic with $\exp g_2 \subset \exp f_2 \cup \text{zeros of } \tau$.

(Received May 26, 1978.)

### 46 ▶ Functional Analysis

**#758-46-1 GEORGE BACHMAN, Polytechnic Institute of N.Y., Brooklyn, N.Y. 11201. Some applications of Functional Analysis to Topological Measure Theory.**

Let $X$ be an abstract set with a lattice of subsets such that $\phi, X \notin \mathcal{L}$. If $\mathcal{L}$ is a delta normal lattice, and if $C_L(\mathcal{L})$ is the Banach space of bounded $\mathcal{L}$-continuous real valued functions on $X$, then the conjugate space $C^*_L(\mathcal{L}) = M_L(\mathcal{L})$, the $\mathcal{L}$-regular additive measures on $C(\mathcal{L})$, the algebra generated by $\mathcal{L}$. $M_L(\mathcal{L})$ is topologized with the weak-star topology, and the subspace $C(\mathcal{L})$ of two-valued measures is a compact space such that $C(T_L(\mathcal{L})) = C_L(\mathcal{L})$ if $\mathcal{L}$ is strongly delta normal. Specific instances of $X$ and $\mathcal{L}$ yield well-known compactifications of $X$, suitably topologized. We are primarily concerned with mappings $T: X \to Y$ which are $\mathcal{L}_1 - \mathcal{L}_2$ continuous where $\mathcal{L}_1$ and $\mathcal{L}_2$ are lattices of subsets of $X$ and $Y$ respectively; under suitable conditions on $T$ and on the lattices, this will induce operators:

$$M_L(\mathcal{L}_1) \to M_L(\mathcal{L}_2), \quad M_{T_L}(\mathcal{L}) \to M_{T_L}(\mathcal{L}_2)$$

given by $T(\mu) = \mu \otimes \mu^{-1}$, and where, in general $M_{T_L}(\mathcal{L})$ consists of those $\mu \otimes \mu^{-1}$ which are $\mathcal{L}$-smooth.

We investigate conditions for the ontoness of these operators. These have as consequences conditions for the preservation of measure repleteness, and, in particular, of repleteness. These questions can be more effectively developed in terms of abstract measure extension problems, and have numerous applications to Topological Measure Theory. (Received May 26, 1978.)

**#758-46-2 Dong Pyo Chi, Seoul National University, Korea. Which selfadjoint operators in the domain of a closed derivation satisfies the domain problem?**

Let $\mathcal{D}(\delta) + \sigma$ be a closed derivation of a $C^*$-algebra $\sigma$ with domain $\mathcal{D}(\delta)$. In his dissertation (Univ. of Penn. 1975) the author showed an interesting relation between spectral theory of non selfadjoint operators and domain problem of closed derivations in a $C^*$-algebra. Especially he conjectured that if $A = A^* \in \mathcal{D}(\delta)$ and $f \in C^1[a, b]$ where $[a, b] \supset \text{spec}(A)$, then $f(A) \in \mathcal{D}(\delta)$. He made this conjecture based on the Kantorovitz' conjecture of spectral theory. McIntosh found a counter example to the above conjecture which in return gives a counter example to the Kantorovitz' conjecture. Hence the next problem is the question in the title i.e., find a necessary and sufficient condition for $A = A^* \in \mathcal{D}(\delta)$ to satisfy so
That if \( f \) is continuously differentiable then \( f(A) \in \mathcal{D}(\delta) \) again. Using spectral theory of Dunford and Schwartz' style, the author found a necessary and sufficient condition for the above problem. As a corollary he could obtain that if \( A = A^* \) and \( \delta(A) \) commute, then \( f(A) \in \mathcal{D}(\delta) \) for all \( f \in C^1[a,b] \) even though this result could be obtained in elementary method. (Received April 21, 1978.)

Some aspects of the classical Wold decomposition for an isometry on Hilbert space are extended to B-spaces. If \( V \) is an isometry with orthocomplemented range on either a rotund or a reflexive B-space a reasonable analogue of the classical decomposition obtains. An example shows that existence of a decomposition depends on the choice of the first innovation space. The extent that the non-unitary part is a shift is discussed as well as existence of projections onto eigenmanifolds. Questions raised in Faulkner and Huneycutt (P.A.M.S. 69(1978) p. 125-128) are settled here. (Received May 26, 1978.)

We give several continuity criteria for linear operators between Frechet spaces of vector valued sequences with continuous coordinate projections. One of these criteria is a matrix representation theorem that generalizes a classic result of Cohen and Dunford for Banach spaces with bases.

We prove a continuity theorem for multiplication operators with values in a space of bounded vector sequences (using a sliding hump technique). This theorem and some algebraic lemmas are used to prove that linear maps commuting with one nontrivial shift in a large class of Lebesgue (and other) spaces are continuous multiplication operators. Our results improve some theorems of R.J. Loy (J. of Functional Analysis, 16 (1974), p.48-60). (Received May 30, 1978.)

Recently the study of completely positive maps has become important to the results of Brown-Douglas-Fillmore on Ext \( (\omega) \), \( \mathcal{C}^* \)-algebra. Attempts to solve questions related to Ext have often turned into questions about the matrix algebras \( M_n \). We wish to discuss a notion of matricial-convexity related to completely positive linear maps, to state some facts about matrix-convexity, and to ask some questions about matrix-convexity.

To a large degree, the tone of this talk is expository. (Received May 30, 1978.)

It is well-known that completeness in necessary for the usual open mapping theorem for Frechet spaces. In contrast, it is shown that, with the obvious exception of \( \omega \) (= product of countably - many copies of the scalar field), each infinite-dimensional locally convex Frechet has another distinct complete topology with the same continuous dual. Also, a preliminary result shows that completeness is a three space property (i.e. if \( Y \) is a subspace of \( X \), so that \( Y \) and \( X/Y \) are complete, then \( X \) is complete). (Received May 30, 1978.)
A special case of reflexive operator algebras are the nest algebras introduced by J. Ringrose. A nest is a family of closed subspaces of a Hilbert space totally ordered by inclusion, and the associated nest algebra is the class of all bounded linear operators from the space into itself which leave invariant each member of the nest. A natural generalization of nest algebra is that of nest-subalgebra of a von Neumann algebra. That is, for a fixed separably-acting von Neumann algebra containing a nest of projections consider the algebra of operators in the von Neumann algebra leaving invariant every member of the nest. These algebras are reflexive algebras with in general non commutative invariant subspace lattices. Many of the structure results for nest algebras generalize to these algebras. In particular a version of Ringrose's characterization of the Jacobson Radical of a nest algebra is obtained for nest-subalgebras of von Neumann algebras. This leads to a characterization of operators commuting with the core of the nest modulo the radical of the nest-subalgebra, and of projections commuting with the entire nest-subalgebra modulo its radical. (Received April 28, 1978.)

Frank G. Gilfeather and David R. Larson, University of Nebraska, Lincoln, NE., Nest-Subalgebras of von Neumann Algebras, Preliminary report.

Carl M. Pearcy, University of Michigan, Ann Arbor, Michigan 48109. Some new theorems in operator theory.

J.J. Buoni and A. Klein, Youngstown State University, Youngstown, Ohio, 44555. On the Generalized Calkin Algebra.

A bounded linear operation \( T: X \to Y \) between Banach spaces is said to be weakly compact if it takes bounded sequences onto sequences which have a weakly convergent subsequence. Let \( W[X,Y] \) denote the weakly compact operators from \( X \) to \( Y \). Buoni, Harte, Wickstead, "Upper and lower Fredholm spectra" Proc. A.M.S., 1977). This construction is then used to derive results with regards to operators \( T \in B[X,Y] \) with a reflexive null space, \( N(T) \), and closed range, \( R(T) \). Operators of this type have been studied by Yang. ("Generalized Fredholm Operators", Trans. A.M.S., 1976). (Received May 17, 1978.)

Seymour Goldberg, University of Maryland, College Park, Maryland 20742 and Harm Bart, Vrije Universiteit, Amsterdam, Holland. Characterizations of Almost Periodic Strongly Continuous Groups and Semigroups.

Suppose \( T(t) \) is a strongly continuous semigroup (group) of bounded linear operators on a Banach space \( X \). \( T(t) \) is almost periodic if for each \( x \) in \( X \), the map \( T_x: t \mapsto T(t)x \) is almost periodic. \( T(t) \) is uniformly almost periodic if \( \{T_x: ||x|| \leq 1\} \) is a uniformly almost periodic family of functions. Characterizations, in terms of the infinitesimal generator, of almost periodic semigroups (groups) and uniformly almost periodic semigroups (groups) are given. (Received May 18, 1978.)


Given a complex Banach space \( X \), let \( T: D(T) \subset X \) be a densely defined closed linear operator. Any type of spectral decomposition can be expressed with the help of a mapping \( E \) from the class of all closed subsets of \( \mathbb{C} \) into the family of (closed) subspaces of \( X \) satisfying the following conditions:

(i) \( E(\emptyset) = \{0\} \), \( E(\mathbb{C}) = X \); (ii) \( E(F) = \overline{\text{cl}\{x \in E(K): K \text{ is compact, } K \subset F\}} \); (iii) for every finite open cover \( \{G_j\}_{j=1}^n \) of \( F \), \( E(F) = \bigcup_{j=1}^n E(F \cap G_j) \); (iv) \( \{x \in E(K): K \text{ is compact, } K \subset F\} \subset D_E \); (v) \( T(E(F) \cap D_E) \subset E(F) \); (vi) \( E([T(E(F) \cap D_E)]) \subset F \). Some basic properties of \( T \) endowed with a mapping \( E \) as defined above now follow. (1) For every compact \( K \subset \mathbb{C} \), the restriction \( T_K = T|E(K) \) is a bounded operator on \( Y = E(K) \).
with the spectral decomposition property: for every finite open cover \( \{G_i\} \) of \( \sigma(T_K) \) there is a system of invariant subspaces \( \{Y_i\} \) expressed by \( Y_i = E(K \cap \overline{G_i}) \) satisfying: \( Y = \bigcup Y_i, \sigma(T|Y_i) \subset \overline{G_i} \), all \( i \). (2) Every \( T \) with \( E \) has the single valued extension property. (3) If \( E \) satisfies \( E(F_1 \cap F_2) = E(F_1) \cap E(F_2) \), \( F_1, F_2 \) closed, then \( T \) bounded is decomposable in the sense of Foias and \( T \) unbounded is weakly decomposable if it is regular \((= e \rho(T))\). For \( T \) spectral \( E \) expresses the ranges of the spectral measure. (Received May 18, 1978.)

C. R. PUTNAM, Purdue University, West Lafayette, Indiana 47907. Invariant subspaces of operators having nearly disconnected spectra. Preliminary report.

Let \( T \) be a bounded operator on a Hilbert space having a spectrum \( \sigma(T) \) lying partly in both the right and left hand planes \( R \) and \( L \). It is shown that under certain conditions \( T \) has invariant subspaces \( M_R \) and \( M_L \) for which \( \sigma(T|M_R) = \sigma(T) \cap R^- \) and \( \sigma(T|M_L) = \sigma(T) \cap L^- \). In general however this assertion is false even if \( \sigma(T) = [-1,0] \cup \{1,1/2,1/3,\ldots\} \). A sufficient condition when \( T \) is completely hyponormal and \( E \) is the absolutely continuous support of \( \Re(T) \) is that \( \int \sigma(t)^{-2} dt < 2\pi \), where \( \sigma(t) \) denotes the linear measure of the vertical cross section of \( \sigma(T) \). (Received May 22, 1978.)

RIDGELEY LANGE, University of New Orleans, New Orleans, Louisiana 70122. Strongly analytic subspaces.

The author introduces the notion of a strongly analytic subspace for a given operator. Such subspaces are shown to be analytically invariant under the operator in Frunza’s sense (Revue Roum. Math. Pures et Appl. 18(1973), 1061-1065). However, examples show that the reverse implication fails. Connection with the theory of decomposable operators is also shown. (Received May 24, 1978.)

JOSE BARRIA, Instituto Venezolano de Investigaciones Cientificas, A.P.1827, Caracas 101, Venezuela. The Commutative Product \( V{v_1}{v_2} = V{v_2}{v_1} \) for Isometries \( v_1 \) and \( v_2 \).

Let \( K \) be a complex Hilbert Space. Let \( U_n \) be the truncated shift of index \( n \) \((n=1,2,3,\ldots) \) defined on the \( n \)-fold direct sum \( K \oplus K \oplus \cdots \oplus K \) by \( U_n: 
\begin{align*}
&f_1, f_2, \ldots, f_n \\
&\quad \mapsto 0, f_1, \ldots, f_{n-1}.
\end{align*}
\) when \( n>1 \) and \( U_1 = 0 \). Let \( U_K = \bigoplus_{n=1}^{\infty} U_n \). It is proved that an operator \( U \) on a complex Hilbert space \( H \) can be written as \( \oplus V_{v_1}, V_{v_2} \) with isometries \( V_{v_1} \) and \( V_{v_2} \) on \( H \) and \( \oplus V_{v_2} = V_{v_1} \) if only if \( U \) is (up to unitary equivalence) a direct sum whose direct summands are unitary operators, shifts, adjoints of shifts, and \( U_K \) for some Hilbert space \( K \). In particular, \( U = \oplus V_{v_1}, V_{v_2} = V_{v_2}, V_{v_1} \) with shifts \( V_{v_1} \) and \( V_{v_2} \) if and only if \( U \) is unitarily equivalent to \( U_K \) for some Hilbert space \( K \). (Received May 25, 1978.)

JOSEPH O. STAMPFLI, Indiana University, Bloomington, IN 47401. The invariant subspace problem. Preliminary report.

A survey of recent results on the invariant subspace problem for bounded linear operators on Hilbert space. (Received May 30, 1978.)

49 • Calculus of Variations and Optimal Control


In an earlier sequence of papers, we studied Lagrange duality theory, solution regularity, and finite element approximation for convex control problems with state and control constraints. These results are now generalized to encompass hereditary
problems. A delay in the system dynamics generates both delay and boundary terms in the dual functional. Except for a boundary layer near the initial time, delays do not alter the global regularity already established for undelayed problems. If the knots are chosen judiciously near the initial time, the convergence rate of the Ritz-Trefftz method is unaltered despite roughness in the initial data. On the other hand, delays do increase computational complexity since the bandwidth associated with the discrete approximation is proportional to the delay magnitude. (Received May 19, 1978.)

758-49-2 EKKEHARD SACHS, Technische Hochschule Darmstadt, D-6100 Darmstadt, West Germany. Optimal Control of Nonlinear Diffusion Problems.

We consider one-dimensional non-linear parabolic boundary control problems where the cost-function acts on the temperature distribution at a certain time $T_o$. Some conditions on the nonlinearity are imposed in order to obtain existence of optimal controls. Furthermore we derive necessary conditions of optimality in form of a bang-bang-principle for bounded controls. (Received May 23, 1978.)

#758-49-3 David Bindschadler, Wayne State University, Detroit, Michigan 48202. Invariant solutions of lowest dimension to the oriented Plateau problem.

Let $G$ be a connected, closed Lie subgroup of $SO(n)$ acting on $\mathbb{R}^n$. Assume there are no exceptional orbits under the action of $G$, the dimension of a principal orbit is $m$, and that the distribution of $(n-m)$-dimensional planes orthogonal to the principal orbits is involutive. If $B_0$ is a finite union of oriented principal orbits, then every solution to the oriented Plateau problem with boundary $\partial \Omega$ is invariant under the action of $G$.

We also show that such problems are equivalent to 1-dimensional variational problems in the orbit space. (Received May 25, 1978.)

#758-49-4 MARC Q. JACOBS, University of Missouri, Columbia, Missouri 65201. Controllability and stabilizability of linear systems. Preliminary report.

We consider systems of the form $\frac{d}{dt} \mathcal{D}(x_t) = L(x_t) + Bu(t)$ where $\mathcal{D}$ is a Hale-type difference operator, $L$ is a bounded linear mapping from $C([-h,0],\mathbb{R}^n)$ into $\mathbb{R}^n$, and $B$ is an $nxm$ matrix. It is our purpose to give some extensions of the exact state controllability results in $W_q(1)([-h,0],\mathbb{R}^n)$ obtained in Jacobs/Langenhop, "Criteria for function space controllability of linear neutral systems", SIAM J. Control and Opt., 14 (1976), 1009-1048, and Rodas/Langenhop, "A sufficient condition for function space controllability of a linear neutral system", SIAM J. Control and Opt., 16 (1978), 429-435. The conditions for controllability will emerge in a form which will make plain the connection between controllability and stabilizability in the sense of Pandolfi, "Stabilization of neutral functional differential equations", J. Opt. Theory and Appl., 20 (1976), 191-204. Manitius and Triggiani, "Function space controllability of linear retarded systems", to appear SIAM J. Control and Opt., have discussed similar results for retarded differential-difference equations. (Received May 30, 1978.)

50 ▶ Geometry


Previous papers have considered the convex polyhedral space-fillers of fewer than eight faces and of more than twelve faces [Jour. Comb. Theory A13(1972)437-443; A16(1974)348-354; A17(1974)375-378; Geometriae Dedicata 6(1977)99-108; 7(1978); 8(1979)]. To reduce the
gap, the search is here continued to the 12-faced convex polyhedral space-fillers. They are obtained by dissection of polyhedra of more faces into congruent parts, by fusion of polyhedra of fewer faces, and by the generation of honeycomb cells as modifications of layers of space-filling prisms. (Received May 1, 1978.)

For any vector space \( V \), let \( P(V) \) be the set of all subspaces of \( V \). If \( V \) and \( V' \) are two right vector spaces of finite dimension at least 3 over possibly distinct division rings and \( * : P(V) \to P(V') \) is a bijection, consider the following three possible conditions:

1. \( U \cap W \implies U' \cap W' \) for all \( U, W \) in \( P(V) \).
2. \( U' \cap W' \implies U \cap W \) for all \( U, W \) in \( P(V) \).
3. \( V \) and \( V' \) have the same dimension.

The Fundamental Theorem of Projective Geometry is usually stated essentially in one of the following ways:

A. If (1) and (ii) hold, then \( * \) is induced by a semilinear bijection of \( V \) onto \( V' \). (R. Baer, Linear Algebra and Projective Geometry, 1952, and O. T. O'Meara, Lectures on Linear Groups, 1974.)

B. If (1) and (iii) hold, then \( * \) is induced by a semilinear bijection of \( V \) onto \( V' \). (E. Artin, Geometric Algebra, 1957, and J. Dieudonné, La Géométrie Des Groupes Classiques, 1954.)

Baer and O'Meara prove that (iii) follows from (1) and (ii). Artin and O'Meara show that (ii) follows from (1) and (iii). In fact, both (ii) and (iii) follow from (1) alone. (Received May 30, 1978.)

52 ▶ Convex Sets and Geometric Inequalities

An example is given of a closed connected set in \( \mathbb{E}^2 \) whose points of local nonconvexity can be decomposed into two convex sets, but which is not arcwise connected and hence is not an \( L_n \) set.

This contradicts a result by Valentine (PAMS 16, p. 1305) to which Stavrakas and Jamison have given a second proof (PAMS 36, p. 229-30). It is also shown that if the set of points of local nonconvexity of a closed connected set \( S \) in \( \mathbb{E}^2 \) can be decomposed into \( n \) compact subsets which are convex relative to \( S \), than \( S \) is an \( L_{2n+1} \) set. (Received April 27, 1978.)

53 ▶ Differential Geometry

Let \( C \) be a closed convex cone in a linear topological space \( L \). A set \( S \) in \( L \) is called C-recessional if \( x + C \subseteq S \) whenever \( x \) is in \( S \). In this article a local characterization theorem is given for closed sets in a linear topological space that have recession cones with nonempty interior. This theorem is then used to characterize the class of upper semicontinuous increasing functions defined on closed subsets of \( d \)-dimensional Euclidean space that are recessional with respect to the cone of nonnegative vectors. (Received May 22, 1978.)
view of the following theorem:

**THEOREM.** Any two isometric real forms of a Hermitian symmetric space $M$ are congruent under a holomorphic transformation of $M$.

This list also gives a classification of the real forms of $M$ up to holomorphic transformations of $M$. (Received May 15, 1978.)

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Let $M = (M, f, g)$ be a globally framed metric manifold. By this we mean that there exists on $M$

(i) a $(1,1)$ tensor field $f$ (satisfying $f^2 + f = 0$) of constant rank $r$ ($r$ even) and (ii) a Riemannian metric $g$ such that $g(fx, y) = -g(x, fy)$ for $C^\infty$-vector fields $X$ and $Y$ on $M$.

A framed structure of rank $r$ determines a set of $(m-r)$ ($m = \dim M$) linearly independent vector fields $\{\xi_i\}$ ($i = 1, 2, \ldots, r$) on $M$; and it is known that integral curves of these vectors are geodesics.

In this paper we discuss the question of existence of closed geodesics and obtain criteria for their existence and also the characterisations of metric $g$ when they are finitely many in number. (Received May 30, 1978.)

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54 ▶ General Topology

758-54-1 ROBERT A. HERRMANN, Math. Dept. U.S. Naval Academy, Annapolis, MD 21402 8-perigidity and the idempotent 8-closure.

In the paper, "8-perfect and 8- absolutely closed functions" (Illinois J. Math. 21(1977), pp. 42-60), relationships between 8-rigid, 8-closed and 8-compact subsets are investigated. The idempotency of the 8-closure on a topology $T$ is used to obtain various results. The authors leave open the characterization of such spaces. Let $X_S$ be the semiregularization for $(X,T)$ and $T_8 = \{X - x | (x \subseteq X) \land (x is 8-closed)\}$ Thm. 1. For $(X,T)$ the following are equivalent. (a) The operator $cl_8$ is idempotent on $T$. (b) The space $(X,T)$ is almost-regular. (c) The operator $cl_\theta = cl_{X_S}$. (d) The operator $cl_\theta$ is idempotent on $\mathcal{P}(X)$. Cor. 1.1. For $(X,T)$ assume that $cl_\theta$ is idempotent on $T$. If $A \subseteq X$ is 8-compact, then $A$ is $a$-compact and, hence, 8-rigid.

Cor 1.2. $T_8 = T_8$ iff $(X,T)$ is almost-regular. (Received February 16, 1978.)

758-54-2 ADEMIRAN, DR. T. M., College of Science And Technology, Port Harcourt, Nigeria. Further Characterizations of $E^2$. Preliminary report

Russell's definition of continuity is obtained by proceeding from the integers through the rationals to the reals; he also gives a sketch, in his book, Principle of Mathematics, Allen and Unwin (1956), for constructing continuity directly from the integers. This paper employs the knowledge of monotone union of spaces to construct the reals from the integers. The first construction is a characterization of the reals as the disjoint union of two integral sets, one of which is a cartesian product of the integers and the other is a monotone union of copies of the integers. The second construction characterizes the reals as a monotone union of infinite subsets of the integers indexed by some set. (Received March 29, 1978.)

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Abstract: A space $X$ has property $b_2$ if each open cover of $X$ has a refinement $\bigcup_{i=1}^{\infty} \mathcal{F}_i$ satisfying,

1. $\mathcal{F}_n$ is a hereditarily closure preserving collection in $X - \bigcup_{k<n} \mathcal{U}_k$, and
2. $\mathcal{F}_n$ is a collection of closed sets in $X - \bigcup_{k<n} \mathcal{U}_k$.

In this paper the author shows that a strengthening of property $b_2$ is equivalent to weak $\mathcal{F}$-refinability while every space with property $b_2$ is irreducible. Applications of these results and new unsolved problems are also included. (Received May 15, 1978.)
Let \( w_1 \) denote the first Stiefel-Whitney class of the universal bundle over the Grassmannian \( G_k(\mathbb{R}^{n+k}) \) of \( k \)-planes in real \((n+k)\)-space. Define the height of \( w_1 \) in \( H^*(G_k(\mathbb{R}^{n+k}); \mathbb{Z}/2) \) to be the unique \( m \) such that \( w_1^m \neq 0 \) but \( w_1^{m+1} = 0 \). Our main result is:

Theorem: If \( 1 < k < n \) then the height of \( w_1 \) in \( H^*(G_k(\mathbb{R}^{n+k}); \mathbb{Z}/2) \) is \( 2^{-\frac{k}{r}} \) where \( \lceil x \rceil \) denotes the smallest integer \( \geq x \) and \( r \) is either 1 or 2.

Our proof uses both the Schubert calculus and the cohomology of flag manifolds. This result finds immediate application to the computation of Lusternik-Schnirelmann category and some combinatorial problems. (Received May 26, 1978.)

Let \( 0 \) denote the infinite orthogonal group and \( U \) the infinite unitary group. The inclusion \( 0 \rightarrow U \) induces maps \( n_0^n(\mathcal{O} \times BO) \rightarrow n_0^n(\mathcal{O} \times BU) \) which, by Bott periodicity, may be taken to be fibrations with fibre \( n_0^n(U/O) \rightarrow n_0^n(B BO) \). As a result, there exist natural transformations \( k^1, k^1 \) such that the following sequences are exact:

\[
\cdots \rightarrow KO_n(X) \rightarrow K^*_n(X) \rightarrow KO_{n+2}(X) \rightarrow KO_{n+1}(X) \rightarrow \cdots \\
\cdots \rightarrow KO_n(X) \rightarrow K^*_n(X) \rightarrow KO_{n-2}(X) \rightarrow KO_{n-1}(X) \rightarrow \cdots
\]

(Bott, Lectures on \( K(X) \), Harvard Lecture Notes, undated.)

Let \( M \) be a stably almost complex \( n \)-manifold, and let \( L + M \) be a complex line bundle such that \( c_1(L) = c_1(M) \). Let \( Y \) be the SU-manifold which arises as the zeroes of a generic section of \( L \), and let \( i: Y \rightarrow M \) be the inclusion. Then \( M \) and \( Y \) possess fundamental classes \( \lbrack M \rbrack \in K_n(M) \) and \( \lbrack Y \rbrack \in KO_{n-2}(Y) \). We show that \( k^1 \) is characterized by the property that \( k^1 \lbrack M \rbrack = i^* \lbrack Y \rbrack \in KO_{n-2}(M) \). (Received May 26, 1978.)

Let \( B \) be a simple extension of the free group \( A \) on symbols \( a_j \). Let \( N_j \) be the smallest normal subgroup of \( B \) containing \( a_j \) (if \( j \)). Assume (i) \( A'/A'' \cong B'/B'' \) is an isomorphism, and (ii) \( B/N_j = W \) with generator \( a_j \). Then \( A \) is a retract of \( B \). (Received May 30, 1978.)
we prove that the \( \mathfrak{J}_i\)'s give rise to a variety of other infinite families of homotopy elements \( \mathfrak{J}_{k,i} \), for \( 0 \leq i \leq p - 2 \) and \( k \leq p - 1 \), where \( \mathfrak{J}_k = \mathfrak{J}_{k,0} \). \( \mathfrak{J}_{k,i} \) is represented in filtration 3 in the Adams - Novikov spectral sequence and lies in the \( 2(p - 1)(p + 1) - 3 \) stem of the stable homotopy groups of spheres. (Received May 30, 1978.)

57 ▶ Manifolds and Cell Complexes

758-57-1 David Sprows, Villanova University, Villanova, Pa 19085. Homeomorphisms of the 2-sphere minus a finite union of closed disks and open disks. Preliminary report.

Let \( D_1, \ldots, D_n \) be disjoint closed disks in \( S^2 \). Let \( M_k, 0 \leq k \leq n \), denote the space obtained by removing the disks \( D_1, \ldots, D_k \) and the interiors of the disks, \( D_{k+1}, \ldots, D_n \) from \( S^2 \). Let \( H(M_k) \) denote the group of isotopy classes of homeomorphisms of \( M_k \). Presentations for the subgroup of \( H(M_n) \) consisting of orientation preserving homeomorphisms have been obtained by W. Magnus and others. It has also been shown that \( H(M_0) \cong H(M_n) \). In this paper we obtain a presentation for \( H(M_k) \) for any \( k \leq n \). (Received May 26, 1978.)

758-57-2 Philip S. Hirschhorn, Amherst College, Amherst, Massachusetts 01020 and John G. Ratcliffe, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139. Algebraic unknotting of spheres in codimension two. Given an embedding \( f: S^{q-2} \rightarrow S^1 \), we let \( C \) be the complement of the embedded sphere. By Alexander duality, \( C \) has the same homology groups as the circle \( S^1 \), but \( C \) is not, in general, homotopy equivalent to \( S^1 \). It is known from work of J. Levine for \( q \geq 5 \), J. Swarup for \( q = 4 \), and S. Eilenberg for \( q = 3 \) that if \( \pi_1 C \cong \pi_1 S^1 \) for \( i \leq (q-1)/2 \), then \( C \) is homotopy equivalent to \( S^1 \); we give a simple proof of this fact, valid in all dimensions, avoiding the use of surgery techniques. (Received May 30, 1978.)


The end invariants, including the fundamental group, of a finitely presented group \( G \) are defined using any two dimensional complex \( K \) which has fundamental group \( G \) and taking the end invariants of \( \tilde{K} \). It is known that if \( M \) is an aspherical manifold of dimension greater than or equal to five with fundamental group \( G \) then \( \tilde{M} \) is homeomorphic to \( R^n \) if and only if \( G \) has one end and the fundamental group of \( G \) is trivial. Theorems are proved about the fundamental group of \( G \) when \( G \) is an extension of two finitely presented groups, when \( G \) is an amalgamated free product, and when \( G \) is an HNN group. The only groups which are known to have non-trivial fundamental groups are also known not to be Poincare duality groups and so could not be the fundamental group of any aspherical manifold \( M \). (Received May 30, 1978.)

758-57-4 Nobuyuki A. Sato, Brandeis University, Waltham, Massachusetts 02154. On a formula of Torres. Preliminary report.

Let \( L = \{ K_1, \ldots, K_m \} \) be a link of \( n \)-spheres in \( S^{n+2} \), and let \( L' = \{ K_1, \ldots, K_m \} \) be the sublink missing the first component. We obtain exact sequences relating the homology of the universal abelian cover of the complement of \( L \) to that of the universal abelian cover of the complement of \( L' \). When \( n = 1 \), these sequences are seen to imply a result of Torres on the relation of the Alexander polynomial of \( L \) to that of \( L' \). The approach used avoids the free differential calculus entirely. (Received May 30, 1978.)
Two generalizations of sub (super) martingales are given. One has an associated \( L_1 \) convergence theorem and the other, an associated pointwise convergence theorem. A process \( \{X_n\}_{n=1}^{\infty} \) is a weak sub (super) martingale in the limit if
\[
\lim_{m \to \infty} \lim_{n \to \infty} E(X_n | \mathcal{A}_m) = (\langle \mathcal{A}_m \rangle_n) \cdot 1 \quad \text{as } n, m \to \infty \text{ with } n > m.
\]
This process can be thought of as a game which gets better (worse) with time. The process is a strong sub (super) martingale in the limit if
\[
\lim_{n \to \infty} \lim_{m \to \infty} E(X_n | \mathcal{A}_m) - X_m \geq 0 \quad \text{a.e.}
\]

Theorem: A process which is a weak uniformly integrable sub (super) martingale in the limit converges in the \( L_1 \) norm.

Theorem: A process which is a strong \( L_1 \) bounded non negative sub (super) martingale in the limit converges a.e.

(Received April 17, 1978.)

*758-60-2 MAURY BRAMSON, Courant Institute of Mathematical Sciences, New York, New York 10012 and DAVID GRIFFEATH, University of Wisconsin, Madison, Wisconsin 53706. Clustering and dispersion rates for some interacting particle systems on \( \mathbb{Z} \).

It is well-known that the voter model on \( \mathbb{Z}^n \) under initial product measure will converge weakly to a random field as \( t \to \infty \); if \( n > 3 \), convergence will be to a nontrivial random field, if \( n = 1,2 \), convergence will be to a linear combination of trivial random fields. Therefore, for \( n = 1,2 \), the cluster size of a particular state around any fixed point tends to become arbitrarily large as \( t \to \infty \). Here, we examine the rate of growth for \( n = 1 \) of this clustering for the nearest neighbor voter model, and the related problem of interparticle distance for nearest neighbor coalescing random walks and annihilating random walks. We show that under spatial renormalization \( \sqrt{t} \), these cluster sizes/interparticle distances in each case approach a nondegenerate distribution. We examine these distributions, and obtain numerical estimates for these and related problems. (Received May 22, 1978.)


Let \( z = (x^1, x^2) \) be a point in \( \mathbb{R}^2 \). Assume that for each \( k = 1,2, \ldots \) a diffusion with zero drift is determined for \( k \) points in \( \mathbb{R}^2 \) having arbitrary initial points \( z_1, \ldots, z_k \) and governed by a \( 2k \times 2k \) diffusion matrix. Assume that the motion for \( k \) points projects consistently to the motion for \( k-1 \) points. Assuming smooth diffusion coefficients and spatial homogeneity, a random flow in \( \mathbb{R}^2 \) is determined having the above diffusions as its \( k \)-point motions. For some results in the isotropic case see the author's abstract in the June, 1978 Notices. Property (b) of that abstract has now been shown to be a.s. true simultaneously for all \( t \). (Received May 25, 1978.)

*758-60-4 THOMAS M. LIGGETT, University of California, Los Angeles, California 90024. Random invariant measures for Markov chains, and independent particle systems.

Let \( P \) be the transition operator for a discrete time Markov chain on a space \( S \). A random measure \( M \) on \( S \) is said to be invariant for \( P \) if the random measure \( MP \) has the same distribution as \( M \). We show for various classes of chains, including aperiodic Harris recurrent chains and aperiodic irreducible random walks that all random invariant measures \( M \) satisfy \( MP = M \) a.s. Some of this is done by exploiting a relationship between random invariant measures and entrance laws for \( P \). These results are then applied to characterize the invariant probability measures for particle systems in which particles move independently in discrete time according to \( P \). (Received May 26, 1978.)

758-60-5 DAVID GRIFFEATH, University of Wisconsin, Madison, WI 53706. Recent results for discrete time particle systems.

We survey recent progress in the theory of discrete time synchronous Markov systems, with emphasis on some new results of Toom, Kurdyumov, and other Soviet probabilists. (Received May 30, 1978.)
A uniqueness theorem for translation invariant spin-flip processes is presented, as well as an example to show that uniqueness does not always hold even when the flip rates are translation invariant on Z, strictly positive, continuous, and attractive, and when the initial configuration is translation invariant. The uniqueness theorem is applied to the stochastic Ising model. A related ergodicity criterion is also given. (Received May 30, 1978.)

Migration models for dioecious (i.e., two sexes) biological populations at low enough population densities to allow genetic drift are discussed. Discrete models ("stepping stone") are applied extensively in the biological literature. Continuous models in more than one dimension lead to partial differential equations with no non-trivial solutions if mating is restricted to creatures at the same location. Also, no underlying continuous probability-space model has been given. We present a continuous migration model giving the usual partial differential equation in non-trivial cases, and a limit theorem giving the exact rate at which the effects of mating are suppressed as the mating distance decreases. (Received May 30, 1978.)

I will discuss some difficult mathematical problems which have arisen repeatedly in neurophysiological modelling. The audience will require no knowledge of biology. The problems involve systems of interconnected elements in which some component of the structure is randomly generated. When the system is large the individual elements should be nearly independent, and their activities might be expected to obey the classical limit laws of probability: the SLLN and the CLT. If these limit laws are in force then one should be able to obtain a description of the time evolution of certain "macroscopic" variables, such as the mean activity of a particular subpopulation, or the variance of that activity. In certain contexts, such as the brainstem respiratory centers, these are probably the most important variables.

Several conjectures along these lines will be made, and supported by simulation. But, for the most part, the proofs are missing. (Received May 30, 1978.)

Let h(t, m) be L^1 with respect to t and C^1 with respect to m. Let m(t) be C^0 (for example, a sample path of a continuous square integral martingale, M(t)) the integral

\[ \int_0^t h(s, m(s)) \, dm(s) \]

can be defined formally using the fundamental theorem of calculus and an appropriate differential rule (due to Kunita-Watanabe, Nagoya Math. J. 30 (1967) pp. 209-245). This is used to define the solution of the stochastic differential equation

\[ dX = f(t, X) \, dt + g(t, X) \, dM. \]

This generalizes the author's previous work (Notices AMS 24 (1977) p. A-648). (Received May 30, 1978.) (Author introduced by Professor Christopher I. Byrnes).

Let \( \{X(i), i \geq 0\} \) be a symmetric gambler's ruin process. Define \( T_a = \inf \{i \geq 0 : X(i) = a\} \) where
Tk = 0 if X(j) ≠ k for all j. Define $D_n^z = E_{z,a} [n!; T_a < T_z]$ for paths restricted to $X(0) = z$ where $0 < z < a$. It is shown that $D_n^z = z^{-1} b_{j=1}^{2n+1} b_j^z (z)$, where $b_j^z$ is the falling factorial and $b_j^z$ is a polynomial of degree $2n-j$ for $j$ even and of degree $2n+1-j$ for $j$ odd. It is conjectured that $b_j^z$ is a polynomial in $a^2$. Recurrence formulae for these polynomials are derived and other properties are developed. (Received May 30, 1978.)

62 ▲ Statistics

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Behrens-Fisher Degrees of Freedom Inequalities.

The Behrens-Fisher problem is that of comparing the means of two populations when the ratio of their variances is unknown and not assumed equal to unity. The problem has an extensive literature and numerous textbooks consider it. Most propose a solution based on the t-distribution; they differ in their choice of degrees of freedom. In this paper, bounds and inequalities relating the two most common choices (together with a third) are derived. As a consequence, the power of one common test is always less than the other(s). In deriving the inequalities, the author rediscovered The Bohr-Archbold Inequality: Let $z_k$ be complex, $a_k$ be positive for $k=1, \ldots, n$ and $a_1 + \cdots + a_n = 1$. Then $\frac{1}{k} \sum_{k=1}^n a_k |z_k|^2$ with equality iff $a_j^k z_j = a_k^j z_k$ for all $1 \leq j, k \leq n$. Proof: Immediate from an application of the Cauchy-Schwarz inequality to $x = (a_1^k z_1, \ldots, a_n^k z_n)$ and $y = (a_1^k, \ldots, a_n^k)$ in $C^n$. (Received May 12, 1978.) (Author introduced by Dr. Harold O. Idd).

65 ▲ Numerical Analysis

MORRIS W. HIRSCH and STEPHEN SMALE, University of California, Berkeley, California 94720.

On algorithms for solving $f(x) = 0$.

Assume $f: \mathbb{R}^n \to \mathbb{R}^n$ is $C^2$, and also: $|f(x)| \to \infty$ as $|x| \to \infty$, the Jacobian determinant $J(x) \neq 0$ almost everywhere, and $J(x) > 0$ if $|f(x)| > K$. For $\varepsilon > 0$ and an initial $x_0 \in \mathbb{R}^n$ an algorithm is described having the following guarantee: for almost every $x_0$ with $|f(x_0)| > K$ a finite sequence is produced which stops at a solution to $|f(x)| < \varepsilon$. Under mild nondegeneracy conditions on $f$ a similar algorithm produces, for almost every $x_0$ as above, an infinite sequence which converges to a zero of $f$, ultimately by Newton-Raphson iteration. The algorithms are easily adapted to finding fixed points. Similar algorithms have worked well in practice, but without guarantees. The basic geometrical idea is to follow the curves $f(x)/|f(x)| = \text{const.}$, reversing direction when $J$ changes sign. Similar methods have been used by C. Baves, H. Scarf, T.-Y. Li, J. Yorke, S.-N. Chow, J. Mallet-Paret. (Received May 26, 1978.)

GEORGE W. REDDIE, Vanderbilt University, Nashville, Tennessee 37235. Discretizations For Control Problems With Delays.

Discretizations for unconstrained optimal control problems with delays are considered. Convergence results for the midpoint difference scheme applied to both the minimization problem and the associated necessary conditions are given along with a generalization to collocation at Gaussian points. (Received May 26, 1978.)


Let $w(x) = w(x_1, x_2, \ldots, x_n)$ be a classical solution of the nonlinear elliptic differential inequality $L[w] = \sum_{i,j=1}^n [\alpha_{ij}(x) \phi(w, w_{x_i}, w_{x_j}) x_i + 2 \sum_{j=1}^n \phi(w, w_{x_i}) B_j(x) w_{x_i} + C(x) f[w(x)] ] \leq 0$ where $\Omega$ is a compact region of $\mathbb{R}^n$. A-544
\( \omega \) will denote the interior of \( \overline{\Omega} \) and \( \partial \Omega \) the boundary of \( \overline{\Omega} \). The matrix \( (a_{ij}(x)) \) is positive definite for \( a_{ij}(x) \in C^1(\overline{\Omega}) \) for \( x \in \overline{\Omega} \). \( \mathbb{R} \) is simply-connected and satisfies the Lyapunov conditions, \( \varphi(w, w_{x_1}, \ldots, w_{x_n}) \in C^2(\mathbb{R}^n \times \cdots \times \mathbb{R}^n), B_j(x), C(x) \in C(\mathbb{R}), \) and \( f(\xi) \in C^1(-\infty, \infty), f(\xi) \neq 0 \) for \( \xi \neq 0 \). The matrix

\[
\begin{pmatrix}
a_{ij}(x) & B_i(x) \\
-B_i(x) & G(x)
\end{pmatrix}
\]

is positive definite for \( G(x) \in C(\mathbb{R}), x \in \overline{\Omega} \). Sufficient conditions are established for the existence of a zero or a bound on \( w(x) \) for \( x \in \overline{\Omega} \) along with a method of computation. (Received May 30, 1978.)

Three methods for solving a second order hyperbolic differential equation arising in the modelling of a lightning stroke are considered. Although the actual model contains a discontinuity in the initial/boundary data, the discontinuity is removed by including a rapidly changing but \( C^1 \) function where the discontinuity had occurred. For a simple test case which results in constant coefficients in the differential equation, a d'Alambert type integral solution is obtained. However, to evaluate the solution, a numerical quadrature may be necessary or at least desirable. A second method of solution for the case of constant coefficients is a Fourier series expansion. The third alternative considered is a finite difference solution. The errors of these three methods are compared as well as their relative efficiency in terms of operation counts. (Received May 30, 1978.)

In standard approaches to finite element analysis, the degree of the approximating polynomial is fixed and accuracy is obtained by letting \( h \), the maximum diameter of all the elements, go to zero. It is also possible to achieve accuracy by fixing the triangulation and letting \( p \rightarrow \infty \). We call the first approach \( h \)-convergence and the second approach \( p \)-convergence. It has recently been shown that if the number of degrees of freedom is taken as a measure of efficiency, then \( p \)-convergence is faster than \( h \)-convergence. In order to implement \( p \)-convergence numerically, a hierarchical family of complete, conforming simplectic finite elements is constructed. This family possesses an embedding property: the elemental stiffness matrix corresponding to an approximation of degree \( p \) is a sub-matrix of the elemental stiffness matrix corresponding to an approximation of degree \( p + 1 \). This essential property results in significant savings in computation. (Received May 30, 1978.)

**Mechanics of Solids**

A summary is given of recent results of David R. Owen and the speaker which bear on the problem of determining the set of all entropy functions compatible with given constitutive equations for the stress, temperature, and heat flux. The problem has been solved for elastic materials, viscous materials, and, more recently, for hypoelastic materials and certain elastic-plastic materials. Partial results have been obtained for classes of materials with gradually fading memory. (Received May 8, 1978.) (Author introduced by Professor C. Truesdell).
In practice, for typical prism problems in elasticity theory, boundary conditions at the ends cannot be known precisely, but some averages can be estimated. Roughly, St.-Venant's Problem is to divide solutions into sets, such that those in one set are close to each other, except very near the ends. We discuss clues as to how this might be given a more precise formulation. (Received May 11, 1978.) (Author introduced by Professor Clifford Truesdell.)

During the past century numerous problems from the theories of linear elasticity and of linearly elastic structures were analyzed. The most illuminating of these problems possess simple geometry. During the last two decades it was shown that geometrically exact quasilinear analogs of these classical linear problems could be cleanly formulated. Here it is shown that the treatment of these quasilinear problems, often relying on the extension of modern results of nonlinear analysis, yields important information about the behavior of materials and important insights into the foundations of solid mechanics. (Received May 15, 1978.)

For the problem stated in the title, the wave velocities, attenuation factors and the nature of stress and temperature discontinuities are analyzed. (Received May 26, 1978.)

The centering force on a fiber traveling through a fluid applicator is determined from a solution of the stationary, linearized Navier-Stokes equation. In this talk the associated boundary problem is defined, uniqueness of its solution is proved, and a numerical scheme for approximating the solution is described. The scheme involves identifying a simple particular solution, then choosing a linear combination of harmonic fields, for the homogeneous part, that satisfies the boundary condition on the fiber and gives a least squares fit to the boundary condition on the applicator. Results for various applicator shapes will be shown. (Received May 30, 1978.)

The photic field of a long cylindrical light source is represented by a scalar quasipotential. For
a tripartite aperture lamp, the three-part step function boundary conditions are satisfied by expressing the solution in two parts: one in elliptic-cylinder coordinates, the other in bicylindrical coordinates. The simple solution in hybrid form in two coordinate systems is compared with the lengthy solution expressed in circular-cylindrical coordinates. (Received May 17, 1978.)

80 • Classical Thermodynamics, Heat Transfer


The foundations of continuum thermodynamics will be discussed. The basic axioms are balance of energy, growth of entropy, and a statement about isolated bodies. The additivity of energy will be shown to depend crucially on whether or not the heat flux is balanced. The existence of temperature will be established and the classical forms of the laws of thermodynamics for continua will be recovered. (Received May 8, 1978.)

*758-80-2 JAMES SERRIN, University of Minnesota, Minneapolis, Minnesota 55455. Postulates for phenomenological thermodynamics

We present a system of postulates for phenomenological thermodynamics which clarifies the classical treatment of the subject, and at the same time is broad enough to apply to the field theories of continuum mechanics. Our central result (obtained jointly with R. Hummel and M. Ricou) is a generalized version of the Clausius inequality, which is shown to be a necessary and sufficient condition for the second law of thermodynamics to hold. This Clausius inequality in turn provides the key to a rapid and easy discussion of the existence of entropy and internal energy for the ideal systems of classical thermodynamics, and for the dissipative systems of fluid mechanics. For materials with more complex constitutive structure, our results provide justification for the assumptions made by Coleman and Owen in their general study of existence of internal energy and entropy. (Received May 15, 1978.)


The first and second laws of thermodynamics often can be stated as requirements that, for every closed curve in a given class, line integrals of certain vector fields on $\mathbb{R}^n$ vanish or not be positive. There has been considerable recent interest in physical systems for which this mathematical formulation is inadequate. Bernard D. Coleman and the speaker have formulated a theory of "actions on systems" which permits a study of the laws of thermodynamics for physical systems whose states cannot naturally be identified with points in $\mathbb{R}^n$ and cannot always be connected one to another by means of processes of the system. (Received May 15, 1978.) (Author introduced by Professor C. Truesdell).

*758-80-4 C. Truesdell, Johns Hopkins University, Baltimore, Maryland 21218. Conceptual analysis in rational thermo-mechanics.

Some remarks on conceptual analysis in rational thermo-mechanics. (Received May 30, 1978.)

81 • Quantum Mechanics

758-81-1 M. A. Hooshyar, Pahlavi University, Shiraz, IRAN. Construction of Spin-Orbit Potentials. Preliminary report.

The problem of constructing the spin-orbit potential from the physically accessible information on the asymptotic behavior of the regular solutions
of the Schrödinger differential equation is considered for the case when the potential is \( o(r^{-3}) \) at large distances. It is shown that, for large values of angular momentum, the appropriate difference between the Jost functions is \( o(t^{-1}) \). This along with our previous results (J. Math. Phys. 19 (1978), 252-263) enables us to construct the potential. (Received May 25, 1978.) (Author introduced by Professor H. Kharaghani).

RAOUL BOTT, Department of Mathematics, Harvard University, Science Center, One Oxford Street, Cambridge, Massachusetts 02138. Recent developments in the Yang-Mills theory.

The Yang-Mills equations are a nonlinear version of the equation characterizing a harmonic 2-form. They were formulated in the 1950s as an extension of the equations of electromagnetism and have played an increasingly important role in the quantum theory of fields ever since. In the late 1960s their quantum version was used in the unified theory of weak and electromagnetic interaction of Salam, Weinberg and Glashow, while in 1975 the pertinence in quantum theory of the solutions of these equations in the classical sense—the so-called instantons—was pointed out by Polyakov. This development has led to a new and refreshing collaboration between physicists and mathematicians which has already enriched both subjects. In this talk I will—apart from some historical remarks—describe these equations only in their geometric setting and then discuss their behavior in the simplest instance, namely over Riemann surfaces. The solutions of the Yang-Mills equations here naturally lead to "stable bundles" in the sense of algebraic geometry and appropriately interpreted, that is in the framework of Morse theory, the manifolds of solutions combine to determine the cohomology of the classifying space \( B\mathcal{G} \) of the group of Gauge transformations \( \mathcal{G} \) for the problem under consideration. More precisely the principal result here, due to Atiyah and myself, is that when properly interpreted, the Yang-Mills functorial defines a perfect Morse Function on \( B\mathcal{G} \). (Received May 30, 1978.)


A sliced cone is a convex linear cone equipped with a prescribed strictly positive linear functional. In 1969, Mielnik (Commun. Math. Phys. 15, 1-46) pointed out that complex Hilbert spaces play their role in quantum mechanics only through the intrinsic geometry of their sliced cones of trace-class positive Hermitian operators (equipped with the trace functionals). This suggested that a physically direct quantum theory could be developed within the theory of sliced cones, but there remained the problem of finding an intrinsic characterization of those sliced cones which are applicable (that is, which are isomorphic to sliced cones of trace-class positive Hermitian operators on complex Hilbert spaces). The present paper solves this problem in the case where the cones are finite-dimensional. In doing so, it provides considerable insight into why complex Hilbert spaces (rather than real or quaternionic Hilbert spaces) are relevant to quantum mechanics. (Received May 30, 1978.)


Quantum-mechanical Yang-Mills theory is connected to its counterpart in classical field theory through integrals defined over spaces of functions. We review this connection and, through its use, describe the recent impact of geometry on the quantum theory of fields. (Received May 30, 1978.) (Author introduced by Professor Raoul H. Bott).


We analyze certain harmonic curvature forms arising as solutions to classical (nonlinear) equations in physics. The curvatures are non square integrable because of regular singular points, and they have a geometric as well as physics interpretation. (Received May 30, 1978).
Economics, Operations Research, Programming, Games


The standard treatment of general equilibrium theory in a Walrasian economy assumes consumption and production to occur in markets for each of a finite number of commodities. If we distinguish between commodities which are produced or consumed at different times or in different states of the world, then it is appropriate to view the commodity space as an infinite dimensional linear vector space. Consequently, we consider a world with a denumerable number of time periods or a countable number of states of the world. In addition, we restrict our attention to bounded commodity bundles, hence our commodity space is $C_b(N)$, the space of bounded real-valued sequences. $C_b(N)$ is then the space of time-contingent or state-contingent consumption or production plans. As in the finite dimensional setting, we characterize an economic agent by his initial endowment, a positive vector in $C_b(N)$, and his utility function, a real-valued functional on $C_b(N)$. There exists on $C_b(N)$ several myopic locally convex (linear) topologies, i.e., topologies such that any continuous utility function discounts consumption in future time periods or improbable states of the world. More formally, an economic agent is said to be strongly myopic if when he prefers a time (state)-contingent consumption plan $\tilde{x}$ to a time (state)-contingent consumption plan $\tilde{y}$, then he prefers $\tilde{x}$ to $\tilde{y}$ augmented by any arbitrary plan $\tilde{z}$ which begins sufficiently far in the future (or is concentrated on the improbable states of the world). We show that the Mackey topology for the pairing $\langle C_b(N), \lambda_1 \rangle$ is the finest locally convex (linear) topology on $C_b(N)$ which is strongly myopic. In addition, we give characterizations of several other myopic locally convex (linear) topologies on $C_b(N)$ and their dual spaces. (Received March 20, 1978.)

JAMES K. HO, Brookhaven National Laboratory, Upton, NY 11973. Structured linear programs and energy modeling. Preliminary report.

Mathematical programming has in recent years been widely used in energy research for the study of supply and demand, the assessment of technological alternatives, and the analysis of policy issues. The need to solve large and complex energy systems optimization models efficiently provides both impetus and tangible targets for methodological research in mathematical programming. At present, the most promising approach is to develop special techniques for large structured linear programs. In this paper we discuss the two most commonly encountered structures in energy research: staircase, arising from intertemporal models; and block-angular, arising from multi-regional models. A status report of current development in this area is presented. (Received May 12, 1976.) (Author introduced by Professor Caulton L. Irwin).


Let $a_1, \ldots, a_m$ and $\beta$ be integer vectors of length $s$. Let $C = \{(v_1, \ldots, v_m) \in \mathbb{N}^m: v_1 a_1 + \ldots + v_m a_m = \beta\}$, where $\mathbb{N}$ denotes the nonnegative integers. Let $d$ be the dimension of the affine subspace of $\mathbb{R}^m$ spanned by $C$.

**Theorem.** Suppose that there are real numbers $-1 < a_i \leq \beta$ such that $\beta = a_1 a_1 + \ldots + a_m a_m$. Then there exist finitely many submonoids $M_1, \ldots, M_t$ of $\mathbb{N}^m$, each isomorphic to $\mathbb{N}^d$, together with vectors $n_1, \ldots, n_t \in C$, such that $C$ is a disjoint union of the sets $n_1 + M_1, \ldots, n_t + M_t$. (Received May 23, 1978.)


Analysis of the supply and demand for energy products involves some interesting applications of mathematical optimization, numerical and classical analysis. Open questions concerning the existence, uniqueness and computation of equilibrium prices and quantities are suggested by various energy models. For example, see W. W. Hogan, "Project Independence Evaluation System: Structure and Algo-
rithms," Proceedings of Symposia in Applied Mathematics, AMS, Volume XXI. An algorithm, which is related to the P.I.E.S. algorithm, for determining market equilibrium for non-integrable supply functions is developed. (A function $f : \mathbb{R}^n \rightarrow \mathbb{R}^n$ is integrable means $f = \partial F$ for some $F : \mathbb{R}^n \rightarrow \mathbb{R}$.) It is shown that a sequence of approximate equilibria converges to a true market equilibrium if a matrix related to the demand elasticities has spectral radius less than one. The relation to known iterative methods is noted and geometric interpretations are discussed. (Received May 25, 1978.)

*758-90-5  MICHAEL J. TODD, Cornell University, Ithaca, New York 14853. Fixed point algorithms that allow restarting without an extra dimension.

We discuss a class of algorithms that provide constructive proofs of the fixed-point theorems of Brouwer, Leray-Schauder and Borsuk-Ulam. These algorithms replace the continuous function of interest with a piecewise-linear approximation via a triangulation; finding a fixed point of the approximation is then a combinatorial problem. After a brief survey of the algorithms of Scarf, Merrill, and Eaves and Saigal, we describe recent methods of Garcia, Tuy, and van der Laan and Talman; the latter allow efficient restarting of the algorithm without explicitly increasing the dimension. We give two attractive convergence results for a modification of the van der Laan and Talman algorithm, but our emphasis is on the geometry of the different approaches. (Received May 25, 1978.) (Author introduced by Professor Louis J. Billera).

*758-90-6  ROBERT M. ANDERSON, McMaster University, Hamilton, Ontario, Canada L8S 4K1. Edgeworth's Conjecture.

The core of an exchange economy is a cooperative equilibrium notion arising from game theory. Roughly, a core allocation is one which could arise through trades, with groups banding together in coalitions to block trades not in their interests. Competitive equilibrium, on the other hand, is a non-cooperative notion in which each individual maximizes a preference relation subject to a price constraint set by supply and demand. In 1881, Edgeworth conjectured that the two concepts were essentially the same.

We give several results affirming Edgeworth's Conjecture. For very general preferences, we show that any core allocation satisfies a condition obtained by perturbing the definition of competitive equilibrium. For strongly convex preferences, we show that any core allocation is on average close to the individuals' demands with respect to some price vector; hence, supply nearly equals demand for this price. We obtain a rate of convergence result in a special case. (Received May 30, 1978.)


A combinatorial abstraction of linear programming in the context of oriented matroids is discussed. This abstraction builds upon work of Camion, Pulskerson, Minty, Rockafellar, and Tucker, and can be regarded to be a development of linear programming duality theory from the Minty coloring property, which characterizes dual pairs of oriented matroids. Moreover, this development indicates that oriented matroids provide the broadest possible setting in which the fundamental linear programming duality results generalize as properties of signed sets. Anticycling pivoting rules for Dantzig's simplex method that were discovered in the context of oriented matroids are described. (Received May 30, 1978.)


The study of simple polyhedra in their dual role as simplicial complexes allows their combinatorial and topological properties to be emphasized. Several properties of polyhedra, among them shellabil-
ity, diameter, and the Hirsch conjecture, can be interpreted in the setting of general simplicial complexes. We present here the concept of k-decomposability and produce a hierarchy of classes of simplicial complexes, of which the largest is the class of simplicial complexes and elements of the smallest satisfy the Hirsch conjecture. We place several important classes of complexes into this hierarchy, some of which were not previously known to be shellable nor to satisfy the Hirsch conjecture, and we give a dual geometric interpretation of k-decomposability for general convex polyhedra. (Received May 30, 1978.)

758-90-9 WITHDRAWN

758-90-10 H. JEROME KEISLER, University of Wisconsin, Madison, Wisconsin 53706. Price adjustment models with infinitesimal traders.

In this lecture we shall describe an exchange economy with a nonstandard finite set of infinitesimal traders trading at random times, where prices are adjusted depending on the actions of the traders. Under appropriate assumptions the economy approaches a competitive equilibrium with probability one. (Received May 30, 1978.)


The prospect for automating the modelling process is shown to be especially grim, particularly in view of our apparent inability to come to grips with an understanding of the 'genesis of mathematical ideas,' the topic of a special symposium announced for this Meeting [NOTICES 25: 168 (1978)]. The six-stage Scientific Method [N.B.: OPER. RES. QUART. 23: 17-29 (1972), but not Ackoff's six 'simultaneously conducted' phases: his 'Scientific Method' (Wiley, 1962)] requires disciplined mental reflection upon sensed experiences. Hence, until we acknowledge the outstanding (minor?) difficulties attending our scientifically derived model of the decision-making mind [cf. COMPSTAT 1976, 256-263 (Physics-Verlag)], a model itself of six well-understood stages [cf. ROLE AND EFFECTIVENESS OF THEORIES OF DECISION IN PRACTICE, 320-327, Crane-Russak (1973)], there will continue to be difficulties in automating the modelling process (i.e., the Scientific Method: Mankind's own previously unwitting mimicry of Nature's modelling processes (first genetic, then neural) by which have been assured the survival of all Life on Earth to date [EPITOME TO DR. BENJAMIN FRANKLIN, Exposition-University Press, New York (1975)]. We must keep in mind both: (A) James G. Miller's revelation [LIVING SYSTEMS, McGraw-Hill (1978)]; every living system, from the cell through the society, contains an intrinsic 'decider'; and (B) Nobel Laureate Konrad Lorenz's comment that he has never published a paper with a graph in it [NATURWISSENSCHAFTEN 60: 1-9 (1973)]. Figure 5.2. of SIMULATION: STATISTICAL FOUNDATIONS AND METHODOLOGY reveals how close we are to "automating" the scientist's modelling process. (Received May 30, 1978.)

758-90-12 GLENN C. LOURY, Northwestern University, Department of Economics, Evanston, Illinois 60201. Inequality and Altruism Across Generations

This paper develops a mathematical theory of the transfer of resources between generations of a family and the effect of such transfers on the distribution of economic advantage in the population. The distribution of income evolves in the population from one generation to the next as a Markoff process. An ergodic theorem for this process is deduced, with the invariant measure taking the interpretation of an equilibrium distribution of economic reward in the society.

The theory is then used to examine certain propositions about the equilibrium distribution which frequently arise in policy discussions. For example, we consider alternative definitions of the concept "reward according to merit," and conclude that the idea of meritocracy is generally inconsistent with the presence of intergenerational altruism. (Received May 30, 1978.) (Author introduced by Professor Donald Brown.)

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The author's graph-theoretic view of the Anderson/Cooper neural model and its relation-theoretic extension to sparsely connected neural networks will be discussed, and some preliminary findings comparing the timing of the author's maximal rectangle algorithm [Springer Lecture Notes in Comp. Science 56, 476-481] and an algorithm of Haralick [J.A.C.M. 21 (1974), 356-366] will be presented. (Received May 30, 1978.)

Neurophysiology, neuroanatomy and neural models. Preliminary report.

We are concerned in this session with models of nervous system organization, specifically with models for mammalian neocortex, where most significant higher level learning, memory, and cognition occur. Experimental neuroscience has taught us a great deal about the organizational and functional properties of the nervous system and its component parts. The pertinent biology greatly constrains the kinds of neural models that are realistic. Several venerable controversies in neuroscience have important implications for theoretical models and will be briefly reviewed. First, are neurons basically analog elements or digital devices? The well-known McCulloch-Pitts model neuron was shown in 1943 to be a general logical element. However, the weight of current experimental evidence supports the idea that neurons are basically analog elements without the convenient dichotomizing properties of binary neurons. Some examples of the properties of specific neurons will be discussed. Second, is memory organization, indeed, brain organization, distributed or localized? Local storage -- file cabinets, computer memories, libraries -- is useful, powerful, and easy to understand and analyze. However, evidence currently suggests that memory in the brain is at least partially distributed, that is, physically spread out so one "memory" takes up very many storage locations and so that one storage location is not the privileged site of one memory but contains information from many memories. Distributed models have pronounced, unfamiliar, and, potentially, testable properties and will be briefly discussed. This talk will primarily try to present some essential factual background which is used to justify some very tentative but quite specific assumptions about brain organization and the nature of memory in biological organisms. (Received May 30, 1978.) (Author introduced by Stuart Geman).

Several types of distributed linearly operating memories have been reported in context of learning in neural networks. Two of them, the sub-optimal correlation matrix-type memories and the optimal associative mappings, are briefly reviewed. Some convergence properties of a new algorithm modelling neural adaptation in visual cortex are considered. This algorithm has the ability to change the state of the adaptive system of cortical neurons from sub-optimal to optimal and again from optimal to sub-optimal, depending only on the input to the system. Input in the form of separate sensory patterns produces asymptotic optimality, while noise-like input containing no sensory information decreases the optimality back to the sub-optimal starting level. This behaviour has a bearing on experimental data showing how cortical cells in cat develop a sharp tuning to input stimuli under favorable sensory experience but may lose it again in the lack of such stimuli. (Received May 30, 1978.) (Author introduced by Stuart Geman).

A model of the head is developed which takes into account heterogeneities of thermal and electrical properties of tissue and the removal of heat by the blood. The problem of determining the temperature excursion in a six tissue layer model of the head in the presence of a plane wave is solved explicitly when the tissue layers are delimited by concentric spheres. (Received May 30, 1978.)
In this paper we consider the problem of using input-output data to estimate parameters in a dynamical system governed by linear retarded functional differential equations (FDE). We shall describe several approximation schemes which lead to computational algorithms. One approach makes use of Trotter-Kato type approximations and results in parameter identification problems in which the dynamical systems are governed by ordinary differential equations. For comparison purposes we also consider a direct discretization of the FDE which results in a finite dimensional minimization problem. Several numerical examples are given to illustrate and compare the methods. (Received May 25, 1978.) (Author introduced by Professor H. T. Banks).


One studies the following problem which occurs in the theory of linear control systems: Given \( a \geq 0 \), a polynomial \( p(\lambda) \) of degree \( n \), and \( m \) linearly independent polynomials \( p_i(\lambda), i=1,2,\ldots,m \), of degree at most \( n-1 \), find \( m \) parameters \( k_i \in \mathbb{R} \), \( i=1,2,\ldots,m \) such that all the roots of the equation \( p(\lambda)+\sum_{i=1}^{m} k_i p_i(\lambda)=0 \) should satisfy the inequality \( Re\lambda<-a \) (This covers, in particular, problems of stabilization of linear control systems.). One finds necessary and sufficient condition for the existence of the parameters \( k_i \) with the above properties, for \( m=n-1 \). As a main step of the proof, one shows that the closed convex hull of the set of all vectors \( a=(a_1,a_2,\ldots,a_n) \) for which the polynomial \( \lambda^n+a_1\lambda^{n-1}+a_2\lambda^{n-2}+\ldots+a_n \) is stable is equal to the nonnegative orthant \( \{a_1,a_2,\ldots,a_n\}|a_i\geq 0, i=1,2,\ldots,n \} \). (Received May 30, 1978.)

EDUARDO D. SONTAG, Rutgers University, New Brunswick, NJ 08903. Parametric identifiability of deterministic nonlinear systems.

An identification input sequence [or function] for a parametric family of systems \( x(t+1) = f(x(t),u(t)), y(t)=H(x(t)) \), \( c \) an unknown parameter, is a bounded support input with the property that the future input/output behavior of the system can be determined just from the response to this input. A family of discrete-time systems is polynomial when states \( x \), inputs \( u \), outputs \( y \), and parameters \( c \) belong to algebraic sets \( X, U, Y, C \), with \( U \) irreducible, and \( P \) and \( H \) are polynomial in all the variables.

THEOREM. A polynomial family has an i.i.s. Moreover, "almost any" input sequence is an i.i.s., in the sense that there is an integer \( r \) and a proper algebraic set \( F \) in \( \mathbb{R}^r \) such that any sequence of length \( r \) not in \( F \) is an i.i.s.

The existence part of the theorem can be easily proved directly, in fact in much more generality (for compact analytic or continuous-time families). The lecture will discuss these and other generalizations. (Received May 30, 1978.)


Let \( M \) be a Hausdorff manifold and let \( F, G_1,G_2,\ldots,G_m \) be vector fields on \( M \). An \( m \)-input control system on \( M \) can be described in local coordinates by

\[ \dot{x}(t) = f(x(t)) + \sum_{i=1}^{m} u_i(t)g_i(x(t)) \]

We call such a system reachable if for any two points on \( M \) there exists a control \( u \) which steers \( x \) from one to the other. We call a reachable control system linear if in the neighborhood of any point

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in $M$ there exists a coordinate system such that the evolution is given as above with $f$ affine and the $g_i$ constant. **Theorem:** There exists a reachable linear system on $M$ if and only if $M = \mathbb{R}^p \mathbb{P}^{(S_1)^p}$ with $p \leq m$.

Let $\phi : M \to \mathbb{R}$ and let $\{F, G_1, G_2, \ldots, G_m\}$ define a reachable linear system on $M$. Consider the variational problem defined by minimizing

$$J = \int_0^\infty \phi(x) + \sum_{i=1}^m u_i^2 dt$$

In this paper we extend the usual spectral factorization (Wiener-Hopf) method of solving these problems in the case that $\phi$ is "quadratic" in an appropriate sense. (Received May 30, 1978.)

758-93-5 ROBERT HERMANN, Harvard University, Cambridge, Massachusetts 02138. **Limits of solutions of matrix Riccati equations and the Lie theory of vector fields on Grassmannians.**

A matrix Riccati equation associated within optimal control problems defines a flow in a coset space $Sp(n,R)/H =$ space of all $n$-dimensional Lagrange subspaces of $R^{2n}$. Some ways of looking at limit-stability properties of solutions using Lie-theoretic techniques are described. (Received May 30, 1978.)


If $(A,B)$ represents a controllable linear system and one loses an input channel, then the resulting system $(A,B')$, $(B' = B$ with a column set equal to zero) may or may not be controllable. Assuming the latter condition, one may ask for system-theoretic properties of $(A,B')$ in terms of those of $(A,B)$; e.g. what are the feedback invariants of $(A,B')$? The author gives a formula for $K'$ in terms of $K$, viz. $K' = K \vee \overline{K}$, where $\overline{K}$ is a Kronecker index computable directly from $n$ and $m$, and where the join is the standard number-theoretic lattice operation, operating on Kronecker indices qua partitions. This is proved by the standard technique of representing a partition by a Young diagram. This problem is a special one of a class treated by the author and C. Martin and illustrates the general study of feedback invariants for systems with parameters by algebraic and lattice theoretic techniques, which will appear in more detail elsewhere. (Received May 30, 1978.)

758-93-7 PETER L. FALB, Brown University, Providence, Rhode Island 02940. **Feedback Constructions for Systems with Parameters.** Preliminary report.

The author studies, using algebraic and geometric techniques, system-theoretic problems concerning systems which depend algebraically on parameters. For example, one can ask for the existence, say generically, of a canonical form under various feedback groups. One such problem is the existence of a constant matrix $K$, so that the family $(F+GK, G)$ has its spectrum in a preassigned subvariety of the complex plane or in the product of the complex plane and the parameter space. Another is to give an abstract characterization of such "spectral varieties". Such results will be announced here and will appear elsewhere. (Received May 30, 1978.)

94 Information and Communication, Circuits, Automata

758-94-1 JOHN KARLOF and CHARLES DOWNEY, University of Nebraska at Omaha, Omaha, Nebraska 68101. **Odd [M,3] Group Codes for the Gaussian Channel.**

An $[M,n]$ nonplanar group code for the Gaussian channel is said to be odd if both $M$ and $n$ are odd. Using the structure of the finite subgroups of the group of rotations in $R^3$, we show that odd $[M,3]$ group codes do not exist. (Received April 7, 1978.)

98 Mathematical Education, Collegiate

758-98-1 Sheldon P. Gordon, Suffolk Community College, Selden, N.Y. 11784. **A Discrete Approach to Computer Oriented Calculus.**

The author has developed a new approach to the calculus using the calculus of finite differences and sums as both motivation and useful tool. The primary advantage of
this is that it provides an ideal context in which to incorporate computers into the calculus in a particularly natural way. Most topics are first developed in the discrete setting and then carried over to the continuous case via the limit. By starting with the finite calculus, a wider range of topics can be included in the course. Thus, the numerical techniques used with computers all fit within the scope of this approach. Also, a study of discrete models based on difference equations and various approximation and interpolation techniques which make calculus usable in practical situations can also be treated.

The present paper is specifically intended to discuss some of the mathematical implications and advantages of the discrete approach and a number of particular applications using the approach are illustrated and discussed. (Received May 30, 1978.)

758-98-2

HASSLER WHITNEY, Institute for Advanced Study, Princeton, New Jersey 08540. Fostering and hindering creativity in mathematics.

The preschool child is exploring and learning at a prodigious rate. His curriculum includes the physical environment, his relation to it, concepts of language, and feelings of his parents. His study process is a continual trying old and new approaches, always revising and refining ideas. In these ways he is similar to a research mathematician. Soon this will be largely stifled by the pressures of society, schooling in particular. Few grow up to revive the early creativity and become high class researchers. We discuss the evidence for these views and what may be done about it. (Received May 30, 1978.)

Miscellaneous Fields

758-ML

IRA M. GESSEL, IBM Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598. A non-commutative generalization and q-analog of the Lagrange inversion formula.

A generalization of the Lagrange inversion formula is obtained by factorization of formal power series in noncommuting variables. Application of a linear operator yields the following q-analog:

Let \( f(x) = f(x; q) \) satisfy \( f(x) = q x \sum_{j=0}^{\infty} g_j f(x) f(q x) \ldots f(q^{i-1} x) \). Let \( g(t) = \sum_{n=0}^{\infty} g_n t^n \), let \( \bar{f}(x) = f(x; q^{-1}) \), and let \( h(x) = [1 - x \sum_{n=0}^{\infty} g_n (1 - x) f(x) \ldots f(q^{i-1} x) \bar{f}(x) \bar{f}(q^{-1} x) \ldots \bar{f}(q^{i-j} x)]^{-1} \). Then the coefficient of \( x^n \) in \( h(x) f(x) f(q x) \ldots f(q^{i-1} x) \) is equal to the coefficient of \( t^{n-k} \) in \( q^{n(n+1)/2} g(q^{-1} t) \ldots g(q^{-n} t) \).

(Received June 16, 1978.)
SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, summer or semester exchange or rental of houses, mathematical typing services and special announcements of meetings. The rate is $3.00 per line. The same ad run in seven consecutive issues is $2.50 per line. Ads will be typed in the AMS office and will be typed solid. If centering and spacing of lines is requested, the charge will be $3.00 per line with the same rate for open space as for solid type.

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DEADLINES for the next few issues are: for October, September 5; for November, September 26; for January, December 5.

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Applicants will be considered without regard to race, creed, or sex. Applicants should submit curriculum vitae and have letters of reference sent to:

Professor Patrick Suppes
Chairman, Logic Search Committee
Ventura Hall
Stanford University
Stanford, California 94305

THE DEPARTMENT OF MATHEMATICS OF SOUTHERN METHODIST UNIVERSITY

announces openings at either the junior or senior level beginning in the academic year 1979–1980. Visiting appointments may be possible. Those with orientation toward applications and/or numerical analysis, and with the ability to interact with disciplines other than mathematics are preferred. Superior teaching ability and interest in curriculum development are expected.

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Further particulars and application forms may be obtained from the Secretary-General, Association of Commonwealth Universities, 36 Gordon Square, London WC1H OPF, England, or the Assistant Secretary (Recruitment), University of Hong Kong, Hong Kong. Closing date for applications is September 30, 1978.

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A-556
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2. date of termination of service;
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ANONYMOUS


ERRATA—Volume 25


In lines 5 and 6 delete the sentence "There is a further class of prepolynomially complete groups which consists of holomorphs of certain nonabelian simple groups."


The entire abstract should be replaced with the abstract below.

A function \( f: X \to Y \) is called quasi-continuous if for each point \( x \in X \) and open sets \( A \subset X \) and \( H \subset f(x) \), where \( x \in A \) and \( f(x) \in H \), we have \( A \cap f^{-1}(H) \neq \emptyset \). Given a family \( F \) of bijections from \( X \) onto \( Y \), a dense set \( D \) in \( X \) is called a simultaneous Blumberg set for \( F \), if for each \( f_i \in F \), the partial function \( f_i|D \) is continuous, \( f(D) \) is dense in \( Y \), and the partial function \( f_i|f_i^{-1}(D) \) is continuous.

Theorem. Let \( X \) and \( Y \) be Hausdorff, second countable, Baire spaces, \( X \) be regular, and let \( F \) be a countable family of quasi-continuous bijections from \( X \) onto \( Y \). Then \( F \) admits a simultaneous Blumberg set if and only if for each \( f_i \in F \), the inverse function \( f_i^{-1} \) is quasi-continuous.

(Received May 22, 1978.) (Author introduced by C. J. Neugebauer)

A-557
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A-558
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A-560
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Algebra of Proofs

by M. E. SZABO, Professor of Mathematics, Concordia University, Montreal, Quebec, Canada.

STUDIES IN LOGIC AND THE FOUN­DATIONS OF MATHEMATICS, Vol. 88

1978 vi + 297 pages
Price: US $43.50/Dfl. 100.00
ISBN 0-7204-2286-8

This book gives the first comprehen­sive account of the connection between elementary proof theory and the properties of a variety of categories with additional structure, including the cartesian closed fragment of an elementary topos. The presentation is self-contained and provides an invaluable summary of all the relevant concepts and defini­tions, together with many mathematical examples of the structures studied.

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Algorithmic Aspects of Combinatorics

Proceedings of a Conference held at Qualicum Beach, Canada

edited by BRIAN ALSPACH, Simon Fraser University, Canada, PAVOL HELL, Rutgers University, U.S.A., and DONALD J. MILLER, University of Victoria, Canada.

ANNALS OF DISCRETE MATHE­MATICS, Vol. 2

1978 x + 222 pages 14 tables 61 illustrations
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Applications of Statistics
edited by PARUCHURI R. KRISNAIAH,
Department of Mathematics and Statistics, University of Pittsburgh, P.A., U.S.A.
1977 xx + 540 pages
Price: US $47.95/Dfl. 110.00
ISBN 0-444-85034-1
This book consists of the 32 invited papers presented at the Symposium on Applications of Statistics, sponsored by the Air Force Flight Dynamics Laboratory. The Symposium was held at Wright State University, Dayton, Ohio in June, 1976.

In these papers, distinguished workers in the field of statistics applications discuss the current state-of-the-art for an impressively broad spectrum of topics. Areas of applications dealt with include acoustics, cancer research, cluster analysis, communication, econometrics, hydrology, meteorology, model building, pattern recognition, pharmacokinetics, psychometrics, reduction of dimensionality, reliability, stability of structures and turbulence.

An undoubtedly stimulating collection of papers, these surveys will interest statisticians and scientists working in all those areas involving applications of statistical methodology. The interdisciplinary nature of the book (covering topics in the behavioural, biological, engineering, physical, medical and social sciences) ensures its appeal to a wide range of readers.

Multivariate Analysis IV
Proceedings of the Fourth International Symposium, Wright State University, June 16-21, 1975
edited by P. R. KRISNAIAH.
1977 xiv + 516 pages
Price: US $54.95/Dfl. 125.00
ISBN 0-7204-0520-3
Outstanding workers from various countries discuss the present state-of-the-art on a broad spectrum of topics in the theory and applications of multivariate analysis. The material in Volume IV generally complements the material in the earlier volumes and in the Journal of Multivariate Analysis. Technological and physical science applications are given particular prominence. The areas covered include classification and pattern recognition, distribution theory, prediction and filtering, multiple decision procedures, characterization problems, contingency tables, hydology and meteorology, information and control theory, time series and stochastic processes, growth curves, statistical physics, reliability, design and analysis of experiments, and statistics of directional data. The book will be of exceptional value to mathematical statisticians, probabilists, as well as to scientists in other disciplines who are involved in the applications and methodology of multivariate analysis techniques.

Contributions to Universal Algebra
edited by B. CSÁKANY, Mathematics Department, József Attila University, Szeged, Hungary, and J. SCHMIDT, Mathematics Department, University of Houston, Houston, Texas, U.S.A.
COLLOQUIA MATHEMATICACA
SOCIETATIS JÁNOS BOLYAI, Vol. 17
1977 607 pages
Price: US $86.95/Dfl. 200.00
ISBN 0-7204-0725-7
This volume consists of 41 papers, most of which are the expanded written versions of lectures delivered at the Colloquium on Universal Algebra held in Szeged, Hungary. A number of invited contributions are also included.

The majority of the papers are concerned with results in the general theory of algebraic systems, while the rest discuss such topics as problems on groupoids, semigroups, groups and lattices, all of these concerning or suggested by universal algebraic notions. Finally, an intriguing list of unsolved problems compiled by the Colloquium participants is appended. The range and depth of this stimulating collection of papers make it a valuable acquisition for any mathematician.


Saks Spaces and Applications to Functional Analysis
by JAMES BELL COOPER, Institut für Mathematik, Johannes Kepler Universität, Linz-Auhof, Austria.
NORTH-HOLLAND MATHEMATICS STUDIES, Vol. 28
1978 about 350 pages
Price: US $30.50/Dfl. 70.00 Paperback
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