Calendar

This Calendar 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.

<table>
<thead>
<tr>
<th>Meeting Number</th>
<th>Date</th>
<th>Place</th>
<th>Deadline for Abstracts and News Items</th>
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</thead>
<tbody>
<tr>
<td>731</td>
<td>January 22–26, 1976</td>
<td>San Antonio, Texas</td>
<td>Nov. 5, 1975</td>
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<tr>
<td>(82nd Annual Meeting)</td>
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<tr>
<td>735</td>
<td>April 23–24, 1976</td>
<td>Reno, Nevada</td>
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<td>736</td>
<td>June 18–19, 1976</td>
<td>Portland, Oregon</td>
<td>April 27, 1976</td>
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<td>(80th Summer Meeting)</td>
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<td>737</td>
<td>November 19–20, 1976</td>
<td>Columbia, South Carolina</td>
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<td>737</td>
<td>November 26–27, 1976</td>
<td>Albuquerque, New Mexico</td>
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<td>737</td>
<td>January 27–31, 1977</td>
<td>St. Louis, Missouri</td>
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<tr>
<td>(83rd Annual Meeting)</td>
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</tbody>
</table>

*Deadline for abstracts not presented at a meeting (by title)

February 1976 issue: January 6
April 1976 issue: February 10

OTHER EVENTS

February 24, 1976 Symposium on Some Mathematical Questions in Biology, Boston, Massachusetts


Please affix the peel-off label on these Notices to correspondence with the Society concerning fiscal matters, changes of address, promotions, or when placing orders for books and journals.

The Notices of the American Mathematical Society is published by the American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940, in January, February, April, June, August, October, November, and December. Subscription prices for the 1975 volume (Volume 22) are list $14.00, member $7.00. Subscription prices for the 1976 volume (Volume 23) are list $19.00, member $9.50. The subscription price for members is included in the annual dues. Back issues of the Notices are available for a two year period only and cost $2.88 per issue list price, $2.16 per issue member price for Volume 21 (1974) and $3.65 per issue list price, $2.74 per issue member price for Volume 22. Orders for subscriptions or back issues must be accompanied by payment and should be sent to the Society at P. O. Box 1571, Annex Station, Providence, Rhode Island 02901. Other correspondence should be addressed to P. O. Box 6248, Providence, Rhode Island 02940. Second class postage paid at Providence, Rhode Island, and additional mailing offices.

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The Seven Hundred Twenty-Ninth Meeting
Virginia Polytechnic Institute and State University
Blacksburg, Virginia
November 7–8, 1975

The seven hundred twenty-ninth meeting of the American Mathematical Society will be held at the Virginia Polytechnic Institute and State University in Blacksburg, Virginia, from noon Friday, November 7, until noon Saturday, November 8, 1975.

By invitation of the Committee to Select Hour Speakers for the Southeastern Sectional Meetings, there will be three one-hour addresses. Professor Robert J. Daverman of the University of Tennessee will give a lecture at 1:00 p.m. Friday, entitled "Embeddings of \((n - 1)\)-spheres in \(n\)-space." Professor James D. Buckholtz of the University of Kentucky will lecture on "Strong convergence and polynomial expansions of analytic function" at 4:30 p.m. Friday, and Professor William Jaco of Rice University will speak on "Three-manifold groups: A survey" at 9:00 a.m. Saturday. All of the invited addresses will be held in the auditorium of the Donaldson Brown Center for Continuing Education.

SPECIAL SESSIONS

In addition to the regular sessions for contributed papers, there will be three special sessions. Professor John Burns of Virginia Polytechnic Institute and State University has organized a special session on Differential Equations and Control Theory; the speakers will include Richard Datko, Kenneth W. Neves, George Redden, James Reneke, Curtis Travis, and Glenn Webb. Professor Richard E. Hodel of Duke University has organized a special session on Point Set Theory (more specifically, Generalized Metrizable Spaces); the speakers will be D. K. Burke, P. W. Harley III, R. M. Stephenson, W. K. Lindgren, David J. Lutzer, Peter J. Nyikos, L. Reed, Frank G. Slaught, Jr., E. K. van Douwen, Michael L. Wage, and J. M. Worrell, Jr. A special session on Binary Relations has been arranged by Professor Eugene M. Norris of the University of South Carolina; the speakers will be D. I. Adu, S. Y. Bang/R. T. Yeh, Alexander R. Bednarek/Stanislaw M. Ulam, Kim K.-H. Butler/S. Schwarz, Temple H. Fay, Richard J. Greechie, Kenneth D. Magill, Jr., and Richard D. Mauldin.

REGISTRATION

The registration desk, which will be located in the lobby of the Donaldson Brown Continuing Education Center, will be open from 10:00 a.m. to 1:00 p.m., and from 3:30 p.m. to 5:00 p.m. on Friday, November 7, 1975. The registration fee will be $3.75, of which $1 will go to the Society.

ACCOMMODATIONS

Reservations for lodging should have been made through the Donaldson Brown Center for Continuing Education, using the preregistration and reservation form which was in the October issue of these Notices, prior to the deadline of October 27. However, telephone reservations will be accepted after that date by calling the department of mathematics at (703) 951-6536.

DONALDSON BROWN CENTER FOR CONTINUING EDUCATION (703) 951-8322
(Conference Headquarters)

Single $10.00 plus tax
Twin $16.00 plus tax

ECONO-TRAVEL MOTOR HOTEL
Route 460, Route 643
(703) 951-4242
1 Bed 1 person $ 9.90
1 Bed 2 persons $12.90
2 Beds 2/3/4 persons $15.90
(all include telephone services)

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Route 460 South
(703) 951-1390
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1 Bed 2 persons $21.00
2 Beds 2 persons $24.00
(each additional person $3.50)

IMPERIAL MOTOR LODGE
South Main Street
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2 Beds in every room
1 person $ 9.95
2 persons $13.59
3 persons $15.59

LAKE TERRACE MOTEL
South Main Street (Route 460 Business)
(703) 552-5132
2 Beds in every room
1 person $ 8.00-$ 9.00
2 persons $12.00-$14.00
(each additional person $2.00 plus tax)

MARRIOTT INN
Prices Fork Road (Route 685)
(702) 552-7001
2 Beds in every room
Single $17.00
Double $24.00
($1.00 higher if on pool side)
RED LION INN
Prices Fork Road and Route 460 Bypass
(703) 552-7770

1 Bed 1 person $13.75
2 Beds 2 persons $21.50
($3.00 each additional person)

UNIVERSITY MOTEL
Route 460 South and 3900 South Main Street,
Blacksburg

2 Beds in every room
1 person $10.40
2 persons $15.60
3 persons $17.68
4 persons $19.76

FOOD SERVICE

The Donaldson Brown dining room and the
Squires Student Center Cafeteria and Snack Bar
will be open for the meeting. A list of other
restaurants in Blacksburg will be available at
the registration desk.

PROGRAM OF SESSIONS

The time limit for each contributed paper in the general sessions is ten minutes
and in the special sessions is twenty minutes. To maintain this schedule, the
time limits will be strictly enforced.

FRIDAY, 1:00 P.M.

Invited Address, Auditorium, Donaldson Brown Center

(1) Embeddings of \((n - 1)\)-spheres in \(n\)-space. Professor ROBERT J. DAVERMAN,
University of Tennessee (729-G20)

FRIDAY, 2:10 P.M.

Special Session on Generalized Metrizable Spaces I, Auditorium, Donaldson Brown Center

2:10-2:30 (2) Base of countable order theory. Preliminary report. Professor J. M. WORRELL,
Jr., Ohio University (729-G13)

of Pittsburgh (729-G9)

3:00-3:20 (4) \(G_\delta\) diagonals and separating open covers. Professor DENNIS K. BURKE, Miami
University (729-G6)

3:25-3:45 (5) Quasi-metrizable spaces. Professor WILLIAM F. LINDGREN, Slippery Rock State
College (729-G10)

3:50-4:10 (6) Symmetrizable and related spaces. Professor PETER W. HARLEY III* and Profes-
sor R. M. STEPHENSON, Jr., University of South Carolina (729-G7)

FRIDAY, 2:10 P.M.

Special Session on Binary Relations I, Conference Room E

2:10-2:30 (7) Connected CM-homomorphisms into semigroups of hereditarily locally connected
continua. Preliminary report. DAVID L. ADU, State University of New York at Buf-
falo (729-A1)

A. R. BEDNAREK*, University of Florida, and Professor S. M. ULAM, University
of Colorado and University of Florida (729-E2)

3:00-3:20 (9) Some applications of categorical relation theory. Preliminary report. Professor
TEMPLE HAROLD FAY, Hendrix College (729-A4)

3:25-3:45 (10) Embedding semigroups into semigroups of closed relations. Preliminary report.
K. D. MAGILL, Jr., State University of New York at Buffalo (729-A2)

*For papers with more than one author, an asterisk follows the name of the author who plans to
present the paper at the meeting.

TRAVEL

Blacksburg is on U. S. Route 460 about
eight miles from Route I-81. Those traveling by
automobile on I-81 should take Exit 37. The Blacks-
burg Limousine Service from the Woodrum Air-
port in Roanoke to Blacksburg, is available at $6
per person one way, or $11 per person round trip.
(Individuals desiring this service should contact
the Blacksburg Limousine Service at the airport,
since the other limousine is more expensive.)

ENTERTAINMENT

There will be a beer party on Friday, No-
vember 7, from 8:00 p.m. until midnight in the
ballroom of Squires Student Center. The cost
will be $1.50 per person. Tickets may be pur-
chased at the registration desk.

MESSAGES

Emergency messages may be left at the
Continuing Education Center switchboard; the
telephone number is (703) 951-8322.
FRIDAY, 2:10 P.M.

Special Session on Differential Equations and Control Theory I, Conference Room F
2:10– 2:30 (11) Stability of linear differential–difference equations. RICHARD F. DATKO, George-town University (729–B3) (Introduced by John A. Burns)
3:00– 3:20 (13) Uniform \( L^1 \) behavior for an integrodifferential equation with parameter. Professor KENNETH B. HANNSGEN, Virginia Polytechnic Institute and State University (729–B4)

FRIDAY, 2:15 P.M.

Session on Algebra I, Conference Room G
2:15– 2:25 (15) A theorem on ordered free groups. Preliminary report. Ms. KATHERINE J. AP-... (729–A3) (Introduced by M. F. Neff)
2:30– 2:40 (16) Unique factorization in modules and symmetric algebras. Professor DOUGLAS L. COSTA, University of Virginia (729–A6)
3:00– 3:10 (18) Permutation polynomials in \( n \) indeterminates over a finite field. II. Dr. R. G. VAN METER, State University of New York, College at Oneonta (729–A10)
3:15– 3:25 (19) Moufang functional equations on GD-groupoids with applications to quasigroups of various arities. Mr. VELIMIR P. PAVLOVIC, Emory University and University of Belgrade, Yugoslavia (729–A11) (Introduced by Trevor Evans)
3:30– 3:40 (20) Free algebras and orthogonal latin squares. Professor TREvor EVANS, Emory University (729–A12)

FRIDAY, 2:15 P.M.

Session on Topology I, Conference Room B
2:15– 2:25 (22) Topics related to homogeneity. Preliminary report. Mr. JAMES STEPHEN WHITE, Auburn University (729–G1)
2:30– 2:40 (23) Representable spaces and strongly \( N \)-homogeneous spaces. Dr. JOHN W. BALES, Auburn University (729–G2)
3:00– 3:10 (25) Isotopically representable spaces. Preliminary report. Dr. JUDy KENNEDY PHELPS, Auburn University (729–G5)
3:15– 3:25 (26) A note on identifications of metric spaces. Dr. FRANK SIWIEC, City University of New York, John Jay College (729–G14)
3:30– 3:40 (27) Bounding a free action of a finite group. Interim report. Dr. RUSSELL J. ROWLETT University of Tennessee (729–G16)

FRIDAY, 2:15 P.M.

Session on Analysis, Conference Room C
2:15– 2:25 (28) The existence of conjugate points for self-adjoint differential equations of even order. Professor ROGER T. LEWIS, University of Alabama–Birmingham (729–B7)
2:30– 2:40 (29) On the local ergodic theorems of Krengel, Kubokawa, and Terrell. Professor STEPHEN A. McGRATH, U.S. Naval Academy, Annapolis, Maryland (729–B8)
2:45– 2:55 (30) Interpolation and approximation of axisymmetric harmonic functions in \( R^3 \). Professor ALLAN J. FRyANT, United States Naval Academy (729–B10)
3:00– 3:10 (31) Some multilinear algebra results applied to partial differential equations. Mr. THOMAS H. PATE, Emory University (729–B11)
3:15– 3:25 (32) Difference methods for optimal control problems described by functional equations. Preliminary report. Mr. FRANK H. MATHis, Vanderbilt University (729–B12)
3:30– 3:40 (33) The mean value of the modulus of an analytic function. Professor HARI SHANKAR, Ohio University (729–B13)
FRIDAY, 4:30 P.M.

Invited Address, Auditorium, Donaldson Brown Center
(34) Strong convergence and polynomial expansions of analytic functions. Professor JAMES D. BUCKHOLTZ, University of Kentucky (729-B9)

SATURDAY, 9:00 A.M.

Invited Address, Auditorium, Donaldson Brown Center
(35) Three-manifold groups–A survey. Professor WILLIAM JACO, Rice University (729-G15)

SATURDAY, 10:10 A.M.

Special Session on Generalized Metrizable Spaces II, Auditorium, Donaldson Brown Center
10:10–10:30 (36) Base conditions, generalized metric spaces, and metrization. Professor PETER NYIKOS, University of Illinois (729-G19)
11:00–11:20 (38) Countable paracompactness, normality, and Moore spaces. MICHAEL L. WAGE, University of Wisconsin (729-G3)
11:25–11:45 (39) Extension properties. ERIC K. VAN DOUWEN, University of Pittsburgh (729-G12)
11:50–12:10 (40) Closed mapping theory. Preliminary report. Professor F. G. SLAUGHTER, Jr., University of Pittsburgh (729-G8)

SATURDAY, 10:10 A.M.

Special Session on Binary Relations II, Conference Room E
10:10–10:30 (41) Relational algebra and its applications to data representation and structuring. Preliminary report. Dr. S. Y. BANG*, Wayne State University and Professor R. T. YEH, University of Texas (729-C5)
10:35–10:55 (42) Circulant binary relations. Professor KIM KI-HANG BUTLER*, Alabama State University, and ŠTEFAN SCHWARZ, Slovak Academy of Science, Bratislava, CSSR (729-A5)
11:00–11:20 (43) Every finite group is the automorphism group of an orthocomplemented projective plane. Professor RICHARD J. GREECHIE, Kansas State University (729-A9)
11:25–11:45 (44) Nonisomorphic analytic sets. Preliminary report. DAN MAULDIN, University of Florida (729-E1)

SATURDAY, 10:10 A.M.

Special Session on Differential Equations and Control Theory II, Conference Room F
10:10–10:30 (45) Boundary value problems for functional differential equations with \(L^2\) initial functions. Professor G. W. REDDIE, Vanderbilt University (729-B6)
10:35–10:55 (46) The existence of realizations of hereditary systems. Professor JAMES A. RENEKE, Clemson University (729-B1)
11:00–11:20 (47) Partial functional differential equations. Professor C. C. TRAVIS*, University of Tennessee, and Professor G. F. WEBB, Vanderbilt University (729-B5)
11:25–11:45 (48) Numerical approximation of nonlinear functional differential equations with \(L^2\) initial functions. Professor GLENN WEBB, Vanderbilt University (729-C1)

SATURDAY, 10:15 A.M.

Session on Algebra II, Conference Room G
10:15–10:25 (49) Perfect splitting polynomials. Professor JACOB T. B. BEARD, Jr., University of Texas at Arlington (729-A13)
10:30–10:40 (50) Finite equationally complete quasigroups. Mr. BRUCE R. CAIN, Emory University (729-A14)
11:00–11:10 (52) Power series rings over absolutely flat rings. Preliminary report. Professor J. BREWER*, E. RUTTER and J. WATKINS, University of Kansas (729-A16)
11:15–11:25 (53) Some categorical results for semigroup categories. Preliminary report. Mr. J. WINSTON CRAWLEY, University of Tennessee (729-A17)
11:30–11:40 (54) On graphs with unique distance trees. Professor LAWRENCE D. STRONG*, University of South Carolina, Salkehatchie Regional Campus, and Professor CHARLES C. ALEXANDER, University of Mississippi (747-A143)
SATURDAY, 10:15 A.M.

Session on Applied Mathematics, Conference Room B
10:15-10:25 (55) The exterior Robin problem for the Helmholtz equation. Dr. JOHN F. AHNER, Vanderbilt University (729-C3)
10:30-10:40 (56) The attainable set of conditional probability measures in stochastic control. Professor STEPHEN H. SAPERSTONE, George Mason University (729-C4)
10:45-10:55 (57) Generalized octorians and quarks. A. M. BUONCRISTIANI, Christopher Newport College (729-C6)
11:00-11:10 (58) Multiple boundary layers in oscillatory convective flows in a rotating system. Dr. A. K. CHATTERJEE, Calcutta Port Comm., Dr. S. C. RAY, River Research Institute and Dr. L. DEBNATH*, East Carolina University (729-C7)

SATURDAY, 10:15 A.M.

Session on Topology II, Conference Room C
10:15-10:25 (59) Closed subgroups of topological groups. Preliminary report. Dr. M. RAJAGOPALAN, Memphis State University (729-G17)
10:30-10:40 (60) Locally bounded topological spaces. Dr. P. TH. LAMBRINOS, University of Thessaloniki, Greece, and Kansas State University (729-G18)
10:45-10:55 (61) An example of a weak $\theta$-refinable $\aleph_1$-compact $T_1$-space which is not meta-Lindelöf. Professor HOWARD H. WICKE, Ohio University (729-G21)
11:00-11:10 (62) Partial semigroups on a Banach space. Professor ROBERT C. ESLINGER, The University of the South (729-G22)

Orville G. Harrold, Jr.
Associate Secretary
Tallahassee, Florida

PRESENTORS OF PAPERS

Following each name is the number corresponding to the speaker's position on the program

*Invited one-hour lecturers

*Special session speakers

*Aden, D. I. #7
Ahner, J. F. #55
Appleson, K. J. #15
Bales, J. W. #23
*Bang, S. Y. #41
Beard, J. T. B., Jr. #49
*Bednarek, A. R. #8
Brewer, J. #52
●Buckholtz, J. D. #34
Buoncristiani, A. M. #57
Burke, D. K. #4
*Butler, K. K.-H. #42
Caine, B. R. #50
Cook, D. #17
Costa, D. L. #16
Crawley, J. W. #53
*Dutko, R. F. #11
●Duverman, R. J. #1
Debnath, L. #58
Deveney, J. K. #21
*van Douwen, E. K. #39

Eslinger, R. C. #62
Evans, T. #20
*Fay, T. H. #9
Fryant, A. J. #30
Giffen, C. H. #24
*Greechie, R. J. #43
*Haddock, J. #12
*Hannagen, K. B. #13
*Harley, P. W., III #6
●Jaco, W. #35
Lambrinos, P. Th. #60
Lee, L. A. #51
Lewis, R. T. #28
*Lindgren, W. F. #5
*Lutzer, D. J. #3
McGrath, S. A. #29
*Magill, K. D., Jr. #10
Mathis, F. H. #32
*Mauldin, D. #44
*Neves, K. W. #14
*Nyikos, P. #36

Pate, T. H. #31
Pavlovic, V. P. #19
*Phelps, J. K. #25
Rajagopalan, M. #59
*Reddien, G. W. #45
*Reed, G. M. #37
*Renke, J. A. #46
*Rowelett, R. J. #27
*Saperstone, S. H. #56
Shankar, H. #33
Swipec, F. #26
*Slaughter, F. G., Jr. #40
Strong, L. D. #54
*Travis, C. C. #47
Van Meter, R. G. #18
*Wage, M. L. #38
*Webb, G. #48
White, J. S. #22
*Wice, H. H. #61
*Worrell, J. M., Jr. #2
The Seven Hundred Thirtieth Meeting  
University of California  
Los Angeles, California  
November 15, 1975

The seven hundred thirtieth meeting of the American Mathematical Society will be held at the University of California, Los Angeles, California, on Saturday, November 15, 1975.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional meetings, there will be two invited hour addresses. Professor Robert Osserman, Stanford University, will lecture at 11:00 a.m. on "The isoperimetric inequality." Professor Jerry L. Kazdan, University of California at Berkeley and University of Pennsylvania, will lecture on "Applications of partial differential equations to differential geometry" at 3:30 p.m. Both addresses will be given in Room MS 4000A, Mathematical Sciences Building.

There will be two special sessions of selected twenty-minute papers. Professor Theodore W. Gamelin of the University of California, Los Angeles, is organizing a special session on Function Algebras and Related Areas. The speakers will be Alice Chang, Irving L. Glicksberg, Donald E. Marshall, Hugo Rossi, Donald E. Sarason, David A. Stegenga, and James Li-Ming Wang. Professor Nathaniel Grossman of the University of California, Los Angeles, is organizing a special session on Differential Geometry. The speakers will be John T. Burns, James B. Carrell, Mark Green, Stefan Hildebrandt, William Meeks, and Joel L. Weiner.

As usual, there will be sessions for contributed ten-minute papers. All sessions will be held in the Mathematical Sciences Building. Speakers who wish to use an overhead projector should communicate with the associate secretary in advance of the meeting. Late papers will be accepted for presentation at the meeting, but will not be listed in the printed program of the meeting.

There will be a meeting of the Association for Women in Mathematics from 12:10 p.m. to 1:00 p.m. in Room 5127, Mathematical Sciences Building.

The registration area will be in the fifth floor lobby of the Mathematical Sciences Building. Registration hours will be from 8:30 a.m. to 12:00 noon and from 1:00 p.m. to 2:30 p.m.

The following hotels and motels are located in Los Angeles near the UCLA campus. Reservations should be made directly with the hotel or motel. The rates listed were in effect in January 1974 and are subject to change; they do not include the six percent hotel-motel tax. Special UCLA discounts may be available. To obtain them, state that you are attending a conference at UCLA and would like the UCLA rate. The following codes apply: RT-restaurant; SP-heated swimming pool; TV-television.

<table>
<thead>
<tr>
<th>Hotel Name</th>
<th>Address</th>
<th>Phone No.</th>
<th>Single</th>
<th>Double</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARRIAGE HOUSE</td>
<td>930 Hilgard Avenue (90024)</td>
<td>(213) 475-8765</td>
<td>$38.00 up</td>
<td>$38.00 up</td>
<td></td>
</tr>
<tr>
<td>CENTURY WILSHIRE HOTEL</td>
<td>10776 Wilshire Boulevard (90024)</td>
<td>(213) 474-4506</td>
<td>$19.00-$28.00 up</td>
<td>$19.00-$28.00 up</td>
<td></td>
</tr>
<tr>
<td>CLAREMONT HOTEL</td>
<td>1044 Tiverton Avenue (90024)</td>
<td>(213) 473-0957</td>
<td>$17.00 up</td>
<td>$20.00 up</td>
<td>$14.00 up</td>
</tr>
<tr>
<td>HOLIDAY INN-WESTWOOD</td>
<td>10740 Wilshire Boulevard (90024)</td>
<td>(213) 475-8711</td>
<td>$17.00 up</td>
<td>$20.00 up</td>
<td>$14.00 up</td>
</tr>
<tr>
<td>TIVERTON TERRACE HOTEL</td>
<td>1052 Tiverton Avenue (90024)</td>
<td>(213) 473-0995</td>
<td>$17.00 up</td>
<td>$20.00 up</td>
<td>$14.00 up</td>
</tr>
<tr>
<td>WESTWOOD INN MOTOR HOTEL</td>
<td>10820 Wilshire Boulevard (90024)</td>
<td>(213) 474-1574</td>
<td>$9.43 up</td>
<td>$12.26 up</td>
<td>$14.15 up</td>
</tr>
</tbody>
</table>

The only eating facility on campus that will be open on Saturday is the COOP on the "A" level of Ackerman Union (open 9:30 a.m. to 5:30 p.m.). There are also food machines outside the fifth floor level of the Mathematical Sciences Building. A list of eating facilities on campus will be available at the registration desk.

The campus is located in Westwood Village and can be reached via the San Diego Freeway. Persons driving to the meeting should take the Wilshire Boulevard exit, drive east to Westwood Boulevard, and then drive north on Westwood to the UCLA campus. Parking on campus is $1.00 per day; parking permits can be purchased at the kiosk on the corner of Westwood and Circle Drive. Structures 8 and 9 are closest to the
Mathematical Sciences Building.

The Los Angeles International Airport is located approximately ten miles from the UCLA campus. Bus transportation from the airport is available on the "Airtransit" bus designated "Westwood-San Fernando Valley." This bus stops in front of each airline's baggage pickup area and the schedule is posted overhead. Fare from the airport is no more than $2.00 per person. You may disembark at the Holiday Inn-Westwood, which is located on the corner of Selby Avenue and Wilshire Boulevard, four blocks south of the UCLA campus. Car rentals may be obtained at the airport and also in Westwood Village near the campus. Taxi service is available from the airport to Westwood; the fare is approximately $8.00. There is a Yellow Cab stand and cab phone at Kirksey Center located on the northeast corner of the intersection of Westwood and Wilshire Boulevards (three blocks west of Holiday Inn).

PROGRAM OF THE SESSIONS

The time limit for each contributed paper in the general sessions is ten minutes and in the special sessions is twenty minutes. To maintain this schedule, the time limits will be strictly enforced.

SATURDAY, 9:00 A.M.

Special Session on Function Algebras and Related Areas I, Room 5117, Mathematical Sciences Building

9:00-9:20 (1) C*-algebras contained in subalgebras between L00 and H00. SUN-YUNG CHANG, University of California, Los Angeles (730-B12)

9:30-9:50 (2) The algebra generated by inner functions. ALAIN BERNARD, University of Grenoble, France, and JOHN B. GARNETT and DONALD E. MARSHALL*, University of California, Los Angeles (730-B4)

10:00-10:20 (3) Quasicontinuous functions. DONALD SARASON, University of California, Berkeley (730-B3)

10:30-10:50 (4) Sums of invariant subspaces. D. A. STEGENGA, Indiana University (730-B7)

SATURDAY, 9:30 A.M.

Special Session on Differential Geometry I, Room 5118, Mathematical Sciences Building


10:00-10:20 (6) Holomorphic maps to complex tori. MARK L. GREEN, University of California, Los Angeles (730-D5) (Introduced by Professor Nathaniel Grossman)

10:30-10:50 (7) Dirichlet's boundary value problem for harmonic mappings of Riemannian manifolds. Preliminary report. Professor STEFAN HILDEBRANDT* and HELMUT KAUL, University of Bonn, Germany, and KJELL-OVE WIDMAN, University of Linköping, Sweden (730-D1)

SATURDAY, 11:00 A.M.

Invited Address, Room 4000A, Mathematical Sciences Building

(8) The isoperimetric inequality. Professor ROBERT OSSERMAN, Stanford University

SATURDAY, 2:00 P.M.

Session on Analysis, Room 5127, Mathematical Sciences Building

2:00-2:10 (9) Convergence criteria for alternating series. Professor CARLOS A. INFANTOZZI, Universidad de la República, Montevideo, Uruguay (730-B2)


2:30-2:40 (11) Positive solutions of the equation \( E: D^p [p(t) D^p y(t)] = p(t[y [t - s])]. Dr. RAYMOND D. TERRY, California Polytechnic State University (730-B9)

2:45-2:55 (12) Once is not enough. Dr. F. DAVID LESLEY, San Diego State University (730-B10)

3:00-3:10 (13) Green's function with ring pole and applications to interpolation. Professor ALLAN FRYANT, U.S. Naval Academy, and Professor MORRIS MARDEN*, California Polytechnic State University (730-B1)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.
SATURDAY, 2:00 P.M.

**General Session,** Room 5128, Mathematical Sciences Building

2:00–2:10 (14) An Erdős-Rényi strong law for sample quantiles. Professor STEPHEN A. BOOK*, California State College, Dominguez Hills, and Professor DONALD R. TRUAX, University of Oregon (730–F1)

2:15–2:25 (15) The fixed-point property for homeomorphisms of almost chainable homogeneous continua. Professor CHARLES L. HACOPIAN, California State University at Sacramento (730–G1)

2:30–2:40 (16) Relations among generalized matrix functions. Professor RUSSELL MERRIS, California State University at Hayward (730–A2)

2:45–2:55 (17) Maximal cancellative subsemigroups and subarchimedeaness. Preliminary report. Ms. DEBORAH GALE* and Professor TAKAYUKI TAMURA, University of California, Davis (730–A3)

3:00–3:10 (18) An odd perfect number not divisible by 3 has at least ten prime factors. Mr. MASAO KISHORE, University of Toledo (730–A1)

SATURDAY, 2:00 P.M.

**Special Session on Function Algebras and Related Areas II,** Room 5117, Mathematical Sciences Building

2:00–2:20 (19) A generalization of a theorem of Sibony-Wermer. J. TAYLOR and H. ROSSI*, University of Utah (730–B5)

2:30–2:50 (20) The behaviour of the functions in R(X) near a point. JAMES LI-MING WANG, University of California, Los Angeles (730–B11)

3:00–3:20 (21) Some remarks on A-holomorphy. I. GLICKSBERG, University of Washington (730–B6)

SATURDAY, 2:00 P.M.

**Special Session on Differential Geometry II,** Room 5118, Mathematical Sciences Building

2:00–2:20 (22) Curvature structures on Lorentz 2-manifolds. Preliminary report. Dr. JOHN T. BURNS, University of Colorado (730–D4)

2:30–2:50 (23) Global properties of spherical curves. Professor JOEL L. WEINER, University of Hawaii (730–D2)

3:00–3:20 (24) Chern classes of the Grassmannians. JAMES B. CARRELL*, University of British Columbia, and DAVID I. LIEBERMAN, Brandeis University (730–D3)

SATURDAY, 3:30 P.M.

**Invited Address,** Room 4000A, Mathematical Sciences Building

(25) Applications of partial differential equations to differential geometry. Professor JERRY L. KAZDAN, University of California, Berkeley and University of Pennsylvania

Kenneth A. Ross
Associate Secretary

Eugene, Oregon
PRELIMINARY ANNOUNCEMENTS OF MEETINGS
The Eighty-Second Annual Meeting
San Antonio Convention Center
San Antonio, Texas
January 22 — 25, 1976

SHORT COURSE ON MATHEMATICAL ASPECTS OF PRODUCTION AND DISTRIBUTION OF ENERGY
January 20 — 21, 1976

The American Mathematical Society will present a two-day short course on Mathematical Aspects of Production and Distribution of Energy on Tuesday and Wednesday, January 20 and 21, in the Fiesta Rooms of the San Antonio Convention Center. The course is designed to acquaint mathematicians with the state of the art in energy-related research in applied mathematics.

The program is under the direction of a committee whose members are George B. Dantzig, Departments of Operations Research and Computer Science, Stanford University; Herbert B. Keller, Firestone Laboratory, California Institute of Technology; Peter D. Lax (chairman), Courant Institute of Mathematical Sciences, New York University; and Robert Marr, Brookhaven National Laboratory.

The short course is one of a series given by the Society on the recommendation of its Committee on Employment and Educational Policy, whose members are Michael Artin, Charles W. Curtis, Wendell H. Fleming (chairman), Calvin C. Moore, Martha K. Smith, and Daniel H. Wagner.

The program will consist of eight one-hour lectures providing concentrated introductions to several different areas of current activity, making it possible for participants to judge whether they would be interested in pursuing any of these areas further. Jean Abadie, Electricite de France, will speak on "Large scale nonlinear optimization problems arising in power production"; George B. Dantzig will speak on "A model for assessing physical impact on the economy of a changing energy picture", joint work with S. C. Parikh, Systems Optimization Laboratory, Stanford University; Richard L. Garwin, IBM Thomas J. Watson Research Center, will speak on "The problem of aggregation in modeling physical and social systems and processes"; Harold Grad, Courant Institute of Mathematical Sciences, New York University, will speak on "Mathematical problems arising in controlled thermonuclear research"; William W. Hogan, Office of Quantitative Methods, Federal Energy Administration, will speak on "Project Independence evaluation system"; Gordon M. Kaufman, Sloan School of Management, Massachusetts Institute of Technology, will speak on "Estimation of undiscovered oil and gas", joint work with Eytan Barouch, Sloan School of Management, Massachusetts Institute of Technology and Clarkson College of Technology; Milton S. Plesset, Engineering Science Department, California Institute of Technology and Clarkson College of Technology; and Frederick D. Tappert, Courant Institute of Mathematical Sciences, New York University, will speak on "Laser fusion."

The lecture by Richard Garwin will be held on Wednesday, January 21, at 8:30 p.m. and is open both to short course registrants and to the public. Dr. Garwin is chairman of the IBM Task Force on Energy, and his lecture will be of general interest to the community.

Summaries of these talks and accompanying reading lists appear on pages A-740 through A-743 of this issue of the Notices.

EIGHTY-SECOND ANNUAL MEETING
January 22 — 25, 1976

The eighty-second annual meeting of the American Mathematical Society will be held in San Antonio, Texas, from Thursday, January 22 through Sunday, January 25, 1976. All sessions will be held in the San Antonio Convention Center, located at the corner of Market and South Alamo Streets.

The forty-ninth Josiah Willard Gibbs Lecture will be presented by Arthur S. Wightman, Department of Physics, Princeton University, at 8:30 p.m. on Thursday, January 22. The title of his lecture is "Nonlinear functional analysis and some of its applications in quantum field theory."

There will be one series of Colloquium Lectures, to be delivered by Isadore M. Singer of Massachusetts Institute of Technology and the Institute for Advanced Study. His subject is "Connections between analysis, geometry, and topology." The four lectures in the series are scheduled for 1:00 p.m. on January 22, 23, 24, and 25.

The Oswald Veblen Prize in Geometry will be awarded at a session at 3:30 p.m. on Friday, January 23.
By invitation of the Committee to Select Hour Speakers for Summer and Annual Meetings, there will be eleven invited one-hour addresses as follows: Peter L. Duren, University of Michigan, 10:30 a.m., Friday; Edwin E. Floyd, University of Virginia, 2:30 p.m., Sunday; Stephen M. Gersten, University of Utah, 2:30 p.m., Saturday; David M. Goldschmidt, University of California, Berkeley, 2:30 p.m., Thursday; Arshag B. Hajian, North-eastern University, 4:00 p.m. Thursday; Melvin Hochster, Purdue University, 4:00 p.m. Saturday; Donald A. Martin, Rockefeller University, 9:00 a.m. Thursday; Peter May, University of Chicago, 4:00 p.m. Sunday; Charles F. Miller III, Princeton University, 10:30 a.m. Thursday; Walter Noll, Carnegie-Mellon University, 9:00 a.m. Friday; and Frank L. Spitzer, Cornell University, 2:15 p.m. Friday. Professor Spitzer's title is 'Time evolutions of one-dimensional systems whose equilibrium state is a renewal process', the titles of the other hour lectures will be announced in the January issue of these Notices.

By invitation of the same committee, there will be twenty-two special sessions of selected twenty-minute papers. The titles of these special sessions and the names of the mathematicians arranging them may be found in the separate listing in the section entitled SPECIAL SESSIONS.

There will be sessions for contributed ten-minute papers on Thursday morning and afternoon, Friday morning and afternoon, Saturday afternoon, and Sunday afternoon. Abstracts should have been sent to the American Mathematical Society so as to arrive by the abstract deadline of November 5. Those having time preferences for the presentation of their papers should have so indicated clearly on their abstracts. In late afternoons, authors will be asked questions for changing the times of presentation of papers cannot be honored if received after November 5. There will be no provision whatsoever for the presentation of late papers.

Those contributing abstracts were asked to consider the possibility of presenting their papers in poster sessions. Poster sessions provide an alternative method of presentation in which authors post their material on easels or bulletin boards and stand by to answer questions and provide further details. Those interested in using this method of presentation should have mentioned this conspicuously on their abstracts. If there is sufficient interest in presentation by the poster method, poster sessions will be scheduled at all the times available for sessions of contributed papers.

The AMS Committee on Employment and Educational Policy will hold a panel discussion on "The changing role of the masters' degree" on Friday evening, January 23, at 8:30 p.m. Lida K. Barrett of the University of Tennessee will be the moderator. A partial list of other speakers appears in the SUMMARY OF ACTIVITIES. The same committee is planning a panel and open discussion on nonacademic employment at 4:30 p.m. on Saturday, January 24, moderated by Burton H. Colvin. A brief panel discussion will be followed by an open discussion with comments and suggestions welcomed from the audience. Names of other panel members will be announced later.

This meeting of the Society will be held in conjunction with the annual meeting of the Mathematical Association of America (Saturday, January 24, to Monday, January 26). At the Association's business meeting at 10:00 a.m. on Sunday, January 25, the Award for Distinguished Service to Mathematics and the Chauvenet Prize will be presented. The Association's program is centered about the Centennial. A more detailed listing of events appears in the SUMMARY OF ACTIVITIES, beginning on page 348.

The Association for Women in Mathematics will hold a panel discussion on "Women mathematicians in business, industry, and government" on Friday, January 23, at 10:30 a.m. This panel discussion will be immediately followed by the AWM business meeting. An open meeting of the AWM Executive Committee will take place at 7:00 p.m. on Thursday, January 22.

The Conference Board of the Mathematical Sciences will hold a panel discussion on "Issues in school-level mathematical education" at 2:00 p.m. on Saturday, January 24.

The Mathematicians Action Group will hold a panel discussion on "Open admissions programs" at 9:00 a.m. on Saturday, January 24, and an open meeting of its Steering Committee at 10:00 a.m. on Wednesday, January 21. The MAG business meeting will take place at 1:30 p.m. on Friday, January 23.

The National Association of Mathematicians will hold its business meeting at 11:00 a.m., and a panel discussion on "Some programs at traditionally black institutions" at 1:00 p.m. on Sunday, January 25. There will also be an invited address at 9:00 a.m. on Sunday.

There will be a breakfast and award ceremony on Saturday, January 24, at which the University of Texas at Austin Prize in Mathematics will be presented. Tickets for the breakfast will be on sale at the Local Information Desk in the Convention Center.

SPECIAL SESSIONS


DONALD J. BROWN of Yale University is organizing a special session on Mathematical Economics. The list of speakers will be announced in the January issue of this * Notices*. CHARLES R. DEPRIMA of California Institute of Technology is organizing a special session on Functional analysis methods for nonlinear partial differential equations. The tentative list of speakers includes Stuart S. Antman, Felix E. Browder, W. V. Petryshyn, and David A. Sattinger, SAMUEL GITLER of the Instituto Politecnico Nacional is organizing a special session on Homotopy theory. The list of speakers will be announced in the January issue of this * Notices*. SAMUEL I. GOLDBERG of the University of Illinois at Urbana-Champaign is organizing a special session on Curvature and analysis. The tentative list of speakers includes Michael J. Cowen, Kyung T. Hahn, Z. HarEl, Toru Ishihara, Peter Kienan, Myung He Kwack, Josephine M. Mitchell, Nicholas Z. Petrides, Jonathan Sachs, Jaak Vidms, and R. O. Wells, Jr. EDWARD L. GREEN of the University of Illinois at Urbana-Champaign is organizing a special session on Representation of groups and algebras. The tentative list of speakers includes Shimson A. Amitsur, Vlastimil Dlab, Kent R. Fuller, Robert Gordon, William H. Gustafson, Israel N. Herstein, Arun V. Jategaonkar, Bruno J. W. Mueller, Murray M. Schacher, and Lance W. Small. ARTHUR M. JAFFE of Harvard University is organizing a special session on Quantum field theory. The tentative list of speakers includes J. Fröhlich, Arthur M. Jaffe, Edward Nelson, Konrad Osterwalder, and T. Spencer. It is hoped that this session can be coupled with a session of contributed papers on quantum field theory. H. ELTON LACEY of the University of Texas at Austin is organizing a special session on Banach spaces. The tentative list of speakers includes Dale E. Alspach, Graham Bennett, Simon J. Bernau, William J. Davis, Leonard E. Dor, Robert E. Huff, Robert C. James, William B. Johnson, Peter D. Morris, Edward R. Odell, and Haskell L. Rosenthal. LEE LORCH of York University is organizing a special session on Special functions: Sources, applications, and current developments. The tentative list of speakers includes Felix M. Arscott, Richard A. Askey, Iswar C. Chakravarty, James A. Donaldson, Charles F. Dunkl, Loyal Durand, George Gasper, Jr., Emil Grosswald, Andrew P. Guinand, Deborah T. Haimo, Velmer B. Headley, Isadore I. Hirschman, Jr., Mourad E.-H. I. Ismail, Nicholas D. Kazarinoff, Yudell L. Luke, Willard Miller, Jr., Benjamin Muckenhoupt, Martin E. Muldoon, Thomas J. Osler, Lowell Schoenfeld, Neil J. Sloane, Kusum K. Soni, Frank Stenger, James D. Talman, William F. French, and Jet Wimp.

COUNCIL AND BUSINESS MEETING

The Council of the Society will meet at 2:00 p.m. on Wednesday, January 21, in the LaVista Room of the Hilton Palacio del Rio. The business meeting of the Society will be held in the Theater in the Convention Center at 4:00 p.m. on Friday, January 23. 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."

MEETING PREREGISTRATION AND REGISTRATION

Registration for the short course only will begin on Monday, January 19, at 4:30 p.m. in the Fiesta Rooms at the Convention Center. Participants who are not attending the short course are advised that no general meeting information (or registration material) will be available prior to the time listed below for Joint Mathematics Meetings registration.

The Joint Mathematics Meetings registration desk will be located in the Banquet Hall of the Convention Center, and the following are the hours that the desks will be open:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Monday, January 19</td>
<td>4:30 p.m.–7:30 p.m.</td>
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<tr>
<td>Tuesday, January 20</td>
<td>8:00 a.m.–4:00 p.m.</td>
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<tr>
<td>Wednesday, January 21</td>
<td>8:00 a.m.–2:00 p.m.</td>
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Joint Mathematics Meetings

<table>
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<tr>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Wednesday, January 21</td>
<td>8:00 a.m.–8:00 p.m.</td>
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<tr>
<td>Thursday, January 22</td>
<td>8:00 a.m.–5:00 p.m.</td>
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<tr>
<td>Friday, January 23</td>
<td>8:00 a.m.–4:00 p.m.</td>
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<tr>
<td>Saturday, January 24</td>
<td>8:00 a.m.–4:00 p.m.</td>
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<tr>
<td>Sunday, January 25</td>
<td>8:00 a.m.–4:00 p.m.</td>
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<tr>
<td>Monday, January 26</td>
<td>8:30 a.m.–2:30 p.m.</td>
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</table>

Participants who wish to preregister for the meetings should complete the Meeting Preregistration Form on the last page of these Notice. Those who preregister will pay a lower registration fee than those who register at the meeting, as indicated in the schedule below. Preregistrants will be able to pick up their badges and programs when they arrive at the meeting. Complete instructions on procedures for making hotel and motel reservations are given in the section entitled ACCOMMODATIONS.

Checks for the preregistration fee should be mailed to arrive in Providence not later than December 19, 1975. It is necessary to complete the Meeting Preregistration Form on the last page of these Notice to take advantage of the lower meeting registration fee even though the services of the housing bureau are not required.

Meeting registration and preregistration fees partially cover expenses of holding the meetings. The preregistration fee does not represent an advance deposit for lodgings. Please note that separate registration fees are required for the Short Course and for the Joint Meetings. These fees are as follows:

<table>
<thead>
<tr>
<th>Preregistration</th>
<th>At Meeting</th>
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<tbody>
<tr>
<td>All participants</td>
<td>$12</td>
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<tr>
<td>Joint Mathematics Meetings</td>
<td></td>
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<tr>
<td>Member</td>
<td>$15</td>
</tr>
<tr>
<td>Student or unemployed member</td>
<td>2</td>
</tr>
<tr>
<td>Nomember</td>
<td>25</td>
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<tr>
<td>One-day fee for last day</td>
<td>6</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.

The unemployed status refers to any member currently unemployed and actively seeking employment. It is not intended to include members who have voluntarily resigned or retired from their last position.

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

A fifty percent refund of the preregistration fee will be made for all cancellations received in Providence prior to January 20. There will be no refunds granted for cancellations received after that date or to persons who do not attend the meetings.

MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

The Open Register will be maintained on Friday, Saturday, and Sunday, January 23–25, in the International Ballroom of the Hilton Palacio del Rio. The first full day of the Open Register (Friday) is for registration processes only. A short orientation session will be held in the Corte Real Room of the Hilton Palacio del Rio by the Joint Committee on Employment Opportunities on Friday morning at 9:00 a.m. The purpose of this session is to familiarize participants with the operation of the Open Register and with the registration procedure. Registration will begin at 9:30 a.m. on Friday in the International Ballroom, and will continue until 4:00 p.m. Applicants and employers must be registered for the Joint Mathematics Meetings.

Interviews will begin on Saturday at 9:00 a.m. and will continue to 5:00 p.m. An experimental evening session has been arranged for 7:30 p.m. on Saturday, for which a special matching will be done to arrange interviews between employers and applicants who mutually request appointments with one another. The duration of this evening session cannot be estimated at this
time, but will run until the last scheduled appoint­ment has been completed.

Interviews will resume on Sunday at 9:00 a.m., and will continue to 5:40 p.m.

An Open Register section will be located at the Joint Mathematics Meetings registration desk in the San Antonio Convention Center during the hours that desk is open through Thursday, January 22 (see page 343 for schedule). For the convenience of applicants and employers arriving at the meeting prior to the dates of the Open Register, registration material will be available at this desk and the registration process may be completed prior to the 4:00 p.m. deadline Friday; advance Open Register registration is not required. Requests for interviews cannot, however, be submitted until Friday, January 23.

CONSORTIUM FOR MODULAR MATHEMATICAL INSTRUCTION

In recent years there has been a prolifera­tion of modular instructional materials in college level mathematics, and the institution of a variety of systems of personalized study. In order for subsequent development to reflect common concerns, have wide spread applicability, and be of high quality, a national cooperative effort is necessary. A user-producer consortium will be formed during the next year to undertake the production and evaluation of new modular materials. Initial funding will be provided by the National Science Foundation through the offices of the Educational Development Center, Newton, Massachusetts. A one-day information and organization meeting will be held on January 21, 1976, in the San Antonio Convention Center, just prior to the Joint Mathematics Meetings. Invited speakers will include William F. Lucas, Professor and Director, Applied Mathematics Center, Cornell University. Anyone interested in this effort and/or in attending this meeting should write or call: Saul Garfunkel, Department of Mathematics, University of Connecticut, Storrs, Connecticut 06268, Telephone (202) 486-3922.

EXHIBITS

The book and educational media exhibits will be located in the Banquet Hall of the Convention Center from Thursday through Sunday, January 22-25. The exhibits will be open from 12:00 noon to 5:00 p.m., on Thursday, from 9:00 a.m. to 5:00 p.m. on Friday and Saturday, and from 9:00 a.m. to 12:00 noon on Sunday. All participants are encouraged to visit the exhibits during the meeting.

BOOK AND AUDIO TAPES SALE

Books published by the Society and the Association and audio tapes of invited addresses will be sold for cash prices somewhat below the usual prices when these same books and tapes are sold by mail.

ACCOMMODATIONS

The form for requesting accommodations will be found on the last page of these Notices. Please note that there are several choices of accommodations offered, varying from single occupancy to quadruple occupancy and suites. When completing lines 9 and 10 of the form, please keep in mind that not all hotels offer triple and/or quadruple occupancy, and be guided by this in your choice of hotel. It should be noted that all rooms set aside for quadruple occupancy contain two double beds.

The use of the housing services offered by the San Antonio Convention & Visitors Bureau requires preregistration for the meeting. Persons desiring accommodations should complete the appropriate form (or a reasonable facsimile) and send it to the Mathematics Meetings Housing Bureau, P.O. Box 6887, Providence, Rhode Island 02940. Reservations will be made in accordance with preferences indicated on the reservation form, insofar as this is possible, and all reservations will be confirmed. Deposit requirements vary from hotel to hotel, and participants will be informed of any such requirements at the time of confirmation. Requests for reservations should be mailed to arrive in Providence no later than December 19, 1975. DO NOT INCLUDE PAYMENT FOR YOUR HOUSING WITH YOUR MEETING PREREGRISTRATION FEE.

ALAMO TRAVELODGE

Singles $13.00
Doubles 16.00-$17.00
Twins 17.00
Triples 25.00
Quadruples 28.00

BLUE BONNET HOTEL

Singles $11.95-$15.80
Doubles 14.70- 19.75
Twins 17.10- 22.40
Triples 20.05- 25.70
Quadruples 27.65
Singles 32.50- 45.00

CROCKETT HOTEL

Singles $11.75-$13.00
Doubles 15.50
Twins 17.50
Triples 19.50
Quadruples 23.00
Suites 35.00

CROCKETT MOTOR INN

(All rooms have two double beds)
Singles $16.00
Doubles/Twins 21.00
Triples 23.00
Quadruples 25.00

DOWNTOWNER MOTOR HOTEL

Singles $11.00
Doubles 14.00-$16.00
Twins 16.00
Triples 18.00
Quadruples 18.00

EL TROPICANO MOTOR HOTEL

Singles $21.00-$29.00
Doubles/Twins 26.00- 34.00
Triples 31.00- 39.00
Quadruples 36.00- 44.00
Singles 55.00- 150.00

GRANADA INN

(All rooms have two double beds)
Doubles/Twins $17.00
Triples 20.00
Quadruples 23.00
1. Alamo Travelodge
2. Blue Bonnet Hotel
3. Crockett Hotel
4. Crockett Motor Inn
5. Downtowner Motel
6. El Tropicano Motor Hotel
7. Granada Inn
8. Gunter Hotel
9. Hilton Palacio del Rio Hotel
10. Holiday Inn - San Antonio - Alamo Area
11. La Mansion Motor Hotel
12. La Quinta-Convention Center
13. Travelodge at Courthouse Square
14. Menger Hotel and Motor Inn
15. Rodeway Inn No. 103
16. St. Anthony Hotel
17. St. Mary's Travelodge
18. Wayfarer Motel
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<th>Hotel Name</th>
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<th>Triples</th>
<th>Quadruples</th>
<th>Suites</th>
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<tr>
<td>GUNTER HOTEL</td>
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<td>$55.00-$61.00</td>
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<tr>
<td>LA MANSION MOTOR HOTEL</td>
<td>$22.00-$30.00</td>
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<td>$32.00</td>
<td>$36.00-$44.00</td>
<td>$40.00-$115.00</td>
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<tr>
<td>LA QUINTA-CONVENTION CENTER</td>
<td>$13.50</td>
<td>$16.00-$18.00</td>
<td>$21.00</td>
<td>$24.00</td>
<td>$38.00</td>
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<tr>
<td>MENDER HOTEL</td>
<td>$18.75-$26.00</td>
<td>$21.75-$28.00</td>
<td>$30.00</td>
<td>$38.00</td>
<td>$58.00-$82.00</td>
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<tr>
<td>RODEWAY INN</td>
<td>$11.00</td>
<td>$15.00</td>
<td>$18.00</td>
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<tr>
<td>ST. ANTHONY HOTEL</td>
<td>$22.00</td>
<td>$32.00</td>
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<tr>
<td>ST. MARY’S TRAVELODGE</td>
<td>$14.00</td>
<td>$16.00-$18.00</td>
<td>$18.00</td>
<td>$21.00</td>
<td>$24.00</td>
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<tr>
<td>TRAVELODGE AT COURTHOUSE SQUARE</td>
<td>$16.00</td>
<td>$22.00</td>
<td>$26.00</td>
<td>$30.00</td>
<td>$75.00</td>
</tr>
<tr>
<td>WAYFARER MOTEL</td>
<td>$12.75</td>
<td>$19.75</td>
<td>$21.75</td>
<td>$23.75</td>
<td>$24.75</td>
</tr>
</tbody>
</table>

Participants, who are able to do so, are urged to share a room whenever possible. This procedure will be economically beneficial. Lines 9 and 10 of the Room Reservation Form should be completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide on Line 9 the names of each person with whom they plan to share a room. (It should be noted that all rooms set aside for quadruple occupancy contain two double beds.) Each person, however, should complete a separate preregistration form. It would be helpful (but it is not essential) to receive in Providence at the same time the forms from all parties wishing to share the same room.

NATIONAL SCIENCE FOUNDATION

NSF staff members will be available to provide counsel and information on NSF programs of interest to mathematicians from 9:00 a.m. to 5:00 p.m. on January 23, 24, and 25.

PUBLIC RELATIONS AND PUBLICITY

The American Mathematical Society and the Mathematical Association of America are jointly supporting a public relations and publicity program for the meetings. Under the co-directorship of Dale W. Lick, Old Dominion University, and Frederick J. Carter, St. Mary’s College, arrangements will be made and material prepared for news releases, newspaper articles, radio and television programming, and general information concerning mathematics and other activities at the meetings. Any assistance you might lend these efforts would be greatly appreciated. Meeting registrants are invited to stop by the press room to learn more about these activities. Suggestions for improving these efforts on behalf of mathematics are also welcomed.

ENTERTAINMENT AND LOCAL INFORMATION

The Paseo del Rio, an arm of the San Antonio River, extends for about two and one-half miles through the center of the city. Located on the river are several of the major hotels, as well as restaurants, shops, craftsmen, and art galleries. Small river taxis ply the river, and one may go from one end of the river to the other for $1. The banks of the Paseo del Rio are beautifully landscaped, and a walkway known as the "River Walk" extends the length of the river with frequent egresses to hotels and shops away from the river. The Convention Center is at one end of the Paseo del Rio. Among the many places of interest are the Alamo (including the Alamo Museum); Brackenridge Park, which has a Chinese Sunken Garden, a one-fifth scale model of a diesel train, and the San Antonio Zoo, ranked as one of the finest in the world; the Hertzberg Circus Collection; La Villita and the Arneson River Theater, a small historic Mexican village and an open air theater; the five Missions of San Antonio, founded between 1720 and 1731; and the Spanish Governor's Palace.

San Antonio has a large number of excellent restaurants, including many open air and sidewalk cafes. While the cuisine is slanted toward
the Mexican, restaurants serving the food of continental Europe are in abundance. The Hilton Palacio Del Rio, directly opposite the Convention Center, has a river level dining room, a sidewalk cafe on the river bank, and a mezzanine coffee shop.

Sightseeing tours of historical buildings and other various points of interest around the city are planned, and possibly a one-day shopping trip by bus across the border to Mexico. More information on these tours will appear in a later issue of these Notices.

The Local Arrangements Committee has planned a "Tamalada" for 9:00 p.m. on Friday, January 23. This will include the serving of tamales or tacos, beer and/or soft drinks, strolling mariachis, and other entertainment in the way of singing and dancing. Details on the exact place and the cost (if any) will appear in a later issue of these Notices.

On Saturday evening at 8:45 p.m., there will be a recital of music for piano and cello, performed by mathematicians Leonard Gillman, University of Texas, and Louis Rowen, Bar Ilan University. The program will consist of sonatas by Bach, Beethoven, Brahms, and Chopin.

TRAVEL

In winter San Antonio is on Central Standard Time. There is regular airline service to the San Antonio International Airport by the following airlines: American, Braniff, Continental, Delta, Eastern, Mexicana, Southern, Texas International, and United Airlines. Amtrak operates train service into San Antonio, with one train daily arriving from the cities of Chicago, Los Angeles, New Orleans, and New York.

WEATHER

The location of San Antonio on the edge of the Gulf Coastal Plains results in a modified subtropical climate, predominantly continental during the winter months. Normal mean temperature during the month of January is 52°. Mild weather prevails during the winter months with below-freezing temperatures occurring on an average of about 20 days each year. For the past 35 years, the average daily maximum temperature during the month of January has been 62.3° and the average daily minimum temperature has been 41.6°. In January the possibility of showers exists.

MAIL AND MESSAGE CENTER

All mail and telegrams for persons attending the meetings should be addressed to Mathematics Meetings, San Antonio Convention Bureau, P.O. Box 2277, San Antonio, Texas 78206. Mail and telegrams so addressed may be picked up at the registration area in the Banquet Hall of the Convention Center.

A message center will be located in the same area to receive incoming calls for all participants. The center will be open from January 21 through January 26 during the same hours as the Joint Meetings registration desk. Messages will be recorded, and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. Individuals planning on attending the meeting are advised to leave the following number with anyone who might want to reach them at the meeting: (512) 222-8061.

LOCAL ARRANGEMENTS COMMITTEE

Efraim Armendariz, Paul T. Bateman (ex officio), Frederick J. Carter, Walker E. Hunt, Constance J. Jones, Robert A. Northcutt, David P. Roselle (ex officio), Peter Terwey, Jr. (chairman), Gordon L. Walker (ex officio), and Stanley G. Wayment.

Urbana, Illinois

Paul T. Bateman
Associate Secretary
SUMMARY OF ACTIVITIES

The purpose of this summary is to provide assistance to registrants in the selection of arrival and departure dates. The program, as outlined below, is based on information available at press time.

<table>
<thead>
<tr>
<th>AMERICAN MATHEMATICAL SOCIETY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MONDAY, January 19</strong></td>
</tr>
<tr>
<td><strong>SHORT COURSE ON MATHEMATICAL ASPECTS OF PRODUCTION AND DISTRIBUTION OF ENERGY</strong></td>
</tr>
<tr>
<td>4:30 p.m. - 7:30 p.m.</td>
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<tr>
<td><strong>TUESDAY, January 20</strong></td>
</tr>
<tr>
<td>8:00 a.m. - 4:00 p.m.</td>
</tr>
<tr>
<td>10:00 a.m. - 11:00 a.m.</td>
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<tr>
<td>William W. Hogan</td>
</tr>
<tr>
<td>11:30 a.m. - 12:30 p.m.</td>
</tr>
<tr>
<td>Jean Abadie</td>
</tr>
<tr>
<td>2:00 p.m. - 3:00 p.m.</td>
</tr>
<tr>
<td>Gordon M. Kaufman</td>
</tr>
<tr>
<td>3:30 p.m. - 4:30 p.m.</td>
</tr>
<tr>
<td>George B. Dantzig</td>
</tr>
<tr>
<td><strong>WEDNESDAY, January 21</strong></td>
</tr>
<tr>
<td>8:00 a.m. - 2:00 p.m.</td>
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<tr>
<td>9:30 a.m. - 10:30 a.m.</td>
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<tr>
<td>Harold Grad</td>
</tr>
<tr>
<td>11:00 a.m. - noon</td>
</tr>
<tr>
<td>Frederick D. Tappert</td>
</tr>
<tr>
<td>1:30 p.m. - 2:30 p.m.</td>
</tr>
<tr>
<td>Milton S. Plesset</td>
</tr>
<tr>
<td>8:30 p.m. - 9:30 p.m.</td>
</tr>
<tr>
<td>Richard L. Garwin</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>AMS - MAA ANNUAL MEETINGS</th>
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</thead>
<tbody>
<tr>
<td><strong>WEDNESDAY, January 21</strong></td>
</tr>
<tr>
<td>American Mathematical Society</td>
</tr>
<tr>
<td>10:00 a.m. - noon</td>
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<tr>
<td></td>
</tr>
<tr>
<td>2:00 p.m.</td>
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<tr>
<td>2:00 p.m. - 8:00 p.m.</td>
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<tr>
<td><strong>THURSDAY, January 22</strong></td>
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<tr>
<td>8:00 a.m. - 5:00 p.m.</td>
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<tr>
<td>9:00 a.m. - 10:00 a.m.</td>
</tr>
<tr>
<td>Donald A. Martin</td>
</tr>
<tr>
<td>10:30 a.m. - 11:30 a.m.</td>
</tr>
<tr>
<td>Charles F. Miller, III</td>
</tr>
<tr>
<td>morning and afternoon</td>
</tr>
<tr>
<td>noon - 5:00 p.m.</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
</tr>
<tr>
<td>Connections between analysis, geometry, and topology</td>
</tr>
<tr>
<td>Isadore M. Singer</td>
</tr>
<tr>
<td>2:30 p.m. - 3:30 p.m.</td>
</tr>
<tr>
<td>David M. Goldschmidt</td>
</tr>
<tr>
<td>4:00 p.m. - 5:00 p.m.</td>
</tr>
<tr>
<td>Arshag B. Hajian</td>
</tr>
<tr>
<td>7:00 p.m. - 8:00 p.m.</td>
</tr>
<tr>
<td>Executive Committee - Open Meeting</td>
</tr>
<tr>
<td>8:30 p.m. - 9:30 p.m.</td>
</tr>
<tr>
<td>Nonlinear functional analysis and some of its applications in quantum field theory</td>
</tr>
<tr>
<td>Arthur S. Wightman</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Time</th>
<th>American Mathematical Society</th>
<th>Other Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. - 4:00 p.m.</td>
<td></td>
<td>REGISTRATION</td>
</tr>
<tr>
<td>9:00 a.m. - 9:30 a.m.</td>
<td></td>
<td>OPEN REGISTER ORIENTATION SESSION</td>
</tr>
<tr>
<td>9:30 a.m. - 4:00 p.m.</td>
<td></td>
<td>OPEN REGISTER</td>
</tr>
<tr>
<td>9:00 a.m. - 4:00 p.m.</td>
<td></td>
<td>Mathematical Association of America</td>
</tr>
<tr>
<td>9:00 a.m. - 5:00 p.m.</td>
<td></td>
<td>Board of Governors</td>
</tr>
<tr>
<td>morning and afternoon</td>
<td></td>
<td>EXHIBITS</td>
</tr>
<tr>
<td>9:00 a.m. - 10:00 a.m.</td>
<td>INVITED ADDRESS</td>
<td>Walter Noll</td>
</tr>
<tr>
<td>10:30 a.m. - 11:30 a.m.</td>
<td>INVITED ADDRESS</td>
<td>Peter L. Duren</td>
</tr>
<tr>
<td>10:30 a.m. - noon</td>
<td></td>
<td>AWM - Panel discussion: Women mathematicians in business, industry, and government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lenore Blum (moderator)</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td>COLLOQUIUM LECTURE II</td>
<td>isadore M. Singer</td>
</tr>
<tr>
<td>2:15 p.m. - 3:15 p.m.</td>
<td>INVITED ADDRESS</td>
<td>Time evolutions of one-dimensional systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>whose equilibrium state is a renewal process</td>
</tr>
<tr>
<td>3:30 p.m. - 4:00 p.m.</td>
<td>Prize Session</td>
<td>MAA - Film Program</td>
</tr>
<tr>
<td>4:00 p.m.</td>
<td>Business Meeting</td>
<td>The definite integral, a film of the MAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calculus Film Series</td>
</tr>
<tr>
<td>7:00 p.m. - 7:30 p.m.</td>
<td></td>
<td>Isometrics, a film of the College Geometry Project</td>
</tr>
<tr>
<td>7:30 p.m. - 8:30 p.m.</td>
<td></td>
<td>Powers of ten, a film by Charles Eames</td>
</tr>
<tr>
<td>8:30 p.m. - 10:30 p.m.</td>
<td></td>
<td>Films of the Topology Film Project</td>
</tr>
<tr>
<td>9:00 p.m.</td>
<td>TAMILADA</td>
<td>Regular homotopies in the plane, Part I</td>
</tr>
<tr>
<td>10:00 a.m. - 11:00 a.m.</td>
<td></td>
<td>Regular homotopies in the plane, Part II</td>
</tr>
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**SATURDAY, January 24**

<table>
<thead>
<tr>
<th>Time</th>
<th>AMS</th>
<th>Other Organizations</th>
</tr>
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<tbody>
<tr>
<td>7:00 a.m. - 7:45 a.m.</td>
<td>University of Texas at Austin Breakfast</td>
<td></td>
</tr>
<tr>
<td>7:45 a.m. - 8:30 a.m.</td>
<td>University of Texas at Austin Prize in Mathematics Award Ceremony</td>
<td></td>
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<tr>
<td>8:00 a.m. - 4:00 p.m.</td>
<td>REGISTRATION</td>
<td>EXHIBITS</td>
</tr>
<tr>
<td>9:00 a.m. - 5:00 p.m.</td>
<td>OPEN REGISTER</td>
<td>MAG - Panel discussion: Open admissions programs</td>
</tr>
<tr>
<td>9:00 a.m. - 10:00 a.m.</td>
<td></td>
<td>MAA - INVITED ADDRESS</td>
</tr>
<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td></td>
<td>Mathematics in colonial times</td>
</tr>
<tr>
<td>10:00 a.m. - 10:50 a.m.</td>
<td></td>
<td>Dirk J. Struik</td>
</tr>
<tr>
<td>11:00 a.m. - 11:50 a.m.</td>
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<td>MAA - INVITED ADDRESS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mathematics in America: The first hundred years</td>
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<tr>
<td></td>
<td></td>
<td>Judith V. Grabiner</td>
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<tr>
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<td></td>
<td>MAA - INVITED ADDRESS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some leaders in American mathematics (1891-1941)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garrett Birkhoff</td>
</tr>
<tr>
<td>SATURDAY, January 24</td>
<td>AMS</td>
<td>Other Organizations</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td><strong>afternoon</strong></td>
<td></td>
<td>Sessions for Contributed Papers</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td></td>
<td>COLLOQUIUM LECTURE III Isadore M. Singer</td>
</tr>
<tr>
<td>2:00 p.m. - 4:00 p.m.</td>
<td></td>
<td>Conference Board of the Mathematical Sciences Panel discussion: Issues in school-level mathematical education James T. Fey (moderator)</td>
</tr>
<tr>
<td>2:30 p.m. - 3:30 p.m.</td>
<td></td>
<td>INVITED ADDRESS Stephen M. Gersten</td>
</tr>
<tr>
<td>4:00 p.m. - 5:00 p.m.</td>
<td></td>
<td>INVITED ADDRESS Melvin Hochster</td>
</tr>
<tr>
<td>4:30 p.m. - 6:00 p.m.</td>
<td></td>
<td>Committee on Employment and Educational Policy Panel and open discussion: Non-academic employment Burton H. Colvin (moderator)</td>
</tr>
<tr>
<td>7:30 p.m.</td>
<td></td>
<td>OPEN REGISTER</td>
</tr>
<tr>
<td>7:30 p.m. - 8:20 p.m.</td>
<td></td>
<td>MAA - INVITED ADDRESS American mathematics from 1940 to the day before yesterday Paul R. Halmos</td>
</tr>
<tr>
<td>8:45 p.m.</td>
<td></td>
<td>CONCERT</td>
</tr>
<tr>
<td><strong>SUNDAY, January 25</strong></td>
<td></td>
<td>REGISTRATION</td>
</tr>
<tr>
<td>8:00 a.m. - 4:00 p.m.</td>
<td></td>
<td>EXHIBITS</td>
</tr>
<tr>
<td>9:00 a.m. - noon</td>
<td></td>
<td>OPEN REGISTER</td>
</tr>
<tr>
<td>9:00 a.m. - 5:40 p.m.</td>
<td></td>
<td>MAA - Panel discussion: Two-year college mathematics in 1976 Donald J. Albers Robert D. Larson (moderator) Peter A. Lindstrom Shelba J. Mormon</td>
</tr>
<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td></td>
<td>National Association of Mathematicians Invited Address</td>
</tr>
<tr>
<td>9:00 a.m. - 10:00 a.m.</td>
<td></td>
<td>MAA - Business Meeting Presentation of Award for Distinguished Service to Mathematics and Chauvenet Prize</td>
</tr>
<tr>
<td>10:00 a.m. - 10:50 a.m.</td>
<td></td>
<td>MAA - Panel discussion: Mathematics in our culture Morris Kline Robert H. McDowell (moderator) Robert A. Rosenbaum</td>
</tr>
<tr>
<td>11:00 a.m. - 11:50 a.m.</td>
<td></td>
<td>NAM - Business Meeting</td>
</tr>
<tr>
<td>11:00 a.m. - noon</td>
<td></td>
<td>NAM - Panel discussion: Some programs at traditionally black institutions</td>
</tr>
<tr>
<td><strong>afternoon</strong></td>
<td></td>
<td>CBMS - Council Meeting</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td></td>
<td>Sessions for Contributed Papers</td>
</tr>
<tr>
<td>1:00 p.m. - 2:00 p.m.</td>
<td></td>
<td>COLLOQUIUM LECTURE IV Isadore M. Singer</td>
</tr>
<tr>
<td>2:00 p.m. - 6:00 p.m.</td>
<td></td>
<td>MAA - Film Program</td>
</tr>
<tr>
<td>2:30 p.m. - 3:30 p.m.</td>
<td></td>
<td>Errors that die, a BBC Broadcast as part of the Open University Foundation Course In Mathematics (black and white)</td>
</tr>
<tr>
<td>4:00 p.m. - 5:00 p.m.</td>
<td></td>
<td>Newton's equal areas, a film produced by Bruce and Katherine Cornewell</td>
</tr>
<tr>
<td>4:00 p.m. - 5:00 p.m.</td>
<td></td>
<td>Shapes of the future, some unsolved problems in geometry, Part II, Three dimensions with Victor Klee, a film of the MAA Individual Lectures Film Project</td>
</tr>
</tbody>
</table>

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# SUMMARY OF ACTIVITIES

<table>
<thead>
<tr>
<th>SUNDAY, January 25</th>
<th>American Mathematical Society</th>
<th>Other Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:05 p.m. - 8:17 p.m.</td>
<td>MAA - Film Program</td>
<td>Inversion, a film of the College Geometry Project</td>
</tr>
<tr>
<td>8:20 p.m. - 9:20 p.m.</td>
<td>The Kakeya problem, with A. S. Besicovitch, a film of the MAA Mathematics Today Series</td>
<td>CBMS - Council Meeting</td>
</tr>
<tr>
<td>8:00 p.m. - 10:00 p.m.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>MONDAY, January 26</th>
<th>AMS</th>
<th>Mathematical Association of America</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m. - 2:30 p.m.</td>
<td>REGISTRATION</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m. - 9:50 a.m.</td>
<td>INVITED ADDRESS</td>
<td>Mathematics and the government: The postwar years as augury of the future</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mina S. Rees</td>
</tr>
<tr>
<td>10:00 a.m. - 10:50 a.m.</td>
<td>Panel discussion: The teaching of mathematics in college: A 1976 perspective for the future</td>
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<tr>
<td></td>
<td></td>
<td>Israel N. Herstein</td>
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<td></td>
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<td>Peter J. Hilton</td>
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<td></td>
<td></td>
<td>Carroll V. Newsom (moderator)</td>
</tr>
<tr>
<td>11:00 a.m. - 11:50 a.m.</td>
<td>INVITED ADDRESS</td>
<td>The history of computing in the United States</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Richard W. Hamming</td>
</tr>
<tr>
<td>2:00 p.m. - 2:50 p.m.</td>
<td>INVITED ADDRESS</td>
<td>European mathematicians in America, 1940-1960</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peter D. Lax</td>
</tr>
<tr>
<td>3:00 p.m. - 3:50 p.m.</td>
<td>Panel discussion: The role of applications in the teaching of undergraduate mathematics</td>
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<tr>
<td></td>
<td></td>
<td>Fred S. Roberts</td>
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<tr>
<td></td>
<td></td>
<td>Sherman K. Stein (moderator)</td>
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<tr>
<td></td>
<td></td>
<td>Alfred B. Willcox</td>
</tr>
<tr>
<td>4:00 p.m. - 4:50 p.m.</td>
<td>INVITED ADDRESS</td>
<td>Probability theory: Reflections on the past and speculations on the future</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mark Kac</td>
</tr>
</tbody>
</table>
Symposium on Some Mathematical Questions in Biology
Boston, Massachusetts
February 24, 1976

The tenth annual symposium on Some Mathematical Questions in Biology will be held on Tuesday, February 24, 1976, at the Sheraton Boston Hotel in Boston, Massachusetts. The symposium is being held in conjunction with the annual meeting of the American Association for the Advancement of Science (February 18–24), and will be cosponsored by the American Mathematical Society and the Society for Industrial and Applied Mathematics. The support of the National Science Foundation is anticipated. Registration and local information will be announced in the November 14 issue of Science.

The program has been arranged by the AMS-SIAM Committee on Mathematics in the Life Sciences, whose members are Hans J. Bremermann, Jack D. Cowan, Murray Gerstenhaber, Simon A. Levin (chairman), Richard C. Lewontin, Robert M. May, George F. Oster, and Sol I. Rubinow.

The symposium will be divided into two half-day sessions; the main topics of the symposium will be biomechanics, developmental biology and immunology. There will be six fifty-minute lectures presented in these two sessions. A partial list of speakers and their titles is as follows:

- George I. Bell, Los Alamos Scientific Laboratory, "Mathematical models in immunology"; 
- Stuart Kauffman, University of Pennsylvania School of Medicine, "Is the mitotic clock a limit cycle oscillator?" (title tentative); 
- Hans Othmer, Rutgers University, "Current problems in pattern formation"; and 
- Sol I. Rubinow, Cornell University Graduate School of Medical Sciences, "Some problems of fluid mechanics in biology." 

A complete program of the sessions will be included in the January issue of these Notices.

Please note that the session for twenty-minute papers, scheduled for Monday, February 23, has been cancelled. Abstracts already submitted for this session will be considered for publication by title in these Notices.

Simon A. Levin, Chairman
Organizing Committee
Tenth Annual AMS-SIAM Symposium on Some Mathematical Questions in Biology

Ithaca, New York

The Seven Hundred Thirty-Second Meeting
Florida Agricultural and Mechanical University
Tallahassee, Florida
March 4–5, 1976

The seven hundred thirty-second meeting of the American Mathematical Society will be held at the Florida Agricultural and Mechanical University in Tallahassee, Florida, from noon Thursday, March 4, until noon, Friday, March 5, 1976. The meeting of the American Mathematical Society will be followed by a meeting of the Southeastern Section of the Mathematical Association of America.

By invitation of the Committee to Select Hour Speakers for the Southeastern Sectional Meetings, there will be three one-hour addresses presented. The speakers will be Professor B. J. Ball of the University of Georgia, Professor Leonard Carlitz of Duke University and Professor Rudolf E. Kalman of the University of Florida.

There will be four special sessions at this meeting. Professor Heron Collins of Louisiana State University is organizing a special session on Functional Analysis; Professors Robert Gilmer and Joe Mott of Florida State University are organizing a special session on Commutative Rings; Professor Mary-Elizabeth Hamstrom of the University of Illinois is organizing a special session on Geometric Topology and Professor Leonard J. Scott of the University of Virginia is organizing a special session on Finite Groups. Any member of the American Mathematical Society who would like to have his or her paper considered for inclusion in one of the special sessions should have his or her abstract so marked and in Providence at least three weeks before the regular closing date for contributed papers, or by December 18, 1975.

There will also be sessions for contributed papers on Thursday and Friday. Abstracts for contributed papers 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 January 8, 1976.

O. G. Harrold
Associate Secretary

Tallahassee, Florida
The seven hundred thirty-third meeting of the American Mathematical Society will be held at the University of Illinois at Urbana-Champaign from Monday, March 15, through Saturday, March 20, 1976. The sessions of the meeting will be held in Altgeld Hall, the headquarters of the Department of Mathematics, and in other nearby classroom buildings of the university.

The period March 15–18 will be devoted to a symposium on Probability; the support of the National Science Foundation is expected under a proposed grant to the American Mathematical Society. The topic of the symposium was selected by the 1974 Committee to Select Speakers for Western Sectional Meetings, which consisted of Richard A. Askey, Paul T. Bateman (chairman), and Donald J. Lewis. The organizing committee for the symposium, responsible for selecting the speakers and arranging the symposium program, consists of Kai Lai Chung, Joseph L. Doob (chairman), Richard M. Dudley, Ronald K. Getoor, Frank B. Knight, and Frank L. Spitzer. The symposium will consist of about fifteen half-hour lectures and a smaller number of hour lectures. The list of speakers will include Donald L. Burkholder, Naresh C. Jain, Frank B. Knight, Paul–André Meyer, P. Warwick Millar, Mark A. Pinsky, and Daniel W. Stroock.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings there will be three invited one-hour addresses. Professor Paul Erdős of the Hungarian Academy of Sciences will address the Society at 11:00 a.m. on Friday, March 19, Professor Stephen Wainger of the University of Wisconsin and the Institute for Advanced Study will give an hour talk at 1:45 p.m. on Friday, March 19, Professor Hugh L. Montgomery of the University of Michigan will speak at 11:00 a.m. on Saturday, March 20. The titles of all three hour addresses will be announced in the January and February Notices.

By invitation of the same committee there will be six special sessions of twenty-minute papers, to be held Friday and Saturday. The subjects of these special sessions and the names of the mathematicians organizing them are as follows: Enumerative Combinatorics, Jay R. Goldman; Numerical Solution of Ordinary Differential Equations, Rolf Jeltsch; Inequalities in Mathematical Physics, Andrew Lenard; Axiomatic Potential Theory, Peter A. Loeb; Partial Differential Equations of Sobolev Type, Ralph E. Showalter; Tutorial on Information Theory, Part I, Probabilistic Theory, and Part II, Algebraic Coding Theory, David Spiegel. Most of the papers to be presented at these special sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract and submit it by December 18, 1975, three weeks before the normal deadline for contributed papers.

There will be sessions for contributed papers on Friday morning, Friday afternoon, and Saturday morning. Abstracts should be sent to the American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940, so as to arrive by the abstract deadline of January 8. (Recall that a typing charge of $7 is imposed on abstracts that are not in camera-ready form.) Those having time preferences for the presentation of their papers should indicate them clearly on their abstracts in large block letters. There will be a session for late papers if needed, but late papers will not be listed on the printed program of the meeting.

ACCOMMODATIONS

The hotel headquarters for the meeting will be the Century 21 Hotel, four block west of Altgeld Hall. Advance reservations are essential, since there will be a high school basketball tournament in Urbana-Champaign on Friday and Saturday, March 19–20. A reservation form will be included in the January Notices. Dormitory accommodations will be available, but only for Monday, Tuesday, Wednesday, and Thursday nights.

Paul T. Bateman
Associate Secretary

Urbana, Illinois

NEWS ITEMS AND ANNOUNCEMENTS

NOTICES TO PUBLISH CLASSIFIED ADVERTISING

Starting in the January 1976 issue, the Notices will publish classified advertising. Suggested uses 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 will be $2.50 per line, or $20 per column inch. Ads must be prepaid. To calculate the length of your ad assume that one line will accommodate 52 characters and spaces and that nine lines measures an inch. Give your own name and address for replies, since the Notices will not handle any anonymous ads except for those in "Situations Wanted".

Deadlines for the next few issues are:

<table>
<thead>
<tr>
<th>Month</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>December 8, 1975</td>
</tr>
<tr>
<td>February</td>
<td>January 26, 1976</td>
</tr>
<tr>
<td>April</td>
<td>March 1, 1976</td>
</tr>
<tr>
<td>June</td>
<td>May 11, 1976</td>
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<td>August</td>
<td>July 5, 1976</td>
</tr>
</tbody>
</table>

Send ad and check to:
Advertising Department
AMS, P. O. Box 6248
Providence, Rhode Island 02940
ORGANIZERS AND TOPICS OF SPECIAL SESSIONS

Abstracts of contributed papers to be considered for possible inclusion in special sessions should be submitted to Providence by the deadlines given below and should be clearly marked "For consideration for special session on (title of special session)." Those papers not selected for special sessions will automatically be considered for regular sessions unless the author gives specific instructions to the contrary.

San Antonio, Texas, January 1976
Robert E. Beck and Bernard Kolman, Computers in the Study of Non-Associative Rings and Algebras
Klaus R. Bichteler, Applications of Vector Measures
Louis Brickman, Univalent Functions
Donald J. Brown, Mathematical Economics
Samuel Gitler, Homotopy Theory
Samuel I. Goldberg, Curvature and Analysis
Edward L. Green, Representation of Groups and Algebras
Arthur M. Jaffe, Quantum Field Theory
H. Elton Lacey, Banach Spaces
Lee Lorch, Special Functions: Sources, Applications, and Current Developments
George G. Lorentz, Approximation Theory
Richard K. Miller and John A. Neibel, Volterra Integral Equations
Karl K. Norton, Number Theory
Elmor L. Peterson, Mathematical Programming Theory
Nestor M. Riviere, Variational Inequalities and Related Topics
J. Barkley Rosser, Uses of the Computer in Teaching Mathematics Courses
Bruce L. Rothschild and Ronald L. Graham, Extremal Problems for Finite Sets
Arthur Schlissel, How Does One Write a History of Mathematics?
John L. Selfridge, Computations and Algorithms in Number Theory
Olga Taussky-Todd, Integral Matrices in Algebra and Number Theory
Paul M. Weichsel, Varieties of Algebraic Structures

Tallahassee, Florida, March 1976
Heron Collins, Functional Analysis
Robert Gilmer and Joe Mott, Commutative Rings
Mary-Elizabeth Hamstrom, Geometric Topology
Leonard J. Scott, Finite Groups

Urbana, Illinois, March 1976
Jay R. Goldman, Enumerative Combinatorics
Rolf Jeltsch, Numerical Solution of Ordinary Differential Equations
Andrew Lenard, Statistical Mechanics
Peter A. Loeb, Axiomatic Potential Theory
Ralph E. Showalter, Partial Differential Equations of Sobolev Type
David Slepian, Tutorial on Information Theory, Part I, Probabilistic Theory, and Part II, Algebraic Coding Theory

INVITED SPEAKERS AT AMS MEETINGS

This section of these Notices lists regularly the individuals who have agreed to address the Society at the times and places listed below. For some future meetings, the lists of speakers are incomplete.

San Antonio, Texas, January 1976
Peter L. Duren
Edwin E. Floyd
Stephen M. Gersten
David M. Goldschmidt
Arshag B. Hajian
Melvin Hochster
Donald A. Martin
Peter May

Charles F. Miller III
Walter Noll
Isadore M. Singer (Colloquium Lecturer)
Frank L. Spitzer
Arthur S. Wightman (Gibbs Lecturer)

Tallahassee, Florida, March 1976
B. J. Ball
Leonard Carlitz

Rudolf E. Kalman

Urbana, Illinois, March 1976
Paul Erdős
Hugh L. Montgomery

Stephen Wainger
CASE STUDIES
Some Mathematicians with Nonacademic Employment

This is the fifth collection of case studies of mathematicians with nonacademic or nontraditional employment assembled by Professor Martha K. Smith of the University of Texas at Austin on behalf of the Society's Committee on Employment and Educational Policy. The first case studies appeared in the November 1974 issue of the Notices, and others were published in the February, June, and August 1975 issues.

STEVEN R. GIVANT
Oakland–Bay Area SEED Program

For five of the past eight years I have been employed by Project SEED, a nationwide program in which professional mathematicians teach advanced mathematics (high school and college level) on a daily basis to full-sized classes of elementary school children from poverty and minority backgrounds. I joined the project while still an undergraduate (a friend told me about the job) and continued teaching in it on a part-time basis (one-two classes) while attending graduate school at the University of California at Berkeley. (I received a Ph.D. in mathematics this year [1975].)

My area of specialization is logic and the foundations of mathematics, with a dissertation in model theory.

My present position, which I assumed in fall, 1973, is that of director of the Oakland–Bay Area SEED program. In this capacity I am responsible for the general administration of the local program. Included in this are various teaching-related duties (teaching demonstration classes, supervising the pedagogical training of mathematics specialists, writing curriculum), as well as the task (shared with the other directors and administrators) of securing funding for the program.

The basic requirement for teaching in the program is the equivalent of a major in mathematics. Many of the specialists have advanced mathematical degrees (M.A., Ph.D.) and there is an increasing number of professors who work in the project. No teaching credential is required. The overwhelming majority of the mathematics specialists come to SEED with little or no teaching experience at all. There is a training period in the Socratic (discovery) method of teaching (the instructional method underlying the program) which has been very successful in teaching mathematicians of diverse personalities into excellent teachers. One of the unusual and appealing characteristics of the program is that it gives specialists the choice of working from one-quarter-time to full-time, thereby enabling them to combine SEED work with other activities. There is ample opportunity for specialists to move into administrative positions. I have been delighted to observe that, to insure quality, the program requires its administrators to be excellent teachers.

Initially, I had serious doubts whether teaching children would provide much of an intellectual or mathematical challenge. To my surprise, I have found the give and take of Socratic teaching extremely stimulating (and this sentiment is shared by most of my colleagues). Indeed, the high level of intellectual involvement, abstract reasoning, and questioning on the part of children normally viewed as slow or rote learners by our society has become for me a special source of pride and satisfaction.

I believe a rather deep conceptual understanding of mathematics is necessary, not only in planning what to teach and how to teach it, but even more so in the actual classroom instruction: Asking thought-provoking questions which illuminate the concepts best; pursuing children's queries and responses (with sequences of questions which often must be devised "on the spot"); understanding the assumptions underlying off-beat answers, questions, and concerns of the children. Our most successful instructors are those who constantly try to gain new insights into the "old" mathematics they are teaching.

My advice to those who have read this far and are interested: You must forget the stereotypes regarding teaching at the elementary level (what can and cannot be taught) and those concerning the ability of "disadvantaged" children to think and reason abstractly. The key assets you can bring to such a job are a keen curiosity, and a desire to understand the reasoning behind students' answers (and not simply to determine the truth or falsity of the answers).

STANLEY J. BENKOSKI
Daniel H. Wagner, Associates

For the past fifteen months I have been employed by Daniel H. Wagner, Associates, a consulting firm in operations research and mathematics. We perform a variety of tasks for a wide range of clients, but the majority of our work is done for the U.S. Navy in the fields of anti-submarine warfare and the theory of search for lost objects.

Currently I am on a field assignment working directly for the Navy. My duties are quite varied, but generally I am assigned to perform as an operations research analyst. My duties have included individual studies without deadlines where I had the sole responsibility from data collection to final format, larger analytical efforts where I worked with many people and tight deadlines, and even ten days at sea at the Navy's expense. More specifically my duties have included analytical studies to determine which factors are influential in the success of a search effort, design of exercises to test hypotheses, studies to determine the optimal use of available resources, evaluation of current and proposed tactics, and the development of models to aid in the evaluations.

I received my Ph.D. from The Pennsylvania State University in 1973. My thesis was in the field of number theory and my mathematical train-
ing was almost entirely in pure mathematics. I took no courses in statistics, probability, applied mathematics or operations research.

My initial contact with my employer was at the job register at the annual meeting in Dallas in January 1973. This in-depth thirteen minute interview was followed by a visit to Daniel H. Wagner, Associates and my eventual employment there. I should point out that I did have two summers of "related" experience, one working as an operations research analyst in Washington, D.C., during the summer after I received my B.A., and the other as a mathematician for the U.S. Navy the next summer. I do not believe that these two jobs played any major role in my firm's decision to hire me, but it did indicate to them that I had some idea of the kind of work they were doing.

While I never took any computer science courses, I did become an adequate programmer. Computers can be an excellent tool for a number theorist; the results of one program I wrote are an integral part of a joint paper with P. Erdős.

Number theory is certainly not the cornerstone of my day-to-day work, but a mathematical background, the ability to do independent research, and some talent in problem solving are invaluable. The ability to recognize the problem, discern the key elements, perform the analysis, write it down in acceptable and intelligible style, and defend it against all comers is valuable in any endeavor, but especially so in the role of a consultant in operations research.

The importance of verbal and written skills arises from the need to explain mathematical ideas to a wide range of people extending from the mathematically naive to the very sophisticated. In this respect both my experience as a teacher and in presenting seminars under the critical eye of my professors and fellow graduate students proved valuable. As a practical recommendation to mathematics departments, more courses where each graduate student must present his own work in front of a critical audience would be worthwhile.

While there is much that mathematicians can do in industrial mathematics, I do not believe that many employers are interested in hiring a pure mathematician. If they desire a mathematico-cal type at all, they will most likely seek out a statistician, an applied mathematician, or a computer scientist. It may be the responsibility of the professional mathematical societies to educate the industrial employers to the potential use of mathematicians. This would probably accomplish much more than tinkering with current graduate programs.

This far I am very pleased with my choice of career. The work is varied and often exciting. It is thrilling to discover that your results can actually affect events. As an extra added attraction, I have learned the equivalent of a good undergraduate course in statistics. I do miss number theory and teaching. There is not much "extra" time for research; the best I have been able to do is to solve three problems for the Monthly and publish two articles based on my thesis.

Some recommendations for anyone considering employment outside of the academic world:

1. Broaden your mathematical background.
2. Try to get a part-time or summer job in a mathematical discipline—you will most likely be a programmer.
3. Start a series of seminars where you can present your own work or selected articles in front of a critical audience. Better yet, present such talks at a faculty seminar.
4. Get practical experience on a computer. Your university probably has one and might also give special crash courses in programming.
5. Find out as much as you can about exactly what it is that industrial mathematicians do.
6. Be honest with yourself about what you really want as a career.

ANONYMOUS
NASA Contractor

I have been employed for one year as a programmer/analyst with one of the NASA contractors working on the space shuttle. My company, which seems fairly typical of these contractors, might be thought of as a factory whose product is computer programs.

I received my Ph.D. six years ago from a large midwestern university and taught until recently at a smaller state university. My education and background included nothing even resembling applied mathematics. About two years ago, I began studying elementary programming, starting with FORTRAN and continuing to PL/I. This study was prompted by a genuine interest in computer science. I am sure my mathematics training helped me make rapid progress. I took a leave of absence and accepted my current job partly for the experience and partly to allow my spouse to study for an advanced degree.

I tried to obtain an academic job in my present city some time before moving but was unable to get even a visiting position. It was perhaps deceptively easy for me to find my present programming job after I moved. I undoubtedly got this job because I could claim (somewhat inflated) programming experience. Because of my Ph.D. I receive a larger salary than other programmers doing similar work. The person who hired me was confident I could do the work and was mainly concerned that I would become bored. This concern was well-founded, as the work gets repetitious even for the other programmers who mostly have a bachelor's in either mathematics or computer science.

The work can be interesting and even challenging, but to quote a physicist who used to work here: The company simply has no Ph.D.-level problems to solve. About the only thing I use is my programming knowledge, although small mathematical matters come up occasionally. On the positive side there has been time for private projects (against official company policy), and I have fairly free access to two large computers. There is room within my company for an ambitious career, but not a mathematical career, except perhaps in computer science.

Although this company occasionally hires beginning engineers who have never programmed, any mathematician looking for a job here needs to claim programming experience—the more the better. More experience would open up more challenging computer related positions.
The first part of this report concerns employment patterns for doctorate level mathematicians this fall. The second concerns student enrollments in mathematics and their relationship to employment of mathematicians. A report on graduate mathematics student phenomena is being prepared separately by Wendell H. Fleming. The data reported in the 1975 AMS survey have been obtained primarily on forms submitted by department chairmen. The current employment status of new Ph.D.'s also includes updated information supplied by some of the new Ph.D.'s themselves. The standard departmental AMS forms request some comparative data for two (or three) years. Thus the year by year changes are rather accurately recorded.

The employment pattern for doctorate level mathematicians in 1975 appears to have been quite similar to that of 1974. The AMS statistics assembled this summer indicate a slight worsening of employment opportunities both for new Ph.D.'s and for nonretained faculty members. However, anecdotal information from early this fall indicates that there was more last minute hiring than previously and, therefore, the overall picture may have been marginally better than a year ago. An apparent unexpectedly large increase in numbers of undergraduate students and, specifically under-

TABLE 1
1975–1976 EMPLOYMENT STATUS OF NEW DOCTORATES IN THE MATHEMATICAL SCIENCES

<table>
<thead>
<tr>
<th>Type of Employer</th>
<th>Algebra and Number Theory</th>
<th>Analysis and functional Analysis</th>
<th>Geometry and Topology</th>
<th>Logic</th>
<th>Probability</th>
<th>Statistics</th>
<th>Computer Science</th>
<th>Operations Research</th>
<th>Applied Mathematics</th>
<th>Mathematics Education</th>
<th>Other</th>
<th>Totals</th>
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<td>45</td>
<td>39</td>
<td>9</td>
<td>13</td>
<td>36</td>
<td>31</td>
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<td>11</td>
<td>9</td>
<td>18</td>
<td>27</td>
<td>4</td>
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<td>3</td>
<td></td>
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<td>Other academic departments and research institutes</td>
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<td>37</td>
<td>110</td>
<td>15</td>
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</table>

*This article comprises the second report based on the Nineteenth Annual AMS Survey, 1975. It was prepared by the author on behalf of the AMS Committee on Employment and Educational Policy whose members are Michael Artin, Charles W. Curtis, Wendell H. Fleming (chairman), Calvin C. Moore, Martha K. Smith, and Daniel H. Wagner. The data in the report were compiled by the AMS staff under the direction of Lincoln K. Durst. Special acknowledgement is made of the contribution of Ernest Davis to this effort.
graduate students taking mathematics courses, created some additional demand for (temporary) faculty at the end of the summer. There are perhaps three major trends in the AMS data that should be noted.

(1) In new pure mathematics Ph. D. degrees, there has been a decided shift: about 39% of the total came from Group I departments in 1974 while about 48% came from Group I departments in 1975. (Departmental classification is described in the box at the top of page 359.)

(2) Including a few departments still to report, there were marginally more pure mathematics doctorates granted in fiscal 1975 than in fiscal 1974, reversing a downward trend observable since 1971. (See Table 2.) However, data on numbers of graduate students and attrition rates strongly suggest that there will be a further downward trend over the next several years.

(3) As discussed in more detail later in this report, there was an increase of about 4% overall in mathematics course enrollments in four-year colleges and universities from fall 1973 to fall 1974. Anecdotal data suggests a further, perhaps even larger, increase from 1974 to 1975. This increase in student enrollment in mathematics courses should produce pressure for a somewhat larger national mathematics faculty over the next couple of years. Therefore, it seems likely that employment prospects will be slightly better next fall than was the case this fall. However, since economic and fiscal funding factors also control job

Full-Time Mathematics Faculty in Four-Year Colleges and Universities in the U.S.

Note: The total faculty listed for 1974–1975 has been adjusted upward by about 400 from estimates of a year ago because of more complete information. The distribution between doctorates and nondoctorates has correspondingly been adjusted.
In this article departments in mathematical sciences in U.S. universities and four-year colleges are classified as below. Groups I-V are departments with Ph.D. programs.

Group I: the top 27 ACE ranked mathematics departments
Group II: the other 38 ACE rated mathematics departments
Group III: 90 ACE unrated mathematics departments
Group IV: 64 statistics, biostatistics and biometry departments
Group V: 99 other mathematical science departments
Group M: 320 departments with masters' programs
Group B: 980 departments which offer at most bachelors' degrees

Note: Group B includes about 100 departments with no degree programs. Both M and B include some departments in universities which have doctoral programs in other areas, in some cases in other areas of the mathematical sciences.

For an account of the ACE ratings referred to above see "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 be found on pages 338-340 of the February 1971 issue of these Notices.

opportunities for faculty, there are enough uncertainties to make any short-term prediction highly problematical. There is no basis for longer term optimism that prospective higher percentages of student enrollments in the 1980s will offset the known substantial decline in numbers of those of college age in that period.

In Table 1, we give the matrix of new Ph.D.'s by mathematical areas together with the nature of their fall 1975 employment. The general pattern is quite similar to that of a year ago and, in fact, of several years ago. The figures given include all the new doctorates listed in the October 1975 Notices, pp. 309 ff., including Canadians. While the total number listed is slightly lower than that for 1974, it is known that some major departments had not reported in time for the October Notices and, thus, figures from such departments are not included. Projections to the total supply of new Ph.D.'s indicate little change in total numbers from 1974.

A comparison with last year's totals, as reported in the November 1974 Notices, shows an approximate 10% increase in statistics and computer science degrees, an increase from 111 to 147 in "not yet employed", but a drop from 90 to 41 in the "unknown" category, which may account for the larger "not yet employed" number.

The Faculty Flow Diagram on the previous page is quite similar to that of a year ago, but is based on somewhat more complete information. It shows a very slight gain (of 30) in total faculty--attributable to statistics and computer science increases. While the number still seeking employment is about the same as a year ago, it is believed that late hiring this year probably kept the number of the 1974-1975 faculty members who were actually professionally unemployed as of September less than the comparable figure of a year ago.

Tenure. The percentage of the total doctorate faculty with tenure increased by about 2% in Groups I-V, and by about 2.5% in Groups M and B. From AMS salary survey data, the percentage of all doctorates on the faculty with tenure is about 72% in departments in Groups I and II, and about 70% in Groups III and M. It is about 55% in Group B. Of course, the percentage of all doctoral faculty of professorial rank having tenure is several percentage points higher in Groups I and II. The indicated percentage of doctoral faculty members who either have tenure or as individuals are expected to be retained indefinitely remains at the 80% or higher level.

As indicated earlier, the distribution of new pure mathematics doctoral degrees among Groups I, II, and III changed markedly this year as compared to last year. Based on all the doctorates reported by mid-August 1975, the net changes of all U.S. departments reporting both in 1974 and 1975 showed the following changes in pure and applied degrees.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pure</th>
<th>Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>+51</td>
<td>-4</td>
</tr>
<tr>
<td>Group II</td>
<td>-11</td>
<td>+20</td>
</tr>
<tr>
<td>Group III</td>
<td>-24</td>
<td>+13</td>
</tr>
</tbody>
</table>

Among all new pure mathematics Ph.D. degrees (about 600 in number), the percentage awarded by Group I departments rose from 38.7% in fiscal 1974 to 47.6% in fiscal 1975.

A study of the distribution of doctorates by sex, race, and citizenship among the various groups of departments showed that 16.7% of all Group III degrees were awarded to non-U.S. citizens, almost 32% of Group IV and V degrees were awarded to non-U.S. citizens. The composite pattern of sex, race, and citizenship data was reported in the October Notices, p. 308.

As would be expected, the percentages of those nonretained doctorate faculty who were still seeking employment generally went up as the research status level of the department they left went down. While only 11% of those leaving Group I departments were still seeking positions when the data were collected, the percentages of those from other groups were 26% for Group II, 31% for Group III, 45% for Group M, and 21% for Group B.

The data provided no evidence that nonretained faculty members with degrees for more than three years had significantly greater difficulty than those who earned their degrees more recently. This year for the first time the AMS survey contained questions regarding "prospects of permanency" for newly hired doctorate faculty. The percentages of those new non tenured doctorate faculty who were hired from other academic employment with prospects of permanency identified as fair-to-better were 72% for those in Groups B and M, 70% for Group III, 61% for Group II, and...
55% for Group I. For new Ph.D.'s, the percentage of those hired with fair-to-better prospects of permanency varied from 74% in Group B departments, to 17% in Group I departments.

This year, there were about 60 doctorates who left positions in departments in the mathematical sciences to take positions in four-year colleges and universities outside such departments. These appear to be expanding opportunities for mathematicians to find academic employment outside their traditional departments.

Almost 200 vacancies a year occur due to deaths and retirements and this number is expected to remain stable for several years and then increase quite slowly till the early 1990's. Therefore we might be tempted to think of a steady-state demand for only about 200 new faculty members per year. That is more or less valid in terms of those who will be retained indefinitely. But, in terms of temporary opportunities for new Ph.D.'s, the steady-state is probably closer to 400 per year, since our evidence indicates that there is a net flow of perhaps another 200 out of temporary departmental positions to scientific or mathematical jobs outside academia, to jobs within academia but outside the usual departments, to two-year colleges and miscellaneous other options.

A more detailed report by Professor Donald J. Albers of Menlo College on two-year college employment and educational phenomena is scheduled on the MAA program at the San Antonio meeting. His report is based in part on data collected by the AMS.

Course Enrollments, Faculty Size and Teaching Loads. For the past three years the AMS has been collecting data on enrollments in mathematics courses. The data collected in 1973 was used by John Jewett in his report in the November 1973 Notices. That data, together with that collected in 1974, provided a basis for some reports on teaching loads.

It should be noted that course enrollment data lags behind other AMS data by almost a year. The data analyzed here were collected in the summer of 1975; they record enrollments for fall 1974 with comparative figures for fall 1973.

TABLE 3

Fall 1973 to Fall 1974 Percentage Changes in Mathematics Course Enrollments by Groups and by Type or Level of Courses

<table>
<thead>
<tr>
<th>Group and % of Departments Reporting</th>
<th>Courses Below Calculus</th>
<th>First Year Calculus</th>
<th>Undergraduate Statistics</th>
<th>Undergraduate Computer Science</th>
<th>All Undergraduate Courses</th>
<th>All Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (70%)</td>
<td>+0.9%</td>
<td>+4.8%</td>
<td>-0.8%</td>
<td>+1.1%</td>
<td>-2.2%</td>
<td>-8.0%</td>
</tr>
<tr>
<td>II (71%)</td>
<td>+5.9%</td>
<td>+11.1%</td>
<td>+3.6%</td>
<td>+3.4%</td>
<td>-0.5%</td>
<td>-5.3%</td>
</tr>
<tr>
<td>III (71%)</td>
<td>+5.4%</td>
<td>+6.1%</td>
<td>+9.1%</td>
<td>+21.2%</td>
<td>-2.8%</td>
<td>-5.0%</td>
</tr>
<tr>
<td>IV (50%)</td>
<td>-</td>
<td>-</td>
<td>+8.5%</td>
<td>-</td>
<td>-</td>
<td>+11.3%</td>
</tr>
<tr>
<td>V (31%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+11.4%</td>
<td>-</td>
<td>+4.7%</td>
</tr>
<tr>
<td>M (43%)</td>
<td>+3.0%</td>
<td>+4.9%</td>
<td>+0.6%</td>
<td>+15.7%</td>
<td>-5.3%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>B (37%)</td>
<td>+7.8%</td>
<td>+3.8%</td>
<td>+4.8%</td>
<td>+16.5%</td>
<td>+3.1%</td>
<td>-</td>
</tr>
</tbody>
</table>

*Includes data from columns on left not individually tabulated because the numbers were too small for the percentages to be meaningful.
science departments in the institutions concerned. The general consistency of the data lends credence to the data itself and to the effectiveness of the tabulation by the AMS staff.

In Table 4 we give projections to the 1974 total faculty size and total course enrollments for the various classes of departments. These projections give an indication of the relative sizes and roles of the various classes in U.S. academia. The projections are obtained from the reported totals by multiplying by the ratio of the total number of departments to the number reporting in the particular category.

For Groups I, II, and III combined, the number of full-time faculty members is 5,172 and the total enrollment is 557,618. For both Group M and Group B the corresponding numbers are comparable in size to these. The totals listed are probably fairly accurate. The least certain figures are those in Groups V and B, where the return rates are smallest. In B, for example, there may be a tendency for the smallest departments, or for departments combined with other science departments, not to report to the AMS. Thus, the total faculty under B may be a few hundred too high. The numbers for Group V are also probably somewhat too large since a few of the departments are only partly in the mathematical sciences and nonreporting departments may be smaller or more specialized. Other data suggest that the total U.S. four-year college and university mathematics faculty is between 17,500 and 18,000. An independent count of all full-time faculty members in Groups I, II, and III as reported in the sixth edition of the MAA Guidebook (1975) shows a total count for 1974 in these departments differing by less than 100 from the figures above.

**TABLE 4**

<table>
<thead>
<tr>
<th>TEACHING STAFF</th>
<th>Total U, S. Departments</th>
<th>Full-time</th>
<th>Part-time</th>
<th>Teaching Assistants</th>
<th>Total Course Enrollments</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>27</td>
<td>1,135</td>
<td>79</td>
<td>1,553</td>
<td>101,331</td>
</tr>
<tr>
<td>II</td>
<td>38</td>
<td>1,463</td>
<td>207</td>
<td>1,474</td>
<td>151,479</td>
</tr>
<tr>
<td>III</td>
<td>90</td>
<td>2,574</td>
<td>281</td>
<td>2,077</td>
<td>304,808</td>
</tr>
<tr>
<td>IV</td>
<td>64</td>
<td>686</td>
<td>196</td>
<td>735</td>
<td>57,476</td>
</tr>
<tr>
<td>V</td>
<td>99</td>
<td>1,374</td>
<td>351</td>
<td>1,533</td>
<td>94,915</td>
</tr>
<tr>
<td>M</td>
<td>320</td>
<td>5,354</td>
<td>954</td>
<td>1,444</td>
<td>552,870</td>
</tr>
<tr>
<td>B</td>
<td>960</td>
<td>5,396</td>
<td>1,322</td>
<td>71</td>
<td>471,493</td>
</tr>
<tr>
<td>Total</td>
<td>17,982</td>
<td>3,390</td>
<td>8,887</td>
<td></td>
<td>1,734,372</td>
</tr>
</tbody>
</table>

**TABLE 5**

<table>
<thead>
<tr>
<th>Courses Below Calculus</th>
<th>First Year Calculus</th>
<th>Undergraduate Statistics</th>
<th>Undergraduate Computer Science</th>
<th>Other Undergraduate Math. Courses</th>
<th>All Graduate Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>22.5%</td>
<td>35.3%</td>
<td>1.6%</td>
<td>0.9%</td>
<td>31.7%</td>
</tr>
<tr>
<td>II</td>
<td>45.5%</td>
<td>29.8%</td>
<td>2.0%</td>
<td>1.1%</td>
<td>17.1%</td>
</tr>
<tr>
<td>III</td>
<td>42.0%</td>
<td>27.6%</td>
<td>4.3%</td>
<td>2.8%</td>
<td>20.0%</td>
</tr>
<tr>
<td>IV</td>
<td>7.2%</td>
<td>-</td>
<td>62.1%</td>
<td>5.8%</td>
<td>-</td>
</tr>
<tr>
<td>V</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>70.1%</td>
<td>5.7%</td>
</tr>
<tr>
<td>M</td>
<td>49.1%</td>
<td>18.2%</td>
<td>6.2%</td>
<td>5.6%</td>
<td>17.4%</td>
</tr>
<tr>
<td>B</td>
<td>44.3%</td>
<td>19.4%</td>
<td>8.7%</td>
<td>8.8%</td>
<td>17.4%</td>
</tr>
</tbody>
</table>

In Table 5 we show the percentage of course enrollments by groups and various types of courses. The similarity of Groups II, III, M, and B, as contrasted to the dissimilarity between them and Group I is worthy of note. The very high (about 70%) enrollments in pre-calculus and calculus courses in Groups I, II, III, M, and B means that a large majority of mathematicians are employed to teach elementary mathematics. The relatively higher statistics and computer science enrollments in Groups III, M, and B are probably the result of two phenomena. One is the absence of separate departments in many of the institutions represented; the other is the fact that, although many departments of statistics and/or computer science are included in the M and B categories, those with doctoral programs are separately classified in Groups IV or V.

**Teaching Loads.** As commented earlier, the evidence appears conclusive that, nationally, teaching loads, as measured by sections per teacher, did not increase from fall 1973 to fall 1974. This evidence contradicts the impression expressed a year ago in surveying department chairmen that loads were expected to rise slightly from 1973 to 1974. This year, department
chairmen have again indicated that they expect a slight rise in teaching loads from fall 1974 to fall 1975. Out of 631 departments in all groups reporting on this question, 559 expected essentially no change, 13 expected a decrease and 59 expected an increase. Thus, a net of about 7% expected some increase. In any event, the pattern does not appear alarming. As noted earlier, it is increased course enrollments and/or teaching loads one year that provide pressure for increased faculty in subsequent years.

There are wide-spread informal reports of increased college and university enrollments for fall 1975 over fall 1974. Thus, it seems likely that there was a further increase in course enrollments in mathematics this fall, hopefully creating substantial pressure for additional faculty positions next year.

NEWs ITEMS AND ANNOUNCEMENTS

AMS RESEARCH FELLOWSHIP FUND

Request for Contributions

The Council and the Trustees of the Society have voted to continue the Research Fellowship Program, begun in 1973, on the same terms as at present with one exception. Starting with the AMS Postdoctoral Research Fellowships to be awarded for 1976–1977 candidates for the fellowships shall be citizens or permanent residents of a country in North America. The Society will continue to contribute a minimum of $9,000 each year, matching one-half the funds in excess of $18,000 raised from other sources, up to a total contribution by the Society of $20,000.

Three Research Fellowships were awarded for 1975–1976. The Society hopes that this number can be increased for 1976–1977. The Fellowships are intended to support Research Fellows for one year and, under the restrictions above, will continue to be awarded strictly on mathematical merit. Each Fellowship for 1976–1977 will carry a partially tax exempt stipend of approximately $10,500.

The Research Fellowship Program demonstrates the importance the Society and its members attach to research. The survival of the Program depends on the contributions the Society receives for the Research Fellowship Fund. It is hoped that every member of the Society will be willing to contribute to the Fund. All members have the opportunity to designate their contribution on the dues billings from the Society. A contribution of at least $3.00 from each employed member would make this Program a highly successful one. Contributions 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 1971, Annex Station, Providence, Rhode Island 02901.

AMS RESEARCH FELLOWSHIPS

Invitation for Applications

The American Mathematical Society invites applications for the AMS Research Fellowships. These are postdoctoral fellowships to be awarded for research in mathematics during the year 1976–1977. They are open to individuals who have recently received the Ph.D., and who are citizens or permanent residents of a country in North America. The stipend will be approximately $10,500, of which a portion will be tax exempt.

Completed applications must be received by March 15, 1976. A small number of fellowships will be awarded, the number depending on the amount contributed to the AMS Research Fellowship Fund. Notification of awards will be made by April 15, 1976.

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

RECENT AMS APPOINTMENTS

Proceedings Editorial Committee. Chandler Davis was elected by the Council to fill out Jacob Feldman's term as editor of the Proceedings Editorial Committee. The term will expire in 1976.

Committee on Science Policy. Leon W. Cohen was appointed vice-chairman of the Committee on Science Policy by the president of the Society. Chairman of the committee is William LeVeque. Other members are R. H. Bing, Garrett Birkhoff, Felix Browder, John Jewett, Anil Nerode and Elias M. Stein.

Editorial Committee for the Colloquium Publications. Samuel Eilenberg is now chairman of the Editorial Committee for the Colloquium Publications.

SECOND AAAS MASS MEDIA INTERN PROGRAM

The American Association for the Advancement of Science has announced its second Mass Media Intern Program to be held in the summer of 1976. The program will support up to fifteen advanced graduate students in the social and natural sciences who are interested in positions as intern reporters, researchers or production assistants. Stipends and travel expenses will be paid by the Association.

Students may apply to the Program by having a faculty member submit a letter of nomination to the AAAS. An applicant must also write a letter describing reasons for wanting to participate in the program, ideas on how journalism may be improved as a result of participation from natural or social scientists, and how scientists could benefit from exposure to an experience in the mass media. The letter should be accompanied by a curriculum vita and three references. Letters of application and recommendation should be sent to William A. Blanpied, Mass Media Intern Program, American Association for the Advancement of Science, 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036. The deadline for receipt of applications is February 1, 1976.
PUBLIC UNDERSTANDING OF MATHEMATICS
by Lynn Arthur Steen

The distance between research frontier and public understanding is probably greater in mathematics than in any other field of human endeavor. In both the arts and the sciences, the general public is aware in a rudimentary fashion of major twentieth century contributions: Most people have at least a vague understanding of electrons, of DNA, of black holes, of atonal music, of cubism, ..., even though they often neither understand nor care to understand such things in detail. In contrast, public vocabulary concerning mathematics is quite primitive. Except perhaps for some pejorative feeling about "sets", most people's closest contact with mathematics has been an (often-times despised) high school course in Euclidean geometry. General understanding of mathematics is more than a millennium out of date. Explaining what is actually happening in current mathematics to the average layman would be like explaining artificial satellites to a citizen of the Roman empire who believed that the earth was flat.

Not only is the public's mathematical vocabulary archaic, but public interest in the issues that are of central concern to the mathematical sciences is virtually nonexistent. All vehicles of public information—newspapers, magazines, television, museums—depend in large measure on the interests of their constituencies. For both financial and psychological reasons, effective articles (or films, or displays) must, first and foremost, be about subjects that people are really interested in. People may be seduced into learning the rudiments of biology because of their intrinsic interest in medicine or the rudiments of chemistry because of interest in environmental problems. But there are no alluring roads to mathematics.

Finally, public understanding of mathematics is impeded by a public attitude that is an anomalous mixture of awe and contempt. Although the average citizen speaks in wondering tones about his 'genius' nephew who scored 800 on his mathematical aptitude test, he appears proud of his own ignorance of things mathematical: 'I never did understand percentages.' Even well-educated people who wouldn't dare admit in public that they have never heard of Keynesian economics will brag of their lack of understanding of statistics or calculus. By and large, non-mathematicians do not value mathematical knowledge enough to regret their ignorance of it.

Despite these impediments, perhaps because of them—many mathematicians and non-mathematicians believe strongly (see, e.g., [1], [2], [4] and [5]) that improved public understanding of mathematics (and, more generally, of all science) is one of our profession's most urgent current problems. In recent years the Mathematical Association of America's Committee on New Priorities listed "the image of science and mathematics" as the number one problem in their 1973 report [6]; AMS Past President Saunders Mac Lane proposed in [3] a "ministudy" to communicate to scientists and laymen the substance of current mathematical research activity; and the Conference Board of the Mathematical Sciences (CBMS)—representing eleven different professional societies—undertook, with NSF support, a one year planning study (see [9]) in public understanding of the mathematical sciences.

Literacy in Mathematics. The astronomer Benjamin S. P. Shen distinguishes (in [8]) three aspects of literacy in science—practical, civic, cultural—that apply equally well to literacy in mathematics. Practical literacy in mathematics is that knowledge which can be put to immediate use in improving basic living standards. The ability to compare loans, to figure unit prices, to manipulate household measurements brings immediate real benefit. Popular demand for texts in "Arithmetic for College Students" suggests, and recent evidence from the National Assessment of Educational Progress (reported, for example, in [7]) corroborates, the enormous extent of practical mathematical illiteracy.

Civic literacy involves more sophisticated concepts, namely those that would enhance public understanding of legislative issues. Although major public debates on energy, environment and the economy usually center on some scientific issue, the inferences drawn from the available data, the projections concerning future behavior, and the interaction among variables involve issues with essentially mathematical content. A public afraid or unable to reason with figures is unable to discriminate between rational and reckless claims in the technological arena.

The third in Shen's levels of scientific literacy is cultural—the attempt to communicate about science or mathematics as a major human achievement. Because cultural literacy lacks an immediate, practical purpose, its appeal will be limited largely to a subset of the intellectual community. When one considers that the readership of the cultural monthlies like Harpers, Atlantic, Scientific American is about one-half of one percent of the U.S. population, a cultural approach to mathematical literacy will hardly contribute to general "public" understanding. Yet it has high leverage, for within the small audience are teachers, politicians, and journalists who mold opinion for the larger public.

The CBMS Study. The recently concluded CBMS planning study focused primarily on cultural literacy. We went directly to the journalists, writers and editors who reach the intellectual community and asked them about "coverage" of mathematics. By and large, these experienced journalists expressed real interest in doing more than they have in the past to treat news from the mathematical sciences. But they have several problems.

First, few science writers know enough mathematics to do stories in this area. Many of the best science writers have no mathematical training beyond high school and thus suffer from the same illiteracy as the public for whom they
are writing. Of course, a good writer may convert this illiteracy from a handicap to a benefit since it makes him more able to empathize with the difficulties his reader will face in reading about mathematics.

But no writer can be expected to communicate if he has nothing to talk about. This leads to the second major problem facing science journalists: The mathematical community provides no useful mechanism—either in its annual meetings or in its publications—to alert journalists to significant stories in terms they can understand. No one but an expert can read any of the publications that discuss current mathematical activity.

To meet these problems, CBMS undertook several exploratory ventures: Some expository writing to show that it is possible to explain mathematical topics in a manner acceptable to experienced editors; a seminar for science writers on selected topics in statistics and mathematics education planned in conjunction with the Council for the Advancement of Science Writers; and a "mock issue" of a new mathematics magazine—tentatively called Mathematical World—designed to communicate news and opinion of the mathematical world in a style that would appeal both to practicing mathematicians and to those laymen (journalists, administrators, politicians) who must occasionally deal with mathematical issues.

Recommendations. In order to nurture the seeds planted by this CBMS venture, the mathematical community should expand its interface with the community of science journalists. One rather simple way to do this is to refocus part of the annual and regional meetings to provide, whenever practicable, one or more "public sessions" in which speakers address a general audience in nontechnical terms. Such an effort would be a solid first step in closing the gap between research mathematics and non-mathematical laymen. But it might not bring spectacular results, especially not at first, since no one except mathematicians is accustomed to attending mathematics meetings.

A device that may bring more immediate results would be for mathematical scientists—especially those involved in applied problems—to contribute papers to the annual meeting of the American Association for the Advancement of Science since this meeting regularly attracts several hundred science reporters. Moreover, to be sure to reach more than a specialized audience, mathematicians presenting papers should provide—as do most other scientists—a detailed nontechnical summary to the AAAS publicity office.

Better use of meetings to facilitate communication of mathematics to journalists and other laymen is relatively easy since it costs virtually nothing. A more substantial step, which would cost members of the mathematical community some money but provide them with extensive and regular benefits, would be to establish a nontechnical forum—such as the proposed magazine Mathematical World—for news of the mathematical sciences. Science journalists frequently report that the most important step the mathematical community could take to close the "communication gap" would be to establish an attractive, nontechnical monthly publication for the exchange of news and opinion concerning the world of mathematics.

Non-print Media. A second thrust of the CBMS exploration of public understanding of mathematics concerned the non-print media such as film, television, and museums. Although these communication channels (especially television) offer the potential for reaching a very wide audience, the impact of mathematics on these media has been very slight.

Two problems tend to stand out. High quality productions in non-print media are very expensive; they involve coordination of specialized skills, and people who have these skills are not often interested or knowledgeable in mathematics. Moreover, the mathematical sciences do not provide a natural attraction for commercial sponsorship on the required scale. Second, whereas mathematical coverage has been attempted in the non-print media, it has brought disappointing results. For example, the team filming the NOVA series for the Public Broadcasting System attempted and gave up on one mathematical topic because "none of the film crew understood the issues"; a knowledgeable critic of existing mathematical films termed those suitable for general public viewing as, on average, worthless.

In the science and technical museums, mathematics has been virtually absent except for Mathematics, a world's fair exhibit in Chicago, Seattle and Los Angeles in which the happy coalescence of Ray and Charles Eames design talent with IBM sponsorship produced a virtuoso display that even today, fifteen years after its creation, is one of the consistent top attractions at its host museums. In an attempt to encourage further mathematics museum displays, CBMS arranged to sponsor, in conjunction with the Association of Science-Technology Centers, a "brain-storming" conference that brought together museum people and mathematicians to generate ideas for new exhibits. Unfortunately, development of actual exhibits will depend on major outside funding.

Talking vs. Doing. Efforts at public understanding of mathematics are often frustrated by a concern that talking about mathematics is not an appropriate or adequate substitute for doing mathematics. Those who hold this view argue that simplification for public understanding necessarily entails oversimplification, and that oversimplified mathematics—lacking precise definitions, hypotheses, and deductions—is no mathematics at all. Since logical precision and not experimental observation is the essence of mathematical reasoning, proper understanding requires the distinctive flavor of precision rather than the hash of incomplete description.

The weight of this argument is formidable. In practice, it has meant that mathematics is virtually the only major scientific discipline that lacks an expository forum for communications with the non-specialist. It has certainly contributed to the impression—widespread among journalists and scientists who have tried to examine mathematics—that mathematicians are haughty and uninterested in relating to ordinary mortals. Even in collegiate education, texts for those courses whose central purpose is "public
understanding" (i.e., survey courses for liberal arts students) focus on elementary and hackneyed topics where the precision of "definition, theorem, proof" may be understood and practiced, rather than on a survey of the current major problems and research frontiers.

Whether intended or not, the effect of this insistence on doing mathematics in order to learn about it, is to erect insurmountable barriers to persons who have other primary interests. Critics call this the mathematician's arrogance: You have to meet me on my terms or not at all. Mathematicians call it scholarship: If you want to learn, do it properly or not at all.

Regardless of how it is labeled or why it exists, this attitude severely impedes public understanding of mathematics. Surely mathematics need no longer adopt the defensive posture of an emerging science that needs to emphasize constantly its "rigor" in order to promote confidence in its results. Correctness of its results is insured by high standards of refereeing in the research journals; belief in the truth of these results is already widespread among scientists and laymen—even when (perhaps, especially when) they do not understand the substance of the results.

Instead of maintaining a narrow preoccupation with precision and rigor, mathematicians must somehow overcome their aversion to the 'loose' language of public communication. We must learn to substitute for the language of definition and proof the language of metaphor and anecdote. It may take a certain degree of self-confidence and maturity to bear the strain of misinterpretation, oversimplification and distortion that inevitably accompanies public communication. But if we are really interested in communicating, these difficulties will be easier to endure than the incomprehension and hostility that usually greets mathematicians when they speak in their own vernacular. An open but noisy channel is far better than a closed one.

Raison d'être. All discussion of strategies for public understanding of mathematics begs the question of basic rationale: Why, indeed, should mathematicians be concerned about public understanding? Inconspicuous existence amidst benign neglect may well be preferable to public scrutiny of the eccentricities of the mathematical world. What, for instance, might be the public reaction if they ever did really understand what mathematicians did with the public's money?

There are fundamentally two reasons for running the risk of public exposure. The first is that mathematicians have an obligation to explain their work—because mathematical research is to a very large extent supported by public funds, and because we, like each of the arts and sciences, bear the burden of transmitting part of man's culture from one generation to the next. The second reason, more selfish than the first, is that mathematics as a profession needs the intellectual and financial support of the public in order to secure its own future.

We should feel fortunate that these two motivations—the sacred and the profane, as one science journalist put it—point in one direction. Professional and financial support of public understanding of mathematics will serve simultaneously as an investment in the future of our profession and as a payment on certain overdue obligations to society.

REFERENCES


CONVERSION OF TEACHING ASSISTANTSHIPS
TO JUNIOR FACULTY POSITIONS
by Martha K. Smith

The Council of the AMS recommended in 1972 (Notices, June 1972, p. 209) that graduate mathematics departments, wherever possible, convert some teaching assistantships into junior faculty positions. As well as creating more positions for Ph.D. mathematicians, such conversion would help check the excess production of Ph.D.'s by providing support for fewer graduate students. More recently, many departments have experimented a decrease in the number of applicants to their graduate programs. At some schools, the resulting shortage of qualified applicants for assistantships has provided further motivation for conversion to faculty positions. So far there has been little public discussion of the nontrivial problem of effecting such a conversion. This article is intended to initiate an exchange of ideas on this problem. It is based on an informal questionnaire sent to some departments known to have converted TA's to faculty positions, on discussion at a meeting of department chairmen held at the Kalamazoo meeting of the Society, and on discussions of the Society's Committee on Employment and Educational Policy.

First, we acknowledge that conditions vary sufficiently from department to department that any valid solution to the problem must be a local one. TA salaries and duties, administrative and budgeting policies, class sizes, size of the graduate program, and many other factors affect the feasibility of conversion and how it may be effected.

Second, we shall proceed under the hypothesis that the desired result of conversion is to create positions as near as possible in salary and teaching load to regular faculty positions at that institution. Since TA's are almost always a "bargain" in salary per contact hour, something clearly must give somewhere in order to achieve this goal. The three most likely means are to obtain more money, to increase class sizes and to reduce graduate offerings.

Obtaining additional funds for conversion is not out of the question. It has been done by several departments. It is interesting (but not surprising) to note that the subset of departments responding to our questionnaire who succeeded in obtaining additional funds is contained in the subset consisting of departments which listed difficulty in recruiting qualified TA's as a primary reason for conversion. Ingenuity may be helpful here. For example, one department supplemented the $5,000 available from half the salary of a faculty member on leave, with $1,000 in additional funds to create a one-year instructorship.

A question which cannot be avoided in discussing temporary positions of the sort created from teaching assistantships is what happens to the people who hold them after their one, two or three years are up. "Converted" positions have not been in existence on a large scale long enough to give an answer to this question based on hard evidence. Undoubtedly, the success of the holders of these positions in finding further employment will be varied and will depend on many factors. An informal accounting of the instructors hired by the author's department in 1972 reveals a variety of experiences. At least two former instructors now have positions with some possibility of permanence, at least two more accepted another temporary position elsewhere, one each went into high school teaching and industry, one is unemployed.

One other problem created by the employment situation which bears on the creation of temporary positions is the lack of mobility felt particularly by mathematicians at small institutions. Large departments which can create only one-year positions might consider offering them to mathematicians who already have positions in more isolated departments, but who could benefit mathematically from a year in a more active environment. No jobs would be lost, since the visitor's home institution would need to replace the faculty member on leave.

Several assistantships are discontinued. One department has created two instructorships (with salaries and teaching loads comparable to those of regular faculty members) from six teaching assistantships, solely by reducing advanced graduate offerings and using faculty where some TA's had formerly taught. The exact figures on salary and teaching load were not given, but the following hypothetical example illustrates how this might be done. If TA's normally teach one course per semester at an annual salary of $3,500 (reasonable but probably better than average conditions for a TA), six TA's earn $21,000 per year, enough to pay two instructors at $10,500 each. The six TA's formerly taught a total of six classes, four of which can be covered by the two instructors teaching two courses each. Each TA would probably be enrolled in three graduate courses, making a total of 18 fewer enrollments in graduate classes after conversion. Thus it is quite natural to offer two fewer graduate courses each semester, releasing two regular faculty members to cover the two remaining classes formerly taught by TA's.

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Of course, combinations of these means may often be the most practical solution. "Soft" money (released from faculty on leave and other variable sources) may also be useful in converting assistantships to faculty positions or even in creating new (almost certainly temporary) faculty positions. For example, one department supplemented the $9,000 available from half the salary of a faculty member on leave, with $1,000 in additional funds to create a one-year instructorship.

A question which cannot be avoided in discussing temporary positions of the sort created from teaching assistantships is what happens to the people who hold them after their one, two or three years are up. "Converted" positions have not been in existence on a large scale long enough to give an answer to this question based on hard evidence. Undoubtedly, the success of the holders of these positions in finding further employment will be varied and will depend on many factors. An informal accounting of the instructors hired by the author's department in 1972 reveals a variety of experiences. At least two former instructors now have positions with some possibility of permanence, at least two more accepted another temporary position elsewhere, one each went into high school teaching and industry, one is unemployed.

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SPECIAL MEETINGS INFORMATION CENTER

The purpose of this center is to maintain a file on prospective symposia, colloquia, institutes, seminars, special years, and meetings of other associations, and to alert the organizers if conflicts in subject matter, dates, or geographical area become apparent. An announcement will be published in these Notices if it contains a call for papers, place, date, subject (when applicable), and 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 volume and page of the 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, speakers (or sometimes general statement on the program), deadline for abstracts or contributed papers, and name of person to write for further information. Meetings held outside the North American area may carry slightly more detailed information. Information on the pre- and 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. Deadlines for particular issues of the Notices are the same as the deadlines for abstracts which appear on the inside front cover of each issue.

September 1, 1975—August 31, 1976
INTERDISCIPLINARY RESEARCH PROJECT ON MATHEMATICAL PROBLEMS OF QUANTUM DYNAMICS, Universität Bielefeld, Bielefeld, Germany (21, p. 219)

November 15–16, 1975
AMERICAN MATHEMATICAL HERITAGE SYMPOSIUM ON THE HISTORY OF ALGEBRA, The University of Texas at El Paso, El Paso, Texas
Program: There will be three half-day sessions beginning November 15 at 9:00 a.m. In each session there will be a lecture by one of the speakers followed by a discussion period.
Speakers: Walter Feit (Yale University), Saunders Mac Lane (University of Chicago), and John Tate (Harvard University).
Information: Carl E. Hall, Department of Mathematics, The University of Texas at El Paso, El Paso, Texas 79968.

December 1975
REGIONAL CONFERENCE ON INTEGRATED MATHEMATICS CURRICULUM DEVELOPMENT FOR DEVELOPING COUNTRIES, India (22, p. 294)

December 3–5, 1975
SIAM-SIGNUM 1975 FALL MEETING, San Francisco, California (22, p. 196)

December 13–15, 1975
FIRST ANNUAL WINTER MEETING, CANADIAN MATHEMATICAL CONGRESS, McGill University, Montreal, Canada (22, p. 294)

December 15–18, 1975
CONFERENCE ON THE THEORY AND APPLICATIONS OF RELIABILITY WITH EMPHASIS ON BAYESIAN AND NONPARAMETRIC METHODS, Tampa, Florida (22, p. 294)

December 28–29, 1975

December 29, 1975—January 3, 1976
INTERNATIONAL RESEARCH SYMPOSIUM ON RELATIVITY AND UNIFIED FIELD THEORY, Calcutta University, Calcutta, India (22, p. 196)

January 1–December 16, 1976
MATHEMATIKS FORSCHUNGS INSTITUT OBERWOLFACH, Federal Republic of Germany (Weekly Conferences) (22, p. 295)

January–February, 1976
SUMMER RESEARCH INSTITUTE OF THE AUSTRALIAN MATHEMATICAL SOCIETY, University of Adelaide, Australia (22, p. 295)

January 1–7, 1976
ANNUAL CONFERENCE OF INTERNATIONAL LEVEL OF INTERNATIONAL CENTRE FOR APPLIED ANALYSTS, Calcutta, India (22, p. 196)

January 5–24, 1976
SCHOOL OF DIFFERENTIAL AND ALGEBRAIC TOPOLOGY, Pontificia Universidade Católica, Rio de Janeiro, Brazil (22, p. 296)

January 10–February 27, 1976
SUMMER SCHOOL ON SINGULARITIES OF MAPPINGS AND APPLICATIONS, Instituto de Matemática Pura e Aplicada, Rio de Janeiro, Brazil
Program: Introductory courses on singularities of mappings and singularities of differential forms and vector fields, Lectures and seminars dealing with research in singularities will start on February 1. During January, scheduling of lectures in this school and the school of differential and algebraic topology at Pontificia Universidade Católica do Rio de Janeiro will be arranged to permit participation in both programs.
Support: Limited financial support will be available.
Information: Escola de Verão de Singularidades, Comissão Coordenadora, IMPA, Rua Luiz de Camões 65, Rio de Janeiro, RJ, Brazil.

January 12–16, 1976
INTERNATIONAL CONFERENCE ON ALGEBRAIC K-THEORY, Northwestern University, Evanston, Illinois (22, p. 249)

January 18–21, 1976
SYMPOSIUM ON APPROXIMATION THEORY, University of Texas at Austin, Austin, Texas (22, p. 296)

January 19–21, 1976
THIRD ACM SIGACT-SIGPLAN SYMPOSIUM ON PRINCIPLES OF PROGRAMMING LANGUAGES, Atlanta, Georgia (22, p. 196)

January 26–30, 1976
NUMERICAL SIMULATION OF FLUID DYNAMICS SYSTEMS, Monash University, Clayton, Victoria, Australia (22, p. 296)

February 1–4, 1976
APPLIED MATHEMATICS CONFERENCE, Jindabyne, New South Wales, Australia (22, p. 296)

February 10–12, 1976
FOURTH ANNUAL ACM COMPUTER SCIENCE CONFERENCE, Anaheim, California (22, p. 296)

February 12–13, 1976
SYMPOSIUM ON COMPUTER SCIENCE AND EDUCATION, Anaheim, California (22, p. 296)
March 4–6, 1976
CONFERENCE ON PROGRAMMING SYSTEMS IN THE SMALL PROCESSOR ENVIRONMENT, New Orleans, Louisiana (22, p. 296)

March 8–12, 1976
NSF REGIONAL CONFERENCE ON SYMPLECTIC MANIFOLDS, University of North Carolina, Chapel Hill, North Carolina
Program: Alan Weinstein (University of California, Berkeley) will deliver a series of ten lectures. There will also be a few selected talks by other participants and informal discussions.
Support: Travel and subsistence allowance for 25 participants will be provided by the National Science Foundation. Applications should be submitted by January 15, 1976.
Information: Robert Gardner, Department of Mathematics, University of North Carolina, Chapel Hill, North Carolina 27514.

March 22–31, 1976
SEVENTH NATIONAL MATHEMATICS CONFERENCE OF IRAN, Azarbaijan University, Tabriz, Iran (22, p. 296)

March 29–31, 1976
THE SECOND NATIONAL SYMPOSIUM ON COMPUTERIZED STRUCTURAL ANALYSIS AND DESIGN, George Washington University, Washington, D.C. (22, p. 298)

March 30–April 2, 1976
CONFERENCE ON THE THEORY OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS, University of Dundee, Dundee, Scotland (22, p. 249)

March 31–April 2, 1976
CONFERENCE ON INFORMATION SCIENCES AND SYSTEMS, The Johns Hopkins University, Baltimore, Maryland (22, p. 298)

Spring, 1976
SECOND CANADIAN SYMPOSIUM ON FLUID DYNAMICS, University of British Columbia, Vancouver, British Columbia, Canada (22, p. 249)

April 1–2, 1976
THIRD ICASE CONFERENCE ON SCIENTIFIC COMPUTING: COMPUTER SCIENCE AND SCIENTIFIC COMPUTING, Williamsburg, Virginia (22, p. 297)

April 6–10, 1976
THE TWENTY-EIGHTH BRITISH MATHEMATICAL COLLOQUIUM, University College of Wales, Aberystwyth, Wales (22, p. 297)

April 20–23, 1976
THIRD EUROPEAN MEETING ON CYBERNETICS AND SYSTEMS RESEARCH, University of Vienna, Vienna, Austria (22, p. 249)

May 3–5, 1976
EIGHTH ANNUAL ACM SYMPOSIUM ON THEORY OF COMPUTING, Hershey, Pennsylvania (22, p. 297)

May 11–15, 1976
INTERNATIONAL GRAPH THEORY CONFERENCE, Western Michigan University, Kalamazoo, Michigan
Program: Invited lectures on topics of current research interest in pure and applied graph theory. Included among the tentative principal speakers are D. H. Hoton (Australia); W. T. Tutte (Canada); J. Bosák and L. Nebeský (Czechoslovakia); N. L. Biggs, J. W. Kennedy, R. Wilson, and D. R. Woodall (England); C. Berge (France); L. Babai (Hungary); J. S. Frame, R. L. Graham, F. Harary, V. Klee, and G. Ringel (United States); L. S. Mel'nikov (USSR). The schedule will allow for a limited number of contributed talks.
Information: International Graph Theory Conference, Mathematics Department, Western Michigan University, Kalamazoo, Michigan 49008.

May 25–28, 1976
1976 INTERNATIONAL SYMPOSIUM ON MULTIPLE-VALUED LOGIC, Utah State University, Logan, Utah (22, p. 297)

June 7–11, 1976
THIRTEENTH YUGOSLAV CONGRESS OF RATIONAL MECHANICS, Sarajevo, Yugoslavia (22, p. 197)

June 16–20, 1976
IFAC SYMPOSIUM ON LARGE SCALE SYSTEMS, THEORY AND APPLICATIONS, Udine, Italy (22, p. 161)

June 23–July 2, 1976
COLING 76: INTERNATIONAL CONFERENCE ON COMPUTATIONAL LINGUISTICS, University of Ottawa, Ottawa, Ontario, Canada (22, p. 161)

June 23–July 3, 1976
FIFTH HUNGARIAN COLLOQUIUM ON COMBINATORICS, Szombathely, Hungary (22, p. 297)

July 2–12, 1976
LMS DURHAM SYMPOSIUM ON POTENTIAL THEORY AND CONFORMAL MAPPING, Durham University, England
Programme: A working research symposium; it will include a number of short lecture courses and seminar talks.
Support: Some limited support from Science Research Council and London Mathematical Society.
Participants: Those who have already indicated that they hope to participate include W. K. Hayman, J. G. Clunie, M. E. Noble, J. M. Anderson, J. Krzyz, C. Pommerenke, L. V. Ahlfors, A. Baernstein, M. M. Schiffer and F. W. Gehring. Attendance is by invitation only, with some 'write-in' places.
Information: D. A. Brannan, Mathematics Department, Queen Elizabeth College, London W8 7AH, United Kingdom.

July 12–23, 1976
LMS DURHAM SYMPOSIUM ON PARTIAL DIFFERENTIAL EQUATIONS, Durham University, England
Programme: A working research symposium; it will include a number of short lecture courses and seminar talks.
Support: Some limited support from Science Research Council and London Mathematical Society.
Participants: Those who have already indicated that they are likely to participate include E. Fraenkel (joint organiser), M. F. Atiyah, F. Browder, L. Nirenberg, H. Weinberger, H. Brezis, J. Leray, J. Lions, L. Garding and L. Hörmander. Attendance is by invitation only, with some 'write-in' places.
Information: D. E. Edmunds, School of Mathematical and Physical Sciences, University of Sussex, Falmer, Brighton BN1 9QH, United Kingdom.

July 14–24, 1976
ST. ANDREWS COLLOQUIUM, University of St. Andrews, Scotland (22, p. 297)

July 26–August 20, 1976
M.A.A. WORKSHOP ON MODULES IN APPLIED MATHEMATICS, Cornell University, Ithaca, New York (22, p. 297)

August 11–13, 1976
SECOND CAPE TOWN SYMPOSIUM ON CATEGORICAL TOPOLOGY, University of Cape Town, Cape Town, Republic of South Africa.
Program: Invited and contributed lectures. The proceedings will be published in the journal Mathematics Colloquium, University of Cape Town.
Information: K. A. Hardie, Department of Mathematics, University of Cape Town, Rondebosch 7700, Republic of South Africa.

August 16–21, 1976
THIRD INTERNATIONAL CONFERENCE ON MATHEMATICAL EDUCATION (ICME), Karlsruhe, Federal Republic of Germany (22, p. 197)

August 23–28, 1976
EIGHTH AICA INTERNATIONAL CONGRESS ON SIMULATION OF SYSTEMS, Delft, The Netherlands (22, p. 297)
VISITING MATHEMATICIANS

Supplementary List

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad.

American and Canadian Mathematicians Visiting Abroad

<table>
<thead>
<tr>
<th>Name and Home Country</th>
<th>Host Institution</th>
<th>Field of Special Interest</th>
<th>Period of Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eisenbud, David (U.S.A.)</td>
<td>Institut des Hautes Etudes Scientifiques, France</td>
<td>Algebra and Ring Theory</td>
<td>9/75 - 8/76</td>
</tr>
<tr>
<td>Goelman, Don (U.S.A.)</td>
<td>Ben Gurion University, Israel</td>
<td>Polynomial Algorithms</td>
<td>9/75 - 6/76</td>
</tr>
<tr>
<td>Lieberman, David (U.S.A.)</td>
<td>Institut des Hautes Etudes Scientifiques, France</td>
<td>Algebraic Geometry and Several Complex Variables</td>
<td>9/75 - 8/76</td>
</tr>
<tr>
<td>Plummer, M. D. (U.S.A.)</td>
<td>Mathematical Institute of the Hungarian Academy of Sciences, Budapest</td>
<td>Graph Theory</td>
<td>9/75 - 6/76</td>
</tr>
<tr>
<td>Siu, Yum-Tong (U.S.A.)</td>
<td>Kyoto University</td>
<td>Several Complex Variables</td>
<td>11/75 - 5/76</td>
</tr>
</tbody>
</table>

Visiting Foreign Mathematicians

<table>
<thead>
<tr>
<th>Name</th>
<th>Host Institution</th>
<th>Field of Special Interest</th>
<th>Period of Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bautista, Raymundo (Mexico)</td>
<td>Brandeis University</td>
<td>Representation Theory of Rings</td>
<td>10/75 - 9/76</td>
</tr>
<tr>
<td>Fernandez-Perez, C. (Spain)</td>
<td>University of Wisconsin–Madison</td>
<td>Differential Equations</td>
<td>8/75 - 6/76</td>
</tr>
<tr>
<td>Grebennikov, V. (U.S.S.R.)</td>
<td>University of Waterloo</td>
<td>Electronic Computers</td>
<td>8/75 - 8/76</td>
</tr>
<tr>
<td>Ior, S. A. (Nigeria)</td>
<td>University of Wisconsin–Madison</td>
<td>Topology</td>
<td>8/75 - 6/76</td>
</tr>
<tr>
<td>Makarov, E. (U.S.S.R.)</td>
<td>University of Waterloo</td>
<td>Electronic Computers</td>
<td>8/75 - 8/76</td>
</tr>
<tr>
<td>Martinez, Roberto (Mexico)</td>
<td>Brandeis University</td>
<td>Artin Algebras</td>
<td>9/75 - 8/76</td>
</tr>
<tr>
<td>Raimondo, Mario (Italy)</td>
<td>Brandeis University</td>
<td>Commutative Algebra</td>
<td>9/75 - 12/75</td>
</tr>
<tr>
<td>Strano, Rosario (Italy)</td>
<td>Brandeis University</td>
<td>Commutative Algebra</td>
<td>9/75 - 8/76</td>
</tr>
</tbody>
</table>
PERSONAL ITEMS

ROBERT G. BARTLE of the University of Illinois has been appointed to a professorship at Georgia Institute of Technology.

R. PAUL BEEM of the University of Pennsylvania has been appointed to an assistant professorship at Indiana University, South Bend.

JOHN T. CANNON of Rockefeller University has been appointed to an assistant professorship at Georgia Institute of Technology.

JAMES CARISTI of the University of Iowa has been appointed to an assistant professorship at Texas Lutheran College.

MARK J. CHRISTENSEN of Wayne State University has been appointed to an assistant professorship at Georgia Institute of Technology.

PAUL C. EKLOF of the University of California at Irvine has been appointed to a visiting associate professorship at Yale University for the 1975-1976 academic year.

RALPH S. FREESE of the University of Hawaii has been appointed to a visiting associate professorship at Vanderbilt University.

MICHAEL GOLOMB of Purdue University has been appointed to a visiting professorship at Brown University.

WILLIAM F. GRAMS of Vanderbilt University has been appointed to an assistant professorship at the University of Tennessee, Nashville.

ULRICH KOSCHORKE of Queens College has been appointed to a visiting research position at the University of Bonn, West Germany.

JOHN PIEPENBRINK of the University of Nebraska at Lincoln has been appointed to an assistant professorship at Georgia Institute of Technology.

RONALD S. RIVLIN of Lehigh University has been awarded the Premio Modesto Panetti for 1975 by the Academy of Sciences of Turin, Italy.

PAUL C. SHIELDS of Stanford University has been appointed to an associate professorship at the University of Toledo.

RENE PETER SPERB of the University of Tennessee has been appointed to a visiting assistant professorship at Vanderbilt University.

ELLEN M. TORRANCE of Kansas State University has been appointed assistant to the president at Cologne Life Reinsurance Company, Stamford, Connecticut.

LYNN R. WILLIAMS of Louisiana State University has been appointed to an assistant professorship at Indiana University, South Bend.

HARVEY E. WOLFF of the University of Texas has been appointed to an assistant professorship at the University of Toledo.

DAVID E. ZITARELLI of Temple University has been appointed to a visiting assistant professorship at Vanderbilt University.

GREGG J. ZUCKERMAN of Princeton University has been appointed to an assistant professorship at Yale University.

PROMOTION

To Chairman. Department of Mathematics, John Jay College of Criminal Justice—CUNY: ARTHUR SCHLISSEL.

To Professor. University of Toledo: H. LAMAR BENTLEY and MARTIN KUMMER.

To Associate Professor, Georgia Institute of Technology: RICHARD A. DUKE; Vanderbilt University: GEORGE W. REDDIEN; University of Toledo: JUNIOR STEIN and STUART STEINBERG.

INSTRUCTORSHIP

Yale University: DOUGLAS E. MILLER and KATHLEEN SINKINSON.

Georgia Institute of Technology: BRUCE R.CAINE.

DEATHS

Professor DONALD B. GILLIES of the University of Illinois at Urbana-Champaign died on July 17, 1975, at the age of 46. He was a member of the Society for 24 years.

Professor Emeritus VICTOR F. LENZEN of the University of California at Berkeley, died in July, 1975, at the age of 84. He was a member of the Society for 46 years.

Professor ECKARD F. SCHMIDT of the University of Calgary died on July 2, 1975, at the age of 37. He was a member of the Society for 4 years.

Professor J. DEAN SWIFT of the University of California at Los Angeles, died on September 16, 1975, at the age of 56. He was a member of the Society for 34 years.
LETTERS TO THE EDITOR

Editor, the Notices

From time to time a question is raised, or an objection is voiced, concerning the coverage of applied mathematics in Mathematical Reviews (MR), so it seems that the following information might be of interest.

A few years ago the Conference Board of the Mathematical Sciences (CBMS) sponsored a Committee on a National Information System for the Mathematical Sciences. In its final report in 1972, that committee gave first priority to the preservation of MR and the broadening of reviewing/abstracting coverage across more of applied mathematics. The Conference Board therefore sponsored a new committee to study the feasibility of the AMS and SIAM jointly publishing some kind of abstracting, indexing or alerting service for applied mathematics (including statistics, computing science, operations research—anything that anyone would call applied mathematics). Three members of the committee (L. E. Block, R. C. DiPrima and C. O. Reville, Jr.) were appointed by SIAM and three (F. W. Gehring, R. Palais and J. T. Schwartz) by the AMS, and I served as chairman on behalf of CBMS. The committee's work was supported by a grant from the Sloan Foundation.

On the basis of a study that had been made by SIAM a year earlier, we almost immediately put aside the possibility of publishing either a reviewing journal such as MR or an abstracting journal such as Zentralblatt für Mathematik; the market will not support such an expensive undertaking. We then considered two other possibilities: a classified subject index of applied papers (appearing reasonably frequently and remaining current), or an offset reproduction of tables of contents of current issues of applied journals. Each product would have been produced in cooperation with the MR editorial office, using the 1100 or more journals regularly scanned in that office, and others if necessary.

Upon the advice of the SIAM Trustees, we conducted a market survey to determine whether a subject index (or alternatively a Table of Contents journal) could be made self-supporting within a reasonable length of time. (In order of magnitude, the first might cost $160,000 per year, the second, one-fourth as much.) When the results were in, the AMS representatives were willing to recommend the inception of the less expensive Table of Contents journal, but after careful evaluation, some of the SIAM Trustees regretfully concluded that neither of the proposed journals is economically viable at present. The final decision of the committee was to recommend to the governing bodies of the two organizations that no action be taken at the present time.

I would make three observations in connection with the committee's work. (a) The applied mathematics community is very diffuse, and is therefore difficult to serve in a unified way. MR costs well over one million dollars per year; its cost would rise sharply if its coverage of the applications of mathematics were substantially increased, while we were uncertain that even a more sharply focussed journal as described above would attract $40,000 in subscription revenue. (b) The difficulty in improving the situation lies in economics, not in an unwillingness on the part of the AMS and SIAM to cooperate. (c) All members of the committee were disappointed at the outcome.

William J. LeVeque

Editor, the Notices

In the winter of 1973, I submitted a paper to a journal published in the United States. Seven months later they informed me that it was accepted. Last week, nearly two years after that, I received the galleys together with the ominous warning that if I didn't return them within 48 hours it would cause a "delay in publication." Are they kidding!

After correcting the galleys I composed a little ditty to be "added in proofreading." But then I realized they would probably have it refereed—and that could take another three years. So I offer it to the mathematical community instead. Perhaps it will motivate somebody somewhere to do something about this problem.

I've pestered the journal continuously, That my paper was treated callously, Yes, it's brought me to tears; How they've held it for years, In the hope of publishing it posthumously!

Ronald L. Lipsman

Editor, the Notices

We find the announcements of the Special Meetings Information Center one of the quite useful features of the Notices.

However, this feature would be even more useful if, in each issue, all future meetings announced so far were listed, in chronological order as always. Space need not prohibit this; after the original listing all that need be given is the meeting title, the dates, and a reference to the original listing.

Stephen B. Maurer

Jonathan L. Gross

EDITORIAL COMMENT: The Special Meetings Information Center has in fact been reorganized in somewhat the way suggested by the writers in the above letter. See pp. 367. The editors welcome suggestions for improving any service of the Society.
NEW AMS PUBLICATIONS

PROCEEDINGS OF SYMPOSIA
IN PURE MATHEMATICS

DIFFERENTIAL GEOMETRY, edited by S. S. Chern and R. Osserman

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The papers in these Proceedings represent the final versions of talks given at the AMS Summer Research Institute on Differential Geometry, which took place at Stanford University, Stanford, California, from July 30 to August 17, 1973. This Institute was made possible by a grant from the National Science Foundation. The organizing committee consisted of Raoul H. Bott, Eugenio Calabi, S. S. Chern, Leon W. Green, Shoshichi Kobayashi, Tilla K. Milnor, Barrett O'Neill, Robert Osserman, James Simons, and I. M. Singer, with the coeditors serving as cochairmen.

The activities were divided between general lectures and seminar talks. In these Proceedings the general lectures have been distributed among the various seminars, according to their subject matter. Generally papers are included in the seminars in which they were presented, although in certain cases the contents would make them more appropriate in another section. In cases where a complete version of the talk appears elsewhere, only an abstract is included, wherever possible, with a reference to the full paper.

The Proceedings is bound in two parts. Each part may be purchased separately.

Listed below are the titles of the seminars in each part, together with the titles of the lectures and talks given in each of the seminars.

PART 1

Riemannian Geometry (J. Cheeger, chairman);"Deformations localement triviales des varietes Riemanniennes" by L. Bérard-Bergery, J. P. Bourguignon and J. LaFontaine;"Some constructions related to H. Hopf's conjecture on product manifolds" by Jean Pierre Bourguignon;"Connections, holonomy and path space homology" by Kuo-Tsai Chen;"Spin fibrations over manifolds and generalised twistors" by A. Crumeyrolle;"Local convex deformations of Ricci and sectional curvature on compact manifolds" by Paul Ewing Ehrlich;"Transgressions, Chern-Simons invariants and the classical groups" by James L. Heitsch and H. Blaine Lawson, Jr.;"A class of compact manifolds with positive Ricci curvature" by Horacio Hernández-Andrade;"Tangent bundles with Sasaki metric" by Mu-Chou Li;"Curvature and critical Riemannian metric" by Yoshihiro Otsuki;"Axioms for the Euler characteristic" by Howard Osborn;"Riemannian manifolds without conjugate points" by John J. O'Sullivan;"Local and global properties of convex sets in Riemannian spaces" by Rolf Walter; and"On the volume of manifolds all of whose geodesics are closed" by Alan Weinstein.

Submanifolds (K. Nomizu, chairman);"On a generalization of the catenoid" by David E. Blair;"Geometric applications of critical point theory to submanifolds of complex projective space and hyperbolic space" by Thomas E. Cecil;"Mean curvature vector of a submanifold" by Bang-yen Chen;"Geometry of submanifolds of Euclidean spaces" by Robert B. Gardner;"The Hopf conjecture concerning surfaces in E^3" by S. I. Goldberg;"Relative Chern-Lashof theorems" by Nathaniel Grossman;"A Sobolev inequality for Riemannian submanifolds" by David Hoffman and Joel Spruck;"Minimal varieties" by H. Blaine Lawson, Jr.;"On a holomorphic analogue of vanishing minimal scalar curvature" by Gerald D. Ludden and Koichi Ogiue;"Complete, open surfaces in E^3" by Tilla Klotz Milnor;"Minimal varieties in tori" by Tadashi Nagano and Brian Smyth;"Elie Cartan's work on isoparametric families of hypersurfaces" by Katsumi Nomizu;"On Kaehler submanifolds" by Koichi Ogiue;"Isoperimetric and related inequalities" by Robert Osserman;"Minimal submanifolds with m-index 2" by Tomonosuke Otsuki;"A problem of Ordnungszemi^etrie" by William F. Pohl;"On the Hessian of a function and the curvatures of its graph" by Robert C. Reilly;"Pairs of metrics on parallel hypersurfaces and ovaloids" by Donald H. Sinyuk;"Some left-over problems from classical differential geometry" by Michael Spivak; and"Manifolds and submanifolds with vanishing Weyl or Bochner curvature tensor" by Kentaro Yano.

Foliations (B. L. Reinhardt, chairman);"On the de Rham complex of B^k" by B. Cenkl;"Locally free Lie transformation groups of codimension two" by Lawrence Conlon;"On compact foliations" by K. deCesare and T. Nagano;"Semisimplicial Weil algebras and characteristic classes for foliated bundles in Cech cohomology" by Franz W. Kamber and Philippe Tondeur;"Line fields transversal to foliations" by Ulrich Koschorke;"Classifying spaces for Riemannian foliations" by Joel Pasterнак;"Codimension one plane fields and foliations" by Paul A. Schweitzer, S. J.;"The double complex of Θ_k" by Herbert Shulman;"A local construction of foliations for three-manifolds", and"The theory of foliations of codimension greater than one" by William P. Thurston; and"Locally free actions and Steifel-Whitney numbers" by B. B. Winkelnkemper.

Algebraic and Piecewise Linear Topology (T. F. Banchoff and H. R. Gluck, chairman);"Steifel-Whitney homology classes and singularities of projections for polyhedral manifolds" by Thomas F. Banchoff;"Axioms for
characteristic classes of manifolds" by John D. Blanton and Paul A. Schweitzer, S. J.; "On the Gel'fand–Fuchs cohomology" by Raoul Bott; "On SU(n) hyperbolic manifolds" by Myung H. Kwack; "Differential surfaces" by Nigel Hitchin; "Holomorphic mappings to Grassmannians of spheres" by J. D. M. Wright and L. Blanton; and "Fibered singularities and holomorphy operations" by Clint McCrory; "Isolated critical points of complex functions" by John Milnor; "The Chern–Weil construction" by Howard Osborn; and "Characteristic classes and singularities of mappings" by Richard Porter.

Miscellaneous (B. O'Neill and J. Simons, chairmen): "Riemannian submersions from spheres" by Richard H. Escobales, Jr.; "Some open problems in differential geometry" by Leon Green; "Some geometrical aspects of geodesy" by Nathaniel Grossman; "The index theorem for closed geodesics" by W. Klingenberg; "The topology of the solutions of a linear homogeneous differential equation on R^n" by Nicholas H. Kuiper; "Unique structure of solutions to a class of non-elliptic variational problems" by Jean E. Taylor; and "Twist invariants and the Pontryagin numbers of immersed manifolds" by James H. White.

PART 2

Complex Differential Geometry (S. Kobayashi, chairman); "Riemann–Roch theorem for singular varieties" by Paul Baum; "A construction of non-homogeneous Einstein metrics" by E. Calabi; "Generalizations of the Schwarz–Ahlfors lemma to quasiconformal harmonic mappings" by S. I. Goldberg and T. Ishihara; "Holomorphic mappings to Grassmannians of lines" by Mark L. Green; "Some function-theoretic properties of noncompact Kähler manifolds" by R. E. Greene and H. Wu; "Differential geometry and complex analysis" by Phillip A. Griffiths; "On the curvature of rational surfaces" by Nigel Hitchin; "Holomorphic extension for nongeneric CR-submanifolds" by L. R. Hunt and R. O. Wells, Jr.; "Holomorphic extension theorems" by Peter Kiernan; "Residues and Chern classes" by James R. King; "Some classical theorems for holomorphic mappings into hyperbolic manifolds" by Myung H. Kwack; "Some results in f-structures motivated by the Cousin problem" by Richard S. Millman; "Holomorphic equivalence and normal forms of hypersurfaces" by Jürgen Moser; and "On compact Kähler manifolds with positive holomorphic bisectional curvature" by Takushiro Ochiai.

Partial Differential Equations (J. L. Kazdan and F. W. Warner, chairmen): "On the size of a stable minimal surface in R^3" by J. L. Barbosa and M. do Carmo; "Geometry of the spectrum. I" by M. Berger; "Constant scalar curvature metrics for complex manifolds" by Meldyn S. Berger; "Sobolev inequalities for Riemannian bundles" by M. Cantor; "Eigenfunctions and eigenvalues of the Laplacian" by Shiu–Yuen Cheng; "Minkahisundra–ram's coefficients on Kaehler manifolds" by Harold Donnelly; "The spectrum of positive elliptic operators and periodic geodesics" by J. J. Duistermaat and V. W. Guillemin; "Random walk on the fundamental group" by James Eells; "Linearization stability of nonlinear partial differential equations" by Arthur E. Fischer and Jerrold E. Marsden; "The spectral geometry of real and complex manifolds" by Peter B. Gilkey; "Spectral geometry and manifolds of constant holomorphic sectional curvature" by Peter B. Gilkey and Jonathan Sacks; "Whitney's imbedding theorem by solutions of elliptic equations and geometric consequences" by R. E. Greene and H. Wu; "Fourier integral operators from the Radon transform point of view" by V. Guillemin and D. Schaeffer; "A hierarchy of nonsolvability examples" by C. Denson Hill; "Extending isometric embeddings" by H. Jacobowitz; "Prescribing curvatures" by Jerry L. Kazdan and F. W. Warner; "On symplectic relations in partial differential equations" by Bohdan Lawruk; "On periods of solutions of a certain nonlinear differential equation and the Riemannian manifold O^2_2n" by Tomonosuke Otsuki; "Singularities and the obstacle problem" by David G. Schaeffer; "Harmonic mappings of sphere" by R. T. Smith; and "Holomorphic R-torsion for Lie groups" by Nancy K. Stanton.

Homogeneous Spaces (J. Wolf, chairman): "The first eigenvalue of the Laplacian on manifolds of nonnegative curvature" by I. Chavel and E. Feldman; "The generalized geodesic flow" by Leon W. Green; "The eigenfunctions of the Laplacian on a two-point homogeneous space; integral representations and irreducibility" by Sigurður Helgason; "The cohomology ring of SO(2n + 2)/SO(2) × SO(2n) and some geometrical applications" by Hon-Fei Lap; "Representations of linear functionals on HP spaces over bounded homogeneous domains in C^N (N > 1)" by Josephine Mitchell; "Noncompact riemannian manifolds admitting a transitive group of conformorphisms" by Morio Obata; "Critical sets of isometries" by V. Ozols; and "Partial spin structures and induced representations of Lie groups" by Joseph A. Wolf.

Relativity (T. Frankel, chairman): "Einstein–Maxwell theory and the structure equations" by George DeBney; "Lorentzian manifolds of nonpositive curvature" by F. J. Flaherty; "General relativity" by Robert Geroch; "Gravitational waves and averaged Lagrangians" by A. H. Taub; and "Gravitational collapse" by John A. Thorpe.

An author and subject index is included in each part.

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The title of the book has been changed from Nonlinear Functional Analysis to Nonlinear Operators and Nonlinear Equations of Evolution in Banach Spaces.

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QUERIES
Edited by Hans Samelson

This column welcomes questions 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 conjectures. When appropriate, replies from readers will be edited into a composite answer and published in a subsequent column. All answers received to questions will ultimately be forwarded to the questioner. The queries themselves, and responses to such queries, should be typewritten if at all possible and sent to Professor Hans Samelson, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

QUERIES


It should be noted that algebraic equations in general can be solved in terms of extended hypergeometric series, that is, in terms of a wide generalization of the type of series that we have been obtaining as solutions of hypergeometric differential equations. The full theory is impossible here; for one thing it requires multiple hypergeometric series, i.e., series in many variables, but we can use (8.15), (8.16) to give an introduction to it.

Can anybody supply a reference to a place where this is described in more detail?

77. Ramón A. Mirabal (Department of Mathematics, Universidad de Los Andes, Mérida, Venezuela). I would like to know if there exists a concept in infinite dimensional spaces (like Banach spaces of infinite dimensions) that generalizes the usual concept of Jacobian (determinant) of a function.

78. Vijay G. Ukadgaonker (Mechanical Engineering Department, Indian Institute of Technology, P. O. IIT-Bombay Powai, Bombay, India). I would like to know the mapping-function for one-to-one mapping of an infinite plane with two elliptical holes into the annular region bounded by two circular boundaries.

RESPONSES TO QUERIES

Replies have been received to queries published in recent issues of these Notices, as follows: The editor would like to thank all who have replied.


55. (vol. 22, p. 71, Jan. 1975, Shepulsky): S. Baskaran points out that the answer to this query appearing on page 198 of the June 1975 Notices is incomplete since 4 does not divide the order of $S_3$. The query raised is in fact a long-standing conjecture by Frobenius (see e.g., M. Hall, The Theory of Groups, Macmillan, New York, 1969, Chapter 9, p. 137). A partial affirmative answer is that the conjecture is true when the group $G$ is soluble (see e.g., loc. cit., p. 145, Chapter 9, p. 145, Theorem 9.4.1).

70. (vol. 22, p. 250, Aug. 1975, Northover): F. H. Northover wishes to state that he posed this question to the New Haven Conference on Functional Calculus in June 1974, but shortly afterwards obtained the answer to it in the affirmative, and that the question was subsequently published herein without his knowledge.
ABSTRACTS PRESENTED TO THE SOCIETY

Preprints are available from the author in cases where the abstract number is starred.
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The papers printed below were accepted by the American Mathematical Society for presentation by title. The abstracts are grouped according to subjects chosen by the author from categories listed on the abstract form. The miscellaneous group includes all abstracts for which the authors did not indicate a category.

An individual may present only one abstract by title in any one issue of the Notices but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Algebra & Theory of Numbers

*A75T-A253* ADAM O. HAUSENHEFT, University of California, Berkeley, CA 94720.
The Automorphism Class Group of the Category of Rings over an Arbitrary Commutative Base Ring. Preliminary report.

Let $\mathcal{A}_R$ and $\mathcal{C}_R$ be the category of all associative algebras over $R$, and the category of all commutative associative algebras over $R$, respectively, where $R$ is a commutative ring with identity. Let $\mathcal{A}_R$ and $\mathcal{C}_R$ denote the corresponding categories of unitary algebras. Let $\text{Aut}(\mathcal{A})$ be the group of isomorphism classes of self-equivalences of $\mathcal{A}=\mathcal{A}_R, \mathcal{C}_R$. The main result is that the isomorphism class $[(x)_R]$ of the free algebra on one generator in $\mathcal{A}$ is characterizable in terms of morphisms of $\mathcal{A}$ and their compositions. Consequently, $[(x)_R]$ is invariant under $\text{Aut}(\mathcal{A})$. The coalgebra structures on $(x)_R$ in $\mathcal{A} = \mathcal{A}_R, \mathcal{C}_R$ or $\mathcal{C}_R$ are determined. Examples are given of pathological coalgebra structures on $(x)_R$ in $\mathcal{C}_R$.

Finally, if $\mathcal{A}$ is any one of the above categories, then $\text{Aut}(\mathcal{A})$ is shown to be generated by the automorphisms of the form $I_\phi$ and $O_\phi$ where, for each automorphism $\phi$ of $R$, $I_\phi$ acts by changing the module-product to $r \cdot x = \phi(r)x$, and where, for each idempotent $e$ of $R$, $O_\phi$ redefines multiplication on each $R$-algebra to be $x * e y = (1-e)xy + eyx$.

(Received August 4, 1975.)

*A75T-A254* ALBERT A. MULLIN, 6840 Todd Street, Patton Park, Ft. Hood, TX 76544
On the algebraic structure of a pre-ring. Preliminary report.

Definitions. On the set $I$ of all positive irrational numbers define two closed binary composition laws as follows: (1) $a * b$ is the irrational number whose simple continued fraction is obtained by component-wise addition of the integers in the simple continued fractions for $a$ and $b$ and, similarly, (2) $a \circ b$ is the irrational number obtained by component-wise multiplication of the integers in the simple continued fractions for $a$ and $b$. Lemma 1. $(I, *)$ is an abelian semigroup and $(I, \circ)$ is an abelian monoid; further, these two laws are related by a distributive law. Lemma 2. Let $Q$ be the set of all positive quadratic irrationalities. Then $(Q, *)$ is an abelian sub-semigroup of $(I, *)$ and $(Q, \circ)$ is an abelian sub-monoid of $(I, \circ)$; further, $(Q, *, \circ)$ is a sub-pre-ring of $(I, *, \circ)$ which is an homomorphic to $(I, *, \circ)$. Note. The multiplicative identity element of $(I, *, \circ)$ is the so-called "Golden Section" as discussed in mathematical aesthetics.

Problem. Determine (up to isomorphism) the algebraic structure of the set of all cubic irrationalities in $(I, *, \circ)$. (Received August 5, 1975.)
A ring $R$ (with unity) is said to be a (right) weak $q$-ring (in short wq-ring) if every right ideal of $R$, not isomorphic to $R_R$, is quasi-injective. Some of the results proved are: (I) A semi-prime Goldie ring is a wq-ring iff $R$ is semi-simple artinian or is a right PID. (II) A semi-prime wq-ring has zero (right) singular ideal. (III) Let $R$ be a ring with singular ideal zero and the lattice of its closed right ideals finite dimensional. Then $R$ is a wq-ring iff $R$ is semi-prime wq-ring or is an upper triangular $2 \times 2$ matrix ring over some division ring. (IV) Let $R$ be a semi-prime ring with zero socle. Then $R$ is a wq-ring iff $R$ is a right PID or is a strongly regular right self-injective ring. (Received August 12, 1975.)

A remark on Goldbach's conjecture, III.

The notation here is the same as that in "Modern prime number theory" by T. Estermann. Fix $\epsilon > 0$, arbitrarily small. Let $x_0^* = x_0 n^{-\epsilon}$, and for each $n$ let $E_n$ be those points in $[x_0, x_0 + 1]$ which are not in any closed neighborhood of radius $x_0^*$ about any rational number $b/q$ where $(b, q) = 1$ and $q \leq \log^2 n$. It is easy to see that $\int_{E_n} \varphi(x, n) \, dx = O(n \log^{-1} n)$. Here, I show that if this estimate could be improved to $O(n \log^{-2+\epsilon} n)$, then it would follow that every sufficiently large even integer can be expressed as the sum of two primes. In this way the restriction that $(q, n) = 1$ in Part II of the paper is effectively eliminated. (Received September 3, 1975.)

Theorems on hamilton lines and four coloring. I.

Theorem 1. Let $G$ be a connected planar graph with maximal cycle $M$. Then $G$ has a hamilton line if and only if the following conditions hold: (a) Each vertex of $G$ not on $M$ lies on the maximal cycle of an outerplanar subgraph $O_j$ of $G$ where $O_j$ has precisely one edge and two vertices on $M$. (b) If $S = \{O_j : j = 1, 2, \ldots\}$ and $1 \neq j$, then either $O_i \subseteq O_j$ or $O_j \subseteq O_i$ or else $O_i$ and $O_j$ have at most one vertex (which must lie on $M$) in common. Theorem 2. Let $G$ be a bridgeless planar graph all of whose minimal cycles are triangles. Then a sufficient condition for $G$ to be four-colorable as a map is that every vertex of $G$ not on its maximal cycle lies on an outerplanar subgraph of $G$ which contains precisely one edge of the maximal cycle. Corollary. If $G$ satisfies the hypotheses of Theorem 2, then the dual graph of $G$ is four-colorable with respect to its vertices. (Received July 4, 1975.)

Strictly regular semigroups.

For definitions and notation, see Abstract 75T-A169, these Notices 22(1975), A-502. A strictly regular semigroup is a regular semigroup $S$ s.t. $T$, the union of the maximal subgroups of $S$, is a locally inverse semilattice $Y$ of completely simple semigroups $(Ty : y \in Y)$ where $Y$ has a greatest element. Let $Y$ be a semilattice with greatest element; $V$ an inverse semigroup with semilattice $Y$ s.t. each $U'$-class of $V$ is a single element; $(I, \ast)$ $(J, \ast')$ a locally inverse semilattice of left zero semigroups (right groups) $(I : y \in Y)((J, \ast') : y \in Y)$; $I \cap J$ $= \{e\}$, a single idempotent, and $e e = e \ast_y y$; $H_y$ the maximal subgroup of $J_y$ containing $e$; $i - B (b - E) ((c, d) = g(c, d))$ a homomorphism (mapping) of $(I, \ast)$ $(V)$ into $P(J_y)((d, y) = g(d, y))$ $(H = \bigcup (H_y : y \in Y))$ s.t. (1) $J \subset H_y$ for each $J$; (2) $g_{y z} = g_{y z} = g_{y z} = g_{y z} = 0$; (3) $E_{y z} = E_{y z} = E_{y z} = E_{y z}$ for $y, z \in Y$. (Received July 9, 1975.)
Finite-dimensional nonassociative algebras are considered which satisfy certain subsets of the following identities: (1) \((x,x,x) = 0\), (2) \((wx,y,z) + (w,x,[y,z]) = w(x,y,z) + (w,y,z)x\), (3) \((w,x \cdot y,z) = x \cdot (w,y,z) + y \cdot (w,x,z)\), (4) \((x,y,z) + (y,z,x) + (z,x,y) = 0\). It is first observed that nil algebras satisfying (1) and (2) are solvable. The standard Wedderburn principal theorem is then established both for algebras satisfying (1), (2) and (3) and for algebras which satisfy (2) and (4). Throughout it is assumed that the base fields have characteristic different from 2 and 3. (Received August 27, 1975.)

THEOREM. Let \(G\) be a finite group containing an \(S_3\)-subgroup \(M\) which satisfies the following conditions:

(i) \(M\) is a noncyclic 3-group.

(ii) \(\forall x \in M, C_G(x) \subseteq M\).

Then one of the following statements is true.

(a) \(G\) is a Frobenius group and \(M \triangleleft G\).

(b) \(G\) is isomorphic to \(\text{PSL}(2, q)\) for some \(q\).

(c) \(G\) contains a simple normal subgroup of index 2 and type \(\text{PSL}(2, 3^n), n > 1\).

(d) \(G\) is isomorphic to \(\text{PSL}(3, 4)\).

If \(G\) is a nonabelian simple group and \(M\) is noncyclic then (ii) implies that either \(G\) is isomorphic to \(\text{PSL}(3, 4)\) or (b). (Received August 28, 1975.)

THEOREM 2. Let \(G\) be a solvable doubly transitive permutation group of degree \(n\) acting on \(\Omega\), \(0 \in \Omega\). Then the following are equivalent: (i) \(G\) and \(H\) are equally distributed. (ii) \(G_0\) and \(H_0\) are equally distributed. (iii) \(G_0\) and \(H_0\) are isomorphic. Theorem 2

Let \(G\) be a solvable doubly transitive permutation group of degree \(p^n\) acting on \(\Omega\), \(0 \in \Omega\). Let \(k\) equal \(p^n - 1\) divided by the maximum order of all the elements in \(G_0\). Let \(p_0\) be the order of \(p\) modulo \(k\). Then the number of inequivalent solvable permutation groups equally distributed to \(G\) is \(\phi(k)/p_0\), provided \(G\) is equivalent to a subgroup of the full semilinear group over the Galois field of \(p^n\) elements; otherwise, the number is one. (Received August 28, 1975.)

THEOREM. Let \(S\) be a Sylow \(2\)-subgroup of \(\hat{A}_{12}\), where \(\hat{A}_n\) denotes the unique perfect central extension of the alternating group \(A_n\), \(n = 12, 13\). By fusion arguments I could prove the following THEOREM. For a finite group \(G\) with...
Sylow 2-subgroups isomorphic to $S$ one of the following statements holds.

(i) $G$ has a normal subgroup of index 2. (ii) $G/O(G)$ is isomorphic to $\hat{A}_{12}$ or $\hat{A}_{13}$. (iii) $G$ has only one class of involutions and for any involution $z$ of $G$ we have $C_G(z)/O(C_G(z)) \cong \hat{A}_{12}$ or $\hat{A}_{13}$. Of course, groups of type (i) or (ii) are not simple. An unpublished theorem of J. G. Thompson shows that groups of type (iii) cannot be simple. (Received September 2, 1975.) (Author introduced by U. Schreier.)


H. L. Montgomery (Proceedings of the symposia in pure mathematics, Vol. 24, AMS 1973 p. 183-184.) has made a striking conjecture on the density of pairs of the zeros of the Riemann Zeta-function. Assuming the Riemann Hypothesis and a strong formulation of Montgomery's conjecture, the sum $\sum_{n \leq N} (\pi(n+h) - \pi(n))^2$, with $h = \log N$ is computed asymptotically for $N \to \infty$. Using an explicit formula, the sum above is written as a sum over pairs of zeros. The diagonal contributes to the main term. The off-diagonal terms, although too many to be estimated crudely, are shown to cancel to lower order as a consequence of the hypothesis on zero pairs. (Received September 2, 1975.)

75T-A264 DAVID SALTMAN, Yale University, New Haven, Connecticut 06520 Brauer Group of a ring of characteristic $p$. Preliminary Report

Theorem: If $R$ is a ring of characteristic $p$ a prime then the $p$-primary part of the Brauer Group, $B(R)$, of $R$ is $p$-divisible. This generalizes a well known result in the case of fields. The main point is Theorem: If $R$ is as above, $p : R \to R$ is the ring homomorphism gotten by taking $p^e$th powers then this map induces the $p$-power map on the Brauer Group. I prove the above by reducing to the case $R$ is Noetherian and nil-free, and using the embedding of the Brauer Group into etale cohomology as presented by Childs in Orzech and Small's Brauer Group of a Commutative Ring. I consider extensions $R_1 \supset R$ of nil-free rings such that $R_1 \subseteq R$ and using these show Theorem: A azumaya over $R$, $R$ as above and $A$ of exponent $p$ in $B(R)$ then $A$ is split by $C \subseteq R$ of the form $C = \mathbb{R}[x_1]/(x_1^{p^e}) \otimes \cdots \otimes \mathbb{R}[x_n]/(x_n^{p^e})$, $a_1, \ldots, a_n \in R$. Using this and a result of Yuan's I explicitly construct Azumaya algebras of exponent $p$ and use these to prove the first Theorem above as well as Theorem: $R$ is as above and $I \subseteq R$ an ideal then $B(R) \to B(R/I)$ is surjective on the $p$-primary parts. (Received September 8, 1975.)

75T-A265 L.M. Mahony, POB 281, Endicott, New York 13760, Sphere Packing and Crystallographic Groups.

Theorem. There is a natural construction from the negative continued fraction expansion of rational numbers $b^2/a > 1$ to positive definite integral quadratic forms with determinant 1, given by expressing the expansion as the quotient of two determinants of symmetric matrices. A remarkable converse holds, namely: Theorem. For any positive definite integral quadratic form with determinant 1, there exist positive integers $a, b (a < b^2)$ such that this quadratic form corresponds to the previous construction to the negative continued fraction expansion of $b^2/a$. Theorem. If all the integers in the negative continued fraction of $b^2/a$ are even, then the number of integers is congruent to 0 mod (8). The line whose slope is an irrational number $\alpha$, is bounded in the first quadrant of the plane by two convex regions; the vertices of both regions give the intermediate convergents of the positive continued fraction of $\alpha$. Theorem. All the integral points on the boundary of the upper convex region, enumerated in ascending order, given the intermediate convergents in the negative continued fraction expansion of $\alpha$. Correspondingly, a 3rd type of continued fraction expansion of $\alpha$ is obtained by taking as the intermediate convergents, the integral lattice points in ascending order on the boundary of the lower convex region. (Received September 10, 1975.)
Let G be a group and \( \gamma \) be the group ring of G over F, where F is a field of characteristic 0. The ideal \( \Delta = \{ \gamma \epsilon \gamma | \gamma \epsilon \gamma, \gamma \epsilon 0 \} \) is called the fundamental ideal of \( \gamma \).

To any ideal \( \Delta \) in \( \gamma \) we may associate the subgroup \( H(\Delta) = \{ g \epsilon G | g - 1 \epsilon \Delta \} \). It can be shown that \( H(\Delta) \) is normal in G. Then the descending chain of ideals \( \Delta > \Delta^2 > \Delta^3 > \ldots \) determines a descending chain of normal subgroups \( D_1 \supseteq D_2 \supseteq D_3 \supseteq \ldots \), where \( D_i = H(\Delta^i) \). The subgroup \( D_i \) is the \( i \)th dimension subgroup of G with respect to F.

Let \( G_i \) be the \( i \)th subgroup in the lower central series of G and let \( K_i \) be its root closure.

Theorem 1: \( D_1 \supseteq D_2 \supseteq D_3 \supseteq \ldots \) is the fastest descending central series in G having torsion free factors.

Theorem 2: For each \( i \), \( D_i \supseteq K_i \). (Received September 11, 1975.)

A sequence of positive integers \( \{ a_n \} \) is complete with respect to the positive integers if every positive integer \( P \) is the sum of a finite number, without repetition, of the terms of the sequence. Ulam's sequence, \( \{ u_n \} \), is \( u_1 = 1, u_2 = 2 \), and for \( n \geq 3 \), \( u_n = \) the least integer which can be represented in just one way as a sum of two distinct preceding terms of the sequence. Thus, \( \{ u_n \} = 1, 2, 3, 4, 6, 8, 11, 13, 16, 18, 26, 28, 36, 38, 47, 48, 53, 57, 62, 69, 72, 77, 82, 87, 97, 99, \ldots \)

**Theorem 1.** \( \{ u_n \} \) is a complete sequence. The proof is obtained via Theorem 1 in the paper by J.L. Brown, Jr., Amer. Math. Monthly, 68 (1961), 557-560. Conjecture 1. For \( p \geq 3 \), the deletion of the sequence \( \{ u_p \} \) from \( \{ u_n \} \) does not destroy the completeness property of \( \{ u_n \} \).

**Conjecture 2.** For \( p, q \geq 5 \), the deletion of the two terms \( u_p \) and \( u_q \) does not destroy the completeness property of \( \{ u_n \} \).

**Conjecture 3.** Let \( u_1 = 1, u_2 = 2 \), and for \( n \geq 3 \), \( u_n = u_{n-1} + u_{n-2} \). Then \( \{ u_n \} \) is a complete sequence. **Conjecture 4.** For \( n \geq 5 \), \( \{ u_n - n \} \) is a complete sequence. **Remark.** For \( u_1 = 1, u_2 = 2 \), and \( n = 0 \), set \( u_n = 0 \). Then \( \{ u_n \} \) is a complete sequence. Additional questions on \( \{ u_n \} \) are posed in the paper by B. Recaman, Amer. Math. Monthly, 80 (1973), 919-920. (Received September 12, 1975.)

For posets \( L \) and \( K \), denote the linear sum of \( L \) over \( K \) by \( L//K \); if \( L \) has a zero, \( 0_L \), and \( K \) has a unit, \( 1_k \), then the reduced linear sum, \( L//K \), of \( L \) and \( K \) is obtained by identifying \( 0_L \) and \( 1_k \).

**Theorem 1.** Let \( A \) be a nontrivial distributive double p-algebra. (i) \( A \) is simple iff there are Boolean algebras \( L \) and \( K \) such that \( A \cong L//K \). (ii) \( A \) is subdirectly irreducible but not simple iff there are nontrivial Boolean algebras \( L \) and \( K \) such that \( A \cong L//K \).

A subset \( U \) of a poset \( P \) is an order ideal if \( x \epsilon U \) and \( y \leq x \) imply \( y \epsilon U \). The set \( O(P) \) of all order ideals of \( P \) is a complete distributive lattice. For all \( n \geq 0 \), denote the corresponding chain by \( n_\omega \), and denote the n-atom Boolean algebra \( 2^n \) by \( B_n \). The equational class generated by \( A \) is denoted by \( \text{Eq}(A) \).

**Theorem 2.** The lattice of equational classes of distributive double p-algebras is isomorphic to \( \bar{O}(\{0 \times 0 \times x \times y \})/2 \). The lattice of equational subclasses of \( \text{Eq}(B//B) \) is isomorphic to \( \bar{O}(\{m \times n \times 2\})/1 \), and the lattice of equational subclasses of \( \text{Eq}(B//B) \) is isomorphic to \( \bar{O}(\{m \times n \})/1 \). (Received September 15, 1975.)

**Preliminary Report.**

Let \( X \) be a class of groups and \( s \) a subgroup theoretical property. (See D.J.S. Robinson, "Finiteness Conditions and Generalized Soluble Groups," A-707.)
Springer-Verlag, Berlin, 1972.) X is a **pseudovariety** if X is subgroup closed and ultraproduct closed. The class of all Z-groups is a pseudovariety but not a variety. A set \( P = \{ K_a : a \in A \} \) of pairs of subgroups of a group G is a **pseudo-series** if \( K_a \unlhd H_a \leq G \) for each a, and for each nonempty finite subset F of G, there exists a A such that \( F \subseteq H_a \), \( G \in P \); each \( H_a/K_a \) is a factor of \( P/P \) is **normal** if \( K_a \unlhd G, H_a \unlhd G \) for each a; P is an **s-pseudoseries** if P is normal and \( (H_a/K_a) \unlhd (G/K_a) \) for each a; \( G \in (s)p \) if G has an s-pseudoseries. THEOREM. If X is a pseudovariety and s is pseudomarginal, then each of \( \Pi_x, \Pi_n x, (s)p \) is a pseudovariety and the generalized local theorem [Abstract 75T-A69, these Notices 22(1975), A-305] holds.

THEOREM. If X is a pseudovariety and s is pseudomarginal, then each of \( \Pi_x, \Pi_n x, (s)p \) is a local class, but the generalized local theorem does not hold.

(Received September 15, 1975.)

**An algebra is generalized alternative if it satisfies the following identities:**

i) \( (ab,c,d) + (a,b,[c,d]) = (a,b,c,d) + (a,c,d)b \)

ii) \( (a,a,a) = 0 \)

iii) \( (a,b,c,d) = bo(a,c,d) + co(a,b,d) \).

The authors show that a nil finite dimensional generalized alternative algebra of characteristic not 2 is nilpotent. (Received September 15, 1975.)

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*75T-A271* ESTHER SEIDEN and CHING-JUNG WU, Department of Statistics and Probability, Michigan State University, East Lansing, Michigan 48824. On construction of three mutually orthogonal Latin squares by the method of sum composition.

Let \( p \) be a prime and \( p^{\alpha} - 1 = rd \), \( d \geq 3, r > 3 \). Let \( G \) be a cyclic group of order \( r \) in \( GF(p^\alpha) \). It is shown that one can construct three mutually orthogonal Latin squares of order \( p^\alpha + r \) provided that one of the two following conditions holds. (1) There exists a \( g_1 \in G \) such that \( \{ 1 + g_1 - g \mid g \in G \} \) intersects at least three cosets of \( G \). (2) There exist three elements \( g_1, g_2, g_3 \in G \), not all equal, such that \( 1 - g_1 + g_1 g_2, 1 - g_2 + g_2 g_3, 1 - g_3 + g_3 g_1 \) are in three distinct cosets of \( G \). The availability of elements of \( G \) satisfying the conditions above follows from the following result established by P.J. Cameron, J.I. Hall, J.H. van Lint, T.A. Springer and H.C.A. van Tilborg (private communication). Let \( p \) be a prime, \( k = GF(p^\alpha), p^\alpha - 1 = rd \) where \( r \geq 3 \) and \( d \geq 3, \xi \in \xi \) let \( G \) be the subgroup of order \( r \) in \( k^X \).

Then the set \( \xi + G \in \{ \xi + g \mid g \in G \} \) has a nonempty intersection with at least 3 cosets of \( G \) in \( k^X \) unless (i) \( G \) is the multiplicative group of a subfield of \( k \) and \( \xi \in \xi \), (ii) \( G \) is the subgroup of index 2 in the multiplicative group of a subfield \( k_1 \) of \( k \) and \( \xi \in k_1 \). (Received September 15, 1975.)

*75T-A272* KEITH NICHOLSON, University of Calgary, Calgary, Canada T2N 1N4. **Lifting idempotents and exchange rings.**

Idempotents can be lifted modulo a one-sided ideal \( L \) of a ring \( R \) if, given \( x \in R \) with \( x - x^2 \in L \), there exists an idempotent \( e \in R \) such that \( e - x \in L \). Rings in which idempotents can be lifted modulo every left (equivalently, right) ideal are studied and are shown to coincide with the exchange rings of Warfield. Some results of Warfield are deduced and it is shown that a projective module \( P \) has the finite exchange property if and only if, whenever \( P = N + M \) where \( N \) and \( M \) are submodules, there is a decomposition \( P = A \oplus B \) with \( A \subseteq N \) and \( B \subseteq M \). (Received September 15, 1975.)

**Analysis**


From the analytical point of view the filtering and extrapolation theory is based on the equation \( \int B \mathcal{R}(x,y) h(y) dy = f(x) \) \((1)\), \( x \in B \cap \mathbb{R} \), where \( f(x), \mathcal{R}(x,y) \) are known correlation functions, dependance on another parameter in
functions \( h(x) \) and \( f(x) \) is omitted in writing. The function \( h(x) \) is to be found in the class of distributions of finite order of singularity. Let us introduce the class \( \mathcal{R} \) of the kernels: \( R \in \mathcal{R} \) if there exists a selfadjoint elliptic operator \( L \) in \( L^2(\mathcal{K}) \) with the spectral kernel \( \phi(x,y,\lambda) \) and spectral measure \( d\lambda \) and polynomials \( P(\lambda) \geq 0, Q(\lambda) \geq 0, \deg P(\lambda) \geq q = \deg \phi(\lambda) \), such that \( R(x,y) = \int \phi(x,y,\lambda) d\lambda \). The main results: the set of all solutions of finite singularity order is described; the existence, uniqueness and stability (in an appropriate sense) of the solution of minimal singularity order (m.s.o.) of eq. (1) is proved; m.s.o. is calculated; the analytic formula to calculate this solution is obtained. The results are new even in the case \( B = \{ -T, t \} \). The similar theory is developed also for the problem of vectorial process filtering, where \( R \) is the correlation matrix, \( E \) is a matrix differential operator, \( D = \{ -T, f \}, T > 0 \), eq. (1) is a system of integral equations. It is essential that we manage to handle the problem without any help of factorization theory, though rather cumbersome, but widely used in the class \( R(x,y) = (R\cdot y) \) and in this very case is of some practical effectiveness only when the Fourier transform \( \mathcal{F}(\lambda) \) is fraction-rational. (Received May 27, 1975.)


The most important version of essential spectra for applications is the limit point spectrum \( \sigma_e(T) \) originally introduced by Weyl for self-adjoint operators \( T \) and later developed by Browder and others for closed densely defined operators \( T \) in a Banach space.

This essential spectrum \( \sigma_e(T) \) may be described as consisting of those scalars \( \lambda \) such that \( T+\lambda I \) is not "algebraically Fredholm," and may be characterized as follows. Theorem. The Weyl-Browder algebraic essential spectrum \( \sigma_e(T) \equiv \bigcap_M \sigma_M\left( P(T+\lambda I) \right) \), where \( M \) is any subspace of finite codimension such that the Weinstein-Aronszajn determinant \( \omega(\lambda; P(T+\lambda I) \right) = 1-P(T+\lambda I) \right) \) does not vanish for small \( \lambda \neq 0 \), \( \lambda_0 \in \sigma_M(P(T+\lambda I) \right) \). This characterization of the Weyl-Browder spectrum via the connection with the Weinstein-Aronszajn determinant theory of intermediate problems is new and corrects and extends a similar but incomplete characterization given by Salinas (Proc. Amer. Math. Soc. 38(1973), 369-373) for \( T \) on a Hilbert space, which proceeded along different lines. (Received June 23, 1975.)

REKHA PANDA, University of Victoria, Victoria, British Columbia, Canada V8W 2Y2 and Ravenshaw College, Cuttack-3, Orissa, India. Certain dual series equations involving Laguerre polynomials. Preliminary report.

By applying a generalization of the multiplying factor technique employed by several earlier writers (cf., e.g., H. M. Srivastava [Pacific J. Math. 30 (1969), 525-527]), the author obtains an exact solution of the dual series equations

\[
(1) \quad \sum_{n=0}^m \left( A_n / (a+n+p+1) \right) L_n^{(a)}(x) = f(x), \quad x \in I_1 = \{ x \mid 0 \leq x < y \}
\]

and

\[
(2) \quad \sum_{n=0}^m \left( A_n / (a+\beta+n+p) \right) L_n^{(a)}(x) = g(x), \quad x \in I_2 = \{ y < x \leq \}
\]

where \( a+\beta+1 > l-m, a+l > a+\beta > 0, m \) is a positive integer, \( p \) is an arbitrary non-negative integer,

\[
(3) \quad L_n^{(a)}(x) = \binom{n}{k} \binom{n}{n-k} \frac{(-x)^k}{k!}, \quad n \in \{0,1,2,\ldots\},
\]

is the Laguerre polynomial of order \( a \) and degree \( n \) in \( x \), and \( f(x) \) and \( g(x) \) are prescribed functions. The values of the series in (1) and (2) on the intervals \( I_2 \) and \( I_1 \), respectively, are also computed. (For \( p = 0 \), equations (1) and (2) would reduce to those considered earlier by Srivastava [loc. cit.].) (Received June 30, 1972.)

S. ZAIDMAN, Université de Montréal, Montréal, Quebec, Canada. A regularity property of abstract differential equations. Preliminary report.

Consider two continuous functions \( u(t) \) and \( f(t) \) from a finite real interval \( [a, b] \) to a Banach space \( X \), and let \( A \) be a linear closed operator with dense domain in \( X \), whose dual operator \( A^* \) also has dense domain in \( X^* \). Assume that \( u' - Au = f \) on \( [a, b] \) in a natural "weak" sense and that the strong derivative \( u'(t_0) \) exists for \( t_0 \in [a, b] \). Then \( Ju(t_0) \in \mathcal{D}(A^{**}) \) and \( (Ju)'(t_0) = A^{**}(Ju)(t_0) + Jf(t_0) \) is verified. Here \( A^{**} \) is the second dual to \( A \) acting in the bidual space \( X^{**} \) and \( J \) is the canonical map of \( X \) into \( X^{**} \). The result and its proof extend previous work of the author. (Received June 30, 1975.)
It is proved that for definite quadratic programs satisfying a constraint qualification, the solutions to the primal and dual problems depend Lipschitz continuously on the data. In many cases, these results yield nonlocal, a priori estimates for the sensitivity of a quadratic program to changes in the data. As an application of the theory, Lipschitz continuity properties are derived for the optimal control solving a state and control constrained, quadratic, optimal control problem and the dual multipliers corresponding to the constraints.

(Received July 16, 1975.)

Using two Bergman operators, one can represent all solutions, holomorphic in a certain domain, of a given second order linear partial differential equation in two variables. For the investigation of general properties of those solutions, operators with polynomial kernels are particularly effective. The authors recently gave a construction principle for equations which admit such kernels, as well as for the kernels themselves. In this paper, it is shown that equations

\[ u \bar{z} z_2 + b \bar{z} z_2 + c u = 0 \]

with coefficients of the form

\[ b = (n - m)h_1 '(h_1 + h_2)^{-1} \]

and

\[ c = -n(m + 1)h_1 'h_2 '(h_1 + h_2)^{-2} \]

are of that type; here, \( m, n \in \mathbb{N} \) and \( h_1(z_1) \) and \( h_2(z_2) \) are such that \( b \) and \( c \) are holomorphic in the domain considered. At present, this is the most general known equation of that type. The kernels are given explicitly. They are of minimal degrees \( n \) and \( m \), respectively. The use of a theorem by the authors (Manuscripta Math. 1 (1969), 369-376) permits the conversion of those representations to a form which is obtainable by certain differential operators. (Received July 30, 1975.)

THEOREM 1. There exists a rational function of the form

\[ r_{m,n}(x) = \frac{P_m(x)}{Q_n(x)} \]

where \( P_m(x) \) and \( Q_n(x) \) are polynomials of degrees \( m \) and \( n \) respectively. Then

\[ \| e^{-x} - r_{m,n}(x) \|_{L^\infty[0,1]} \leq \frac{C_1}{2^{m+n}(m+n)!} \]

THEOREM 2: There exist polynomials of the form

\[ P(x) = \lambda_1 \sum_{k=1}^{n} \frac{\lambda_k x^k}{\lambda_1^2} \]

where \( a_0 > 0 \) and \( \lambda_k \)'s are positive integers for which

\[ \| e^{-x} - \frac{1}{P(x)} \|_{L^\infty[0,\infty]} \leq C_2 (\log \lambda_1)^{1-\lambda_1} \]

\( C_1 \) and \( C_2 \) are suitable positive constants. (Received August 18, 1975.)

A note on the eigenvalues of densifying mappings

Theorem 1. Let \( D \) be an open bounded subset of a Banach space \( X \) such that origin belongs to \( D \). Let \( T: D \rightarrow X \) be a densifying mapping. Suppose \( T \) does not have a fixed point in \( D \). Then there exist \( \lambda_1 > 0, \lambda_2 < 0 \) and \( x_1, x_2 \) such that \( T(x_j) = \lambda_j x_j, j = 1,2,1.e. \) \( T \) has a negative eigenvalue and a nonnegative eigenvalue.

Theorem 2. Let \( D \) be a cone in a Banach space \( X \). Let \( T: D \rightarrow X \) be a positive densifying mapping such that for some \( N_0 > 0, \inf_{x \in D} \| T(x) \| > 0 \). Then the operator \( T \) has
at least one eigenvector \( x_0 \), \(|x_0| = M_0 \) in the cone \( D \), corresponding to a positive eigenvalue \( \lambda \), \( T(x_0) = \lambda x_0 \). As a corollary of Theorem 2, we have Corollary 1. Let \( X \) be a Banach space. Let \( D \) be a cone in \( X \). Let \( T: D \rightarrow X \) be a positive densifying mapping satisfying \( \inf_{x \in D} |T(x)| > 0 \). Then \( T \) has an eigenvector \( x_0 \), moreover \(|x_0| = M_0 \). As a corollary to corollary 1, we have following result due to E. H. Rothe, Corollary 2. A positive completely continuous operator \( T \) has an eigenvector \( x_0 \), \(|x_0| = M_0 \) if the following condition is satisfied \( \inf_{x \in D} |T(x)| > 0 \). (Received August 19, 1975.)

On a nonlinear dispersive equation

We consider the equation \( (1) u_t + u_x - u_{xxt} + (F(u))_x = 0 \) for \(-\infty < x < \infty , \ t \geq 0 \) where subscripts indicate partial derivatives and we improve some recent results about equations of type \( (1) \) (See Notices Vol.22, #4, June 75 75T-B116 and 75T-B122): we have the THEOREM: Consider the equation \( (1) \) in \(-\infty < x < \infty , \ t \geq 0 \), with initial data at \( t = 0 \) which is \( 1 \)-periodic, belongs to \( C^\infty (R) \) and the boundary condition \( u(x+1,t) = u(x,t) \) for all \(-\infty < x < \infty , \ t \geq 0 \) and \( F(\cdot) \in C^\infty \) (without any assumption on the sign of \( F' \)). Then there exists a unique periodic (in \( t \)) solution \( u \in C^\infty \). We also treat the initial value problem by assuming that the initial data (of \( (1) \)) at \( t = 0 \) is sufficiently smooth and vanishes rapidly at \(|x| \to \infty \), provided that \( F \in C^\infty \) and such that \( e^{-|s|} |F(s)| \to 0 \) as \(|s| \to \infty \), then \( (1) \) has a unique (classical) non-periodic solution. For this last part we use a fixed point type argument. (Received August 27, 1975.)

Strong interpolation of \( \Lambda_0(X) \) and applications, Preliminary report.

The notation and definitions of the \( \Lambda_0(X) \) spaces are taken from Sharpley ("Spaces \( \Lambda_0(X) \) and interpolation", J. Functional Analysis 11 (1972), 479-513). Under mild restrictions either \( X \in U, X \in L \), or both) the following results hold. Lemma 1 \( K(t,f;\Lambda(X),M(X)) \leq \int_0^T 0 < \infty \). \( K \) is Peetre’s \( K \) functional, \( \Theta \) the decreasing rearrangement for the measure \( \mu(t) = \log t \). Thm 1 \( \Lambda_0(X) = \{ \int |[f_F h_X]^s| \} < \infty \) is an interpolation space for \( (\Lambda(X),M(X)) \). Cor 1 \( \Lambda_0(X),\Lambda_1(X),\Lambda_2(X) \) are \( \Theta \)-invariant and \( \Lambda_0(X) = \Lambda_0(Y) \subseteq \Lambda_1(Z) \) if \( \alpha \beta > \gamma \), and \( \varphi_2(st) \leq c_{\varphi_2}(s) \varphi_2(t) \), \( \varphi_2(t) \) the projective cross norm. Most of the above results were announced orally at the AMS special session on "Interpolation of Operators and Applications" in Washington, 1975. Complex interpolation yields: Thm 2 \( \Lambda_0(X),\Lambda_1(Y) \subseteq \Lambda_1(Z) \), where \( Z = [X,Y]_\gamma \), \( \gamma = (1-\theta)\alpha + \theta \beta \). Cor 3 \( \Lambda_0(X) \subseteq \Lambda_0(Y) \subseteq \Lambda_1(Z) \), if \( \alpha \beta > \gamma \), \( t\varphi_2(t) \leq c_{\varphi_2}(t) \varphi_2(t) \). Similar applications to other multilinear operators including mixed norm results for integral operators, follow. (Received September 5, 1975.)

If \((A_0,A_1)\) is an interpolation pair with \( A_0 \subseteq A_1 \) and \( T \) is a possibly nonlinear operator which maps \( A_0 \) into \( A_0 \) and \( A_1 \) into \( A_1 \) with \( \|Tx\|_{A_0} \leq M_1 \|x\|_{A_0} \) and \( \|Ty-Tz\|_{A_1} \leq M_1 \|y-z\|_{A_1} \) for all \( x \in A_0 \), all \( y \) and \( z \in A_1 \) and some constant \( M_1 \), then it is known that \( T \) also maps the real interpolation spaces \((A_0,A_1)\) into themselves. We construct an example which proves a conjecture of J-L. Lions, namely that such an operator \( T \) does not necessarily map the complex interpolation spaces \([A_0,A_1]\) into themselves. (Received June 20, 1975.)
The chief purpose of this paper is to present an alternate approach to results concerning the existence and uniqueness of monosplines which have a maximum number of zeros (the fundamental theorem of algebra for monosplines). In addition, we discuss the related problems of "double precision" quadrature formulae and one-sided $L^1$-approximation by spline functions with fixed knots. For the most part, the methods available for dealing with versions of the fundamental theorem of algebra for monosplines required detailed analysis based on the implicit function theorem. Our approach here explores a method based on moment theory, originally suggested by I. J. Schoenberg, and relies on the following theorem proved in this paper. Theorem 1:

Let $M$ be a weak Chebyshev subspace of even dimension on $[0,1]$, which contains a strictly positive function on the open interval $(0,1)$. Then every positive measure relative to $M$ has a lower principal representation. (Received August 1, 1975.)

Some results on derived spaces. Preliminary report. (Received September 11, 1975.)

Let $G$ be a locally compact group equipped with a left-invariant Haar measure. For $h \in L_1(G)$, let $||h||_{sp}$ be the norm of $h$ as a left convolution operator on $L_1^p(G)$ and for $1 \leq p \leq \infty$, let $L_0^p$ be the set of functions $f$ in $L_1(G)$ for which the norm $||f||_p = \sup ||hf||_{L_1^p}$ is finite, where the sup is taken over all $h \in L_1(G)$ for which $||h||_{sp} \leq 1$.

The Banach space $L_0^p$ is called the derived space of $L_1(G)$. Theorem 1. If $G$ is compact, the trigonometric polynomials are dense in $L_0^p$. Theorem 2. There exists a compact group $G$ and an $f \in L_1(G)$ such that if $f^k(x) = f(x^{-1})$, then $f^k \in L_0^p$. Theorem 3. If $G$ is not compact and if $1 \leq p < 2$, then $L_0^p = \{0\}$. Theorem 4. If $G$ is noncompact and abelian, if $1 \leq q \leq 3$, and if $p^{-1} + q^{-1} = 1$, then there exists $f \in L_1(G)$ such that $f^pL_q(G) \in B(G)$ but $f^qL_p(G) \notin B(G)$. Thus $f \in L_0^p$ but $f$ is not approximable in the $L_0^p$ norm by Fourier transforms of functions in $L_1(G)$. Remarks: Theorems 1 and 2 answer questions of D. S. Browder [Pacific J. Math. 43(1972), p. 49]. Theorem 3 generalizes results of several authors, and Theorem 4 partially answers a question of D. B. Hahn-Talamanca [Rend. Sem. Mat. Univ. Padova 35(1965), p. 186]. (Received September 12, 1975.)

New estimates are derived and used to prove the existence of global solutions to the Cauchy Problem for the one-dimensional Maxwell-Dirac
and Klein-Gordon-Dirac Equations. The basic inequalities are obtained for the $H^1$-norm of the spinor field, and it is shown that this norm dominates the square of the same norm of the corresponding potentials, a result which is also valid in higher dimensions. In addition, the exact solution of the one-dimensional Maxwell-Dirac equations is given for the case $M=0$. (Received September 15, 1975.)


We prove the direct analogue for retarded functional differential equations of the form $x'(t) = f(\lambda, x_t)$ (notation as in Hale's book, Functional Differential Equations) of a global bifurcation theorem of Alexander and Yorke ("Global bifurcation of periodic orbits", to appear) for ordinary differential equations. The main technical difficulties stem from the infinite dimensional nature of the problem (contrast the O.D.E.'s case) and the fact that the map $\phi: C([-r,0], \mathbb{R}^n) \rightarrow x_t$ is not compact for $0 \leq t < r$. A detailed statement of the result is too long to give here. (Received September 15, 1975.)

Applied Mathematics


The Value Function of MIP: II.

Notation as in I; again, assume $g(0) = 0$, and $A, B$ matrices of rationals. Define $W_b = \{ (x, y) \mid Ax + By = b; x, y \geq 0 \}$ and $L(b) = \inf \{ cx + dy \mid (x, y) \in W_b \}$.

Theorem 1: There are constants $C, D$; vectors $w_1, \ldots, w_k$; and a matrix $T$; such that

$$g(b) = \inf \left\{ H(b - Ax) \mid T(b-Ax) \geq 0, x \geq 0, x \text{ integer, } \right\}$$

where $H(v) = \max \{ w_1 v, \ldots, w_k v \}$.

Theorem 2: There exists a constant $K$, such that, for any $b$ with $S_b \neq \emptyset$, if $(x_0, y_0) \in W_b$ and $cx_0 + dy_0 = L(b)$, then there is $(x_1, y_1) \in S_b$ with $cx_1 + dy_1 = g(b)$, for which

$$\left| (x_0, y_0) - (x_1, y_1) \right| \leq K.$$

Theorem 3: For any $a \in \mathbb{R}^m$ there is $c_0 \in \mathbb{R}$ such that, if $S_b \neq \emptyset$, the infimum of $c_0x_0 + cx + dy$ (subject to $Ax + By = b$, $x_0, x, y \geq 0$ and $x_0, x \text{ integer}$) is $g(b)$.

(Received July 11, 1975.)


Finite Basis Theorems for Integer Variables: II.

Notation and terminology is from I; $M$ is an integral monoid. A polyhedral monoid is one defined by $M = \{ x \text{ integer } \mid Ax \geq 0 \}$ for some rational matrix $A$. A slice is a set $S$ of the form $T + M$, $M$ with finite basis and $T \neq \emptyset$ a finite set of integer vectors. Proposition: The convex span of a slice is a (rational) polyhedron.

Theorem 1: $M$ has a finite basis if and only if it is the projection of a polyhedral monoid on certain co-ordinates.

Theorem 2: If $S = \{ x \mid Ax \geq b, x \text{ integer } \}$ with $A, b$ rational and $S \neq \emptyset$, then $S$ and all of its co-ordinate projections are slices.

Theorem 3: If $S_1, S_2$ are slices and $S_1 \cap S_2 \neq \emptyset$, then $S_1 \cap S_2$ is a slice.
Theorem 4: If M has a finite basis, there is a decomposition M = H+M′ into a group H and an integral monoid M′, with clcone (M′) pointed and H ∩ M′ = {0}. H = M ∩ L, where L is the lineality space of clcone (M). (Received July 14, 1975.)

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Minimal Error Difference Formulas.

The r th advancing difference of f(X), at intervals of h, when calculated by the well-known expression Πnk=0(-1)r-kf(X0+kh), could be in error by 2rε, where ε is the [error] in f(X). Within any finite interval, normalised to [1,1], when f(X)=or ax, with sufficient closeness) P(X), for many combinations (Xo,h), and choices of X1, i=1(1)n+1, within [-1,1], we have αi<2

The nodes X_i that minimize 2 separately for each relation (2) are given for (Xo,h), expressed as h>h_0 which depends upon X_0 and extrema of Chebyshev polynomials. (Received September 8, 1975.)

*75T-C65 RENATO M. CAPOCELLI, Laboratorio di Cibernetica del Consiglio Nazionale delle Ricerche, Arco Felice, Napoli 80072, Italy, A necessary and sufficient condition, an alternate to the one of Sardinas and Patterson, for unique decipherability of coded messages is provided, (Received September 12, 1975.)

Logic and Foundations

75T-E75 ALAN ADAMSON, Univ. of California, Berkeley, Ca. 94720.

Admissible Sets and Saturation of Models, Preliminary report

Let A be an admissible set. Let M=(M,.....) be a structure for a language L. M is A-Saturated means that the existential quantifier and A-finite disjunction distribute over conjunctions of A x collections of formulas of L_A in Th_{co,w}(M). A(M) is the collection of sets built on urelements M, constructible from M and elements of A in co steps, ≤A. C is admissible over A means C is an admissible set containing A and satisfying the schema ∀XєX, ∀yєA → ∃ωєX, ∃yєA, Σ, for Σ, Saturated.

Theorem 1: FAE i) M is A-Σ-saturated ii) A(M) is admissible over A.

Theorem 2: If ωєA, FAE i),(ii),(iii) There is an admissible over A C with no urelements, containing an isomorphic copy of M.

Using these two theorems, it is possible to prove all the standard theorems on Σ-saturated structures from generalisations of standard theorems of admissibility theory.

Remark: i) is not implied by "A(M) is admissible". (Received August 23, 1975.)

*75T-E76 ALAN MEKLER, Department of Mathematical Sciences, Lakehead University, Thunder Bay, Ontarip, Canada

The Size of Epimorphic Extensions

A sharp bound is given for the size of epimorphic extensions in categories of models defined over elementary logic and L_{ωκ}, where κ is strongly compact. For fragments of L_{ωκ}, an example is given of a category which has a countable model with epimorphic extensions whose cardinals approach and include the first measurable cardinal. If no measurable cardinal exists then this category has a countable model with epimorphic extensions of unbounded cardinality. (Received September 2, 1975.)

75T-E77 STAVI, JONATHAN, Dept. of Math., Stanford University, Stanford, California 94305

"On Σ-equivalence of Boolean algebras, rings and groups"
isomorphic. Fix a regular uncountable cardinal $\lambda$. M. Morley proved that there exist trees $G, B$ such that $N_\lambda(G, B)$. Theorem 1. (a) There exist Boolean algebras (atomic, as well as atomless) such that $N_\lambda(G, B)$. [Hence, there exist also Boolean rings with this property.] (b) If $\lambda$ is strongly inaccessible one can choose $G$ and $B$ as atomless, $< \lambda$-complete and $(< \lambda, < \omega)$-distributive Boolean algebras. Theorem 2. Let $2^\lambda$ be the (full) direct product of $\lambda$ copies of the ring $\mathbb{Z}$ of integers. There exist subrings $G, B \subseteq 2^\lambda$ such that $N_\lambda(G, B)$.

Theorem 1. Let $\mathfrak{M}_{\mathfrak{A}}$ be the group of even permutations of 5 elements. There exist subgroups $G, B \subseteq \mathfrak{M}_{\mathfrak{A}}$ such that $N_\lambda(G, B)$.

Theorem 1(a) is proved by associating Boolean algebras with the trees constructed by Morley, l(b) by some forcing constructions. Theorems 2 and 3 are deduced from 1 by considering a subdirect product operation associated with any atomic Boolean algebra. The proof of 3 makes use of the simplicity of $\mathfrak{A}_{\mathfrak{A}}$.

For more on the relation $N_\lambda$ (linear orderings) see a previous abstract with Mark Nadel in these Notices, October 1975. (Received September 2, 1975.) (Author introduced by Mr. Scott Wolpert)

CARL F. MORGENSTERN, University of Colorado, Boulder, Colorado 80302

An independence result concerning the ordering of certain large cardinals.

Define a cardinal $\kappa$ to be huge if there is an elementary embedding $j : V \rightarrow M$ with $\kappa$ the first ordinal moved by $j$ and $M$ a transitive class containing the ordinals which is closed under $j(\varepsilon)$ sequences. From a certain large cardinal axiom one can produce models $M_1 \vDash \text{ZFC } + \text{"1st huge cardinal } > \text{1st strongly compact cardinal"}$ and $M_2 \vDash \text{ZFC } + \text{"1st strongly compact cardinal } > \text{1st huge cardinal."}$ The result remains true when "huge" is replaced by "2 - huge", "Vopenka", etc. (Received September 8, 1975.)


Invariant sentences were defined in Abstract 75T-E36, these Notices 22(1975), A-473. Theorem. Two topological ultrapowers of the same similarity type have topologically isomorphic ultrapowers iff they satisfy the same invariant sentences. (Received September 11, 1975.)

Statistics and Probability


Fix $0 < \beta < 1$, and fix a continuously differentiable monotone-increasing function $F$ with $F(0) = 0$ and $F(1) = 1$. Given $n$, define a probability distribution $\{p_1^{(n)}, \ldots , p_n^{(n)}\}$ via $p_1^{(n)} = F(i/n) - F((i-1)/n)$. There are $n$ balls labeled $1, \ldots, n$ and a box which can hold the fraction $\beta$ of the $n$ balls. At each discrete time, one of the $n$ balls is selected, where ball $i$ is selected with probability $p_i^{(n)}$. If the selected ball is not in the box, then it is placed in the box, and the ball in the box which has been least recently selected is removed. The box always contains the $\lceil \beta n \rceil$ balls which have been most recently selected. The expected weight $W_n$ of the box, that is, the expected sum of the selection probabilities of the balls in the box (which is also the long-range probability that the next ball selected is already in the box) is given by a complicated combinatorial sum, but is shown to be approximated arbitrarily closely (as $n \to \infty$) by $Z_n = 1 - M(S^{\infty}((\beta n) \downarrow)))$, where $S(T) = n \sum_{i=1}^n (1 - p_i^{(n)})^T$, and $M(T) = \sum_{i=1}^n p_i^{(n)} (1 - p_i^{(n)})^T$. Also, $W_n$ and $Z_n$ are $1 - f(y^{\beta}(\beta)), \text{ where } f(y) = \int_0^1 p'(x) e^{-y f'(x)} dx$, and $g(y) = 1 - \int_0^1 e^{-y f'(x)} dx$. If the box is a computer's fast memory, and the balls are pages of either data or instructions, then $W_n$ is known in computer science as the "least-recently-used hit ratio", and $Z_n$ as the "working-set hit ratio", in the "independent reference model". (Received June 30, 1975.)
Topology

75T-Gl17 CHANDAN S. VORA, The Free University of Iran, P.O. Box 11-1962, Tehran 14, Iran. Fixed Point Theorems for certain compact weighted maps of a manifold. Preliminary report.

Weighted maps were defined by G. Darbo in his paper "Teoria dell omologia in una categoria di mappe plurivalenti ponderate," Rend. Sem. Mat. della Univ. di Padova 28 (1958). He proved Lefschetz type fixed point theorem for such mappings of a compact weighted maps of metric ANR's. In this paper author proves a theorem for certain symmetric product mappings of a manifold, and that of J.W. Jaworowski for certain mappings of a manifold as particular cases. (Received July 21, 1975.)

75T-Gl18 CARLOS R. BORGES, University of California, Davis, California 95616. Weak Unions of Absolute Retracts.

It is easily seen that the union of an expanding sequence of absolute retracts may not even be an absolute neighborhood retract. We prove that the weak union of an expanding sequence of absolute (neighborhood) retracts is an absolute (neighborhood) retract. We also partially answer a question of K. Borsuk; we prove that the hyperspace of compact subsets of a locally compact, connected and locally connected metric space, with the Hausdorff metric, is an absolute retract. (Received July 28, 1975.)

*75T-Gl19 Teodor Przymusinski, 00-950 Warszawa, Poland, Institute of Mathematics of the Polish Academy of Sciences; Normality and collectionwise Hausdorff property.

Let MA stand for Martin's Axiom and let $E(\omega_k)$ be the statement: there is a set $E$ of ordinals of cofinality $\omega$ which is stationary in $\omega_2$, but not in any smaller limit ordinal. Making extensive use of W.Fleissner's technique and of a recent result of R.Pol we obtained the following examples:

Example 1. $E(\omega_2) + CH / \text{A first countable perfectly paracompact space } X \text{ such that } X^2 \text{ is collectionwise Hausdorff, but not normal.}$

Example 2. $E(\omega_2) + MA + \neg CH / \text{A first countable paracompact space } X \text{ such that } X^2 \text{ is perfectly normal and collectionwise Hausdorff, but not collectionwise normal.}$

Example 3. $E(\omega_2) / \text{A perfectly normal collectionwise Hausdorff space, which is not collectionwise normal.}$ (Received July 7, 1975.)

*75T-Gl20 MICHAEL COWLING, Istituto di Matematica, Università di Genova, Via L.E.Alberti 4, Genova, Italy. On a Conjecture of F.M.Stein.

Let $G$ be a connected semisimple Lie group with finite center, and $L^p(G)$ the usual Lebesgue space on $G$ relative to Haar measure. It is shown that, if $1 \leq p \leq 2$, then $L^p(G) \subseteq L^2(G).$ This verifies a conjecture of F.M.Stein (Advances in Math., 1970). (Received September 3, 1975.)

75T-Gl21 W. W. COOOGRT and TEKLEHAIMANOT RETTA, Wesleyan Univ., Middletown, CT 06457. Separable unions of copies of $\aleph_1N$. Preliminary report.

R. Levy and R. H. McDowell [Proc. Amer. Math. Soc. 49 (1975), 426-430] have shown that for $\omega \leq \gamma \leq 2^\omega$ there is a separable completely regular Hausdorff space $S(\gamma)$ which is equal to the (appropriately topologized) union of $\gamma$ disjoint copies of $\aleph_1N$. A-716
and they asked whether such a space $S(\gamma)$ exists for $\gamma > 2^{2^\omega}$. We respond. Theorem. Such a space $S(\gamma)$ exists if and only if $\omega \leq \gamma \leq 2^{2^\omega}$. Proof. (⇒) Immediate, elementary. (⇐) Let $2^{\omega} < \gamma \leq 2^{2^\omega}$, let $X$ be the union of $\gamma$ pairwise disjoint subsets of $\beta\mathbb{N}\setminus\mathbb{N}$ of which each is homeomorphic to $\beta\mathbb{N}\setminus\mathbb{N}$ (as given, for example, in W. W. Comfort and S. Negrepontis, The Theory of Ultrafilters, Springer-Verlag 1974; Lemma 7.14 or Lemma 16.13(b)), define $S(\gamma) = (\mathbb{N} \times S(\omega)) \cup X$ -- i.e., obtain $S(\gamma)$ from $\mathbb{N} \times X$ by replacing each $n \in \mathbb{N}$ by the Levy-McDowell space $S(\omega)$ -- and take as a base for $S(\gamma)$ the family $\mathcal{B}_0 \cup \mathcal{B}_1$, where $\mathcal{B}_0 = \{[n] \times U : n \in \mathbb{N}, U \text{ open in } S(\omega)\}$ and $\mathcal{B}_1 = \{(A \times S(\omega)) \cup \{q \in X : A \in q\} : A \subseteq \mathbb{N}\}$.

(Received September 5, 1975.)

\*75T-G122 AKI KANAMORI, University of California, Berkeley, California 94720. On p-points in $\beta\mathbb{N}$. Let $U$ be an ultrafilter over $\omega$. Theorem 1. $U$ is a $p$-point iff whenever $X \in U$ and $A \subseteq U$ so that for any $n \in \omega$, $[Y \in \mathbb{N} \mid Y \cap n = X \cap n]$ has infinite cardinality, there is an infinite $B \subseteq A$ so that $\cap B \in U$. Theorem 2. If $U$ is a $p$-point and $[X_\alpha[\alpha < \omega_1] \subseteq U$, for any $\delta < \omega_1$ there is a $T \subseteq \omega_1$ so that $T$ has order type $\delta$ and $\cap \{X_\alpha[\alpha \in T] : T \subseteq \omega_1\} \in U$. (Received August 28, 1975.)

\*75T-G123 O.T. AIAS, Caixa Postal 20570 (Iguatemi), São Paulo, Brazil. On compact-expandable spaces. Preliminary report. Let $E$ be a Hausdorff space and $n$ be an infinite cardinal number. Definition: $E$ is compact-$m$-expandable (compact-$m$-collectionwise normal) if for each locally finite family (discrete family) of compact subsets of $E$, $(F_i)_{i \in I}$, with $|I| < m$, there is a locally finite (discrete) family of open subsets of $E$, $(U_i)_{i \in I}$, such that $F_i \subseteq U_i$, $\forall i \in I$. Definition: $E$ is compact-$m$-normal if for each two disjoint closed subsets of $E$, $F$ and $K$, one of which is the union of a locally finite family (of cardinality $\leq m$) of compact subsets of $E$, there are two disjoint open sets containing $F$ and $K$ respectively. Theorem. Let $E$ be a compact space with weight $\nu(E)$ and $Z$ be a Hausdorff space. If $X \times Z$ is compact-$\nu(X)$-normal, then $Z$ is compact-$\nu(X)$-expandable. Other results are proved. (Received September 8, 1975.)

\*75T-G124 Professor Graham H. Toomer, The Ohio State University, 231 W. 18th Avenue Columbus, Ohio 43210

Realizing the quotients of the lower central series naturally.

Let $A$ be a connected space, $m \geq 1$ a fixed integer and $k \geq 0$ arbitrary. Theorem 1. There are spaces $\pi^k_m(A)$ and functorial maps $A \to \pi^k_m(A)$ which induce the canonical map $\pi^k_m(A)/\pi^k_m(A)$, where $\pi^k_m(A)$ denotes the $k$th term in the lower central series of the $m$th Postnikov stage of $A$. Theorem 2. An $(m+1)$-homology equivalence $\alpha : A \to \alpha$ induces an isomorphism $\pi^k_m(A)/\pi^k_m(A)$ provided (1)

$$H_m(A) \to H_m(\alpha(A))$$

is injective (ii) $H_r(A) \to H_r(\alpha(A))$ is surjective, $r = m+1, m+2$.

The theorems of Stallings-Stammbach and Dror [A generalization of the Whitehead Theorem. Lecture Notes in Math #249, Springer Verlag (1971) 13-22] follow readily. Corollary 3. (Generalized Hurewicz Theorem) Let $n \geq 0$ and $H_r(\alpha(A)) = 0$ for $r \leq n+1$. Then $\pi^k_m(A) = 0$ for $r \leq n+1$ provided $A$ and $\alpha(A)$ are nilpotent.

Neither group cohomology nor spectral sequence techniques are used. (Received September 10, 1975.)
A Note on Monotonic Ortho-bases.

At the 1974 Topology Conference at Charlotte, North Carolina, Peter Nyikos introduced the concept of an ortho-base and announced that a $T_2$ paracompact first-countable $\delta$-space having an ortho-base is metrizable. The purpose of this paper is to introduce an obvious monotonic generalization of ortho-bases and to prove the following theorem.

**Theorem.** If $S$ is a regular $T_0$ space having a monotonic ortho-base, then each of the following implies that $S$ has a base of countable order:

1. $S$ is connected;
2. $S$ is a $\delta$-space [Gen. Top. and Appl. 1 (1971), 85-100];

Nyikos' theorem is a corollary to (3) and Arhangelskii's theorem that a $T_2$ paracompact space having a base of countable order is metrizable.

**Miscellaneous Fields**

**Scalar and vector plausibility and feasibility measures for decision-making under uncertainty.**

Given a $b \times 1$ logical matrix ("truth table"), $M$, with entries 1 ("true"), 0 ("false"), over a basis of $b$ independent statements. Definition 1. $B(S) = n/2^b$ is the (scalar) plausibility measure of statement $S$ iff $n$ is number of ones in $M(S)$. Theorem 1. If $T,F,C$ denote, resp., any tautological, contradictory, contingent statements, $B(T)=1$, $B(F)=0$, $0 < B(C) < 1$. Definition 2. $O(i,j)$ is an Ockem function iff $O(i,j) = (\phi_i \circ \phi_j)$, for hypothesis $H_i$, prediction $P_j$, (in scientific research, medical diagnosis, forensic, intelligence report analysis, etc.). Theorem 2. $B(O(i,j)) = 1/2^b + 1/2^b$. Corollary. Given (postulated) imbedding in (analytically) continuous supersystem, $\lim B(O(i,j)) = 1$. Theorem 3 ("Ockem's Razor"). $B(O(i+1,j), i,j \geq 1$. But $B$ is optimally sensitive to (iterated) predictability. Theorem 4. $B(O(i+1,j+1)) > B(O(i,j))$, for any $i,j,k \geq 1$. Given our formulation ("Matrices over free lattice logics"), these NOTICES 22(1975), 64(7) of a $2^b \times 2^b$ matrix, $M$, for nonstandard logics, a vector plausibility measure follows (with lexicographic ordering over statements): $B(S) = \lfloor n_1/2^b, n_2/2^b, \ldots \rfloor$ iff $n_i$ is number of ones in ith "orbit" (column) of $M(S)$. Adaptation: If ultimate consequence (event or structure), $U$, has attribute, $A_k$, then $U$ presages $A_k$ through "pilot" sign, $S_k$. $B$ then maps into a feasibility measure (scalar or vector), $F(U(i,j))$, for iterative decision-making, within a logical calculus, under uncertainty, regarding competing weapons systems (or other materiel or personnel), medical prognosis, teleological ethics, etc. The product measure of feasibility (plausibility) times value (e.g. cost, loss) may also be appealed to. etc. (Received September 4, 1975.)

The November Meeting in Chicago, Illinois
November 1, 1975

**Abstract families for cartesian categories.**

Given a cartesian category $S$ (i.e., a category with finite limits) an $S$-indexed category $A$ consists
of: (1) for each object \( I \) of \( \mathbb{S} \) a category \( \mathbb{A}^I \) (whose objects are called \( I \)-indexed families of objects of \( \mathbb{A} \)), and (2) for each morphism \( \alpha: J \to I \) in \( \mathbb{S} \) a functor \( \alpha^*: \mathbb{A}^J \to \mathbb{A}^I \) (called the substitution functor for \( \alpha \)) such that

\[
\alpha^* \circ (\beta^*) = (\beta^* \circ \alpha^*) \quad \text{and} \quad (1^I)^* = 1^I.
\]

If \( \mathbb{S} \) itself is an \( \mathbb{S} \)-indexed category where an \( \mathbb{S} \)-indexed family of objects of \( \mathbb{S} \) is (roughly) a morphism \( X^\mathbb{S} \) of \( \mathbb{S} \).

For any category object \( C \) of \( \mathbb{S} \) we get a canonical indexed category \( [C] \) where \( [C]^1 = 1 \).

Categories of the form \( [C] \) are called small and from this we have a way of discussing general smallness conditions, such as categories with small homs, well-powered categories, etc. We can define small limits and small completeness. The general and special adjoint functor theorems can be stated and proved in this context. These concepts are applied in the case where \( \mathbb{S} \) is a topos with natural numbers object, to show that certain free algebras exist. (Received September 15, 1975.)

Author introduced by Professor Heydar Radjavi

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A theorem is given which demonstrates that solutions of a stochastic differential equation decay to zero at least as fast as a function \( \psi(t) \) provided

\[
L(\ln \psi) \leq \frac{d}{dt} (\ln \psi),
\]

where \( \psi \) is a Liapunov-like function, and \( L \) is the operator associated with the stochastic equation. The result is an extension of some recent results of Friedman and Pinsky. A further generalization is discussed. (Received September 22, 1975.)

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The November Meeting in Blacksburg, Virginia

November 7–8, 1975

Algebra & Theory of Numbers


A topological space \( X \) is a \( C \)-space if it is \( T_1 \) and compositions of closed relations on \( X \) are closed. \( C[X] \) is the semigroup, under composition, of all closed relations on the \( C \)-space \( X \). A. H. Clifford and D. D. Miller [Union and symmetry preserving endomorphisms of the semigroup of all binary relations on a set. Czech. Math. J. 20 (95), 1970, 303-314] introduced the notion of a homomorphism from one such semigroup into another which preserves unions and carries symmetric relations into symmetric relations. We refer to such homomorphisms which are nonconstant as CM-homomorphisms. In this paper we investigate connected CM-homomorphisms and by a connected homomorphism we mean one which carries connected relations into connected relations. We are able to show, among other things, that for certain spaces \( Y \), any connected CM-homomorphism from \( C[X] \) into \( C[Y] \) must take a particularly simple form. Specifically, if \( X \) is any infinite \( C \)-space and \( Y \) is any hereditarily locally connected continuum, then for each connected CM-homomorphism \( \varphi \) from \( C[X] \) into \( C[Y] \), there exists a unique continuous monotone function \( \mu \) from a closed subset of \( Y \) onto \( X \) such that \( \varphi(\alpha) = \mu^{-1} \cdot \alpha \cdot \mu \) for each \( \alpha \) in \( C[X] \). This generalizes a result of K. D. Magill, Jr. [Connected CM-homomorphisms into \( C[I] \), Czech. Math. J. 23 (98), 1973, 257-268]. (Received August 12, 1975.)

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729-A2 K. D. MAGILL, JR., SUNY at Buffalo, 4246 Ridge Lea Road, Amherst, N.Y. 14226. Embedding semigroups into semigroups of closed relations, Preliminary report.

A closed relation on a topological space \( X \) is any closed subset of \( XX \). A space \( X \) is a \( C \)-space if it is \( T_1 \) and compositions of closed relations are closed. \( C \)-spaces include all compact Hausdorff spaces and are characterized among the first countable spaces as those which are either sequentially compact or discrete. \( C[X] \) denotes the semigroup, under composition, of all closed relations on a \( C \)-space \( X \). This is a report of our preliminary investigations concerning the problem of embedding various semigroups in \( C[X] \). For example, if \( X \) is any infinite first countable \( C \)-space, then any countable semigroup can be embedded in \( C[X] \). If \( X \) is an infinite compact metric space and the continuum hypothesis holds,
then the full transformation semigroup $T_Y$ on a set $Y$ can be embedded in $C[X]$ if and only if $|Y| \leq \aleph_0$. Comparisons are made between $C[X]$ and $S(X)$ the semigroup, under composition, of all continuous selfmaps of $X$ particularly in the case where $X$ is the closed unit interval. (Received August 12, 1975.)

729-A3 KATHERINE J. APPLESON, Dept. of Mathematics, Emory University, Atlanta, Ga.30322. A theorem on ordered free groups. Preliminary report.

It is known that any free group can be totally ordered. (B.H. Neumann, Amer. J. Math 75(1949), 1 - 18.) Everett and Ulam (Trans. Amer. Math. Soc. 57(1945), 208 - 216.) constructed a directed order on the free group on two generators which is not a lattice order. We show that there is no lattice order on a free group which is not a total order. As a corollary we get that there is no lattice order on a locally cyclic group which is not a total order. (Received August 18, 1975.)


Several set theoretic results, principally due to Riguet, and a group theoretic result called Goursat's Theorem are shown to be consequences of a categorical result called the Induced Morphism Theorem (IMT). The Difunctionally Induced Morphism Theorem, generalized from a result of Norris and Bednarek, is shown to be equivalent to the IMT in an exact (in the sense of Barr) category. Characterizations of when a regular category is exact are derived using relation theoretic techniques. Certain relation theoretic conditions for "admissible relations" in a variety are collated, showing these conditions to be categorical in nature and holding in larger classes of algebras than varieties. (Received August 23, 1975.)

*729-A5 KIM KI-HANG BUTLER, Alabama State University, Montgomery, Ala. 36101 & STEFFAN SCHNARZ, Slovak Academy of Science, Bratislava, CSSR. Circulant binary relations

Let $R_n$ be the semigroup of binary relations on a finite set $X$, with $\text{Card } X = |X| = n$ represented as $n \times n$ matrices over the Boolean algebra $\{0, 1\}$. The set of all circulants (of order $n$) under multiplication forms a semigroup $C_n$ with $|C_n| = 2^n$ (including zero circulant). $C_n$ is a subsemigroup of $R_n$. The purpose of this note is to give an explicit description of all idempotents contained in $C_n$ and all maximal subgroups of $C_n$. It turns out that the set of all maximal subgroups of $C_n$ is exactly the set of all cyclic groups of order $\text{d}$, $\text{d}$ being a divisor of $n$. A remarkable feature of the results obtained in this paper is the fact that an explicit description of maximal subgroups in a semigroup is only very rarely available. (Received August 29, 1975.)

*729-A6 DOUGLAS L. COSTA, University of Virginia, Charlottesville, Va.22903. Unique factorization in modules and symmetric algebras.

A torsion-free module $M$ over a UFD $D$ is factorial if every non-zero element $x \in M$ can be written uniquely (up to units) $x = dy$, where $d \in D$, $y \in M$, and $y$ is divisible only by units of $D$.

Necessary and sufficient conditions are given for a torsion-free module $M$ over $D$ to admit a smallest factorial module containing it. This factorial hull is $\bigcap M\_h$, the intersection taken over the height one primes of $D$. In case $M$ is finitely generated, the hull is $M\*\*$, the bidual of $M$. If the symmetric algebra $S\_D(M)$ admits a hull, then the hull is the smallest graded UFD containing $S\_D(M)$. $S\_D(M)$ is a UFD if and only if it is a factorial $D$-module. If $M$ is finitely generated, but not necessarily torsion-free, then $\bigoplus \_D (S\_D(M)\*\*)$ is a graded UFD.

Examples are given to show that any finite number of symmetric powers of $M$ may be factorial, with $S\_D(M)$ not factorial. (Received September 12, 1975.)
Tables for non-commutative groups are tedious to construct, especially for beginning algebra classes.

If \( n \) is a positive integer, then the following table is isomorphic to the Dihedral group of order \( n \).

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(Received September 12, 1975.)

729-A6


Let \( K \) be a field extension of characteristic \( p \neq 0 \). A field extension \( L \supseteq K \) is called reliable if \( L = K(M) \) for every relative \( p \)-basis \( M \) of \( L \) over \( K \) (Mordeson and Vinograd). It is a well known result that if \( L \) is a finitely generated separable algebraic extension of \( K \), then \( L \) is a simple extension of \( K \), i.e. \( L = K(\theta) \). We examine the following question. Let \( L \) be a finitely generated separable (non-algebraic) extension of \( K \). Does there exist an element \( \theta \in L \) such that \( L = L'(\theta) \) for all subfields \( L' \) over which \( L \) is separable algebraic. Such an element \( \theta \) is called a generalized primitive element (gpe). Theorem 1. \( \theta \) is a gpe for \( L/K \) if and only if \( L/K(\theta) \) is reliable.

Theorem 2. If \( [K:K^p] > p \), then there exists a generalized primitive element for \( L/K \).

(Received September 15, 1975.)

729-A9

RICHARD J. GREECHIE, Kansas State University, Manhattan, Kansas 66506. Every finite group is the automorphism group of an orthocomplemented projective plane.

Given a finite group \( G \) we construct, using the results of Frucht, Sabidussi and Schrag, a projective plane \( \pi \) and an absolute-point free polarity on \( \pi \) such that \( G \) is isomorphic with the collineations of \( \pi \) which respect the polarity. The construction is made by focusing attention on the clique structure of the orthogonality graph determined by the polarity. (Received September 17, 1975.)

729-A10

R. G. Van Meter, State University College, Oneonta, New York 13820. Permutation polynomials in \( n \) indeterminates over a finite field, II.

A polynomial \( f \) in some \( n \) indeterminates, say \( x_1, \ldots, x_n \), over a finite field \( K \) of order \( q \) and characteristic \( p \) is called a \((q,n)\)-permutation polynomial if the number of solutions \( x \in K^n \) of the equation \( f(x) = a \) is \( q^{n-1} \) for all \( a \in K \). H. Niederreiter [Proc. Japan Acad. 46 (1970), 1001-1005] has given an effective characterization of such polynomials of degree at most two. Niederreiter made use of exponential sums. In this
paper, Niederreiter's Theorem 3, giving the characterization for \( p = 2 \), and certain auxiliary theorems on \((q,n)\)-permutation polynomials and other polynomials are obtained by very simple methods not involving the use of exponential sums. (Received September 17, 1975.)

**729-All** VELIMIR P. PAVLOVIC, Emory University, Atlanta, GA 30322 and University of Belgrade, Belgrade, Yugoslavia, *Moufang functional equations on GD-groupoids with applications to quasigroups of various arities.*

Generalized Moufang functional equations: (1) \( A_1(A_2(x,y),A_2(z,x)) = A_4(A_3(x,A_6(y,z)),x) \); (2) \( B_1(x,B_2(y,B_2(z),x)) = B_4(B_3(B_6(x,y),x),x) \); (3) \( C_1(C_2(C_3(x,y),y),x) = C_4(x,C_5(x,C_6(y,x))) \), are considered when the operations are GD-groupoid operations.

Equations (1) and (2) are solved by reducing to simpler equations on GD-groupoids \( C(x,w) \cdot D(w,x) = C(x,w \cdot w') \cdot D(w,x) \) and \( E(x,v) \cdot F(x,v) = E(x,v \cdot v) \cdot F(x,v) \), respectively, and these equations are solved when \( \cdot, \cdot \) are Moufang loop operations. As an application the solutions of the equations

\[
A_1(A_2(x^{k+1},k+1),A_2(x^{k+2},k+2)) = A_4(A_3(x^{k+1},k+1),x^{k+1}),
\]

\[
B_1(x,B_2(x^{k+1},k+1),B_2(x^{k+2},k+2),x^{k+1},k+2)) = B_4(B_3(x^{k+1},k+1),x^{k+1},x^{k+2},k+2),
\]

are introduced and it is shown that equations (1), (2) and (3) are equivalent. (Received September 18, 1975.) (Author introduced by Trevor Evans.)

**729-A12** TREVOR EVANS, Emory University, Atlanta, GA 30322

Free algebras and orthogonal latin squares.

Some simple universal-algebraic ideas are used to study properties of orthogonal latin squares and related designs. Let \( N = \{1, 2, \ldots, n\} \) and let \( \mathcal{B} \) be the clone of all binary operations on \( N \), let \( \mathcal{M} \) be the monoid of all ordered pairs of elements of \( \mathcal{B} \). Properties of elements in \( \mathcal{B} \) and \( \mathcal{M} \) are linked with identities satisfied by binary operations on \( N \) and with combinatorial properties of tables on \( N \). For example, (i) identities implying that a quasigroup is orthogonal to one of its conjugates are classified (ii) let \( F \) be a finite free algebra in a variety \( \mathcal{V} \) on generators \( x, y \) and let \( w_1(x, y), \ldots, w_t(x, y) \) be elements of \( F \) such that each pair of \( \{x, y, w_1, \ldots, w_t\} \) generate \( F \); then \( w_1(x, y), \ldots, w_t(x, y) \) define m.o.l.s. on every finite algebra in \( \mathcal{V} \), (iii) for each \( q \geq 2 \) there is a variety \( \mathcal{V}(q) \) defined by binary operations and 2-variable identities, whose algebras are all \( q \)-sets of m.o.l.s. - this allows a simple universal-algebraic version of a counter-example to the Euler conjecture. (Received September 19, 1975.)

**729-A13** JACOB T.B. BEARD, JR., University of Texas at Arlington, Arlington, Texas 76019.

Perfect splitting polynomials.

The monic polynomial \( A(z) \in GF[q,z] \) is perfect over \( GF(q) \) provided the sum \( \sigma(A(z)) \) of the distinct monic divisors in \( GF[q,z] \) of \( A(z) \) equals \( A(z) \). All perfect polynomials which split in \( GF[p,z] \) are characterized and a partial characterization is obtained for those which split in \( GF[q,z] \), extending the results announced in Abstract 717-A10, these Notes 21(1974), A-602.

**Theorem 1.** The polynomial \( A = \prod_{i=0}^{p-1}(z-x_i)A_i(z) \) is perfect over \( GF(p) \) if and only if \( \alpha(0) = \alpha(j) \) for \( 1 \leq j < p \) and \( \alpha(0) = \alpha(p) = 0 \) for some \( N \) \( (p-1) \) and some \( n \geq 0 \). **Theorem 2.** The polynomial \( A = \prod_{a \in GF(q)}(z-a)^{N_q(x-1)} \) is perfect over \( GF(q) \) if and only if \( N \) \( (q-1) \) and \( n \geq 0 \). **Theorem 3.** Let the polynomial \( A = \prod_{i=1}^{m} x^i \) be perfect.
over $GF(q)$ where the primes $P_i \in GF(q,x)$ are distinct, $\mu(i) > 0$, and $\deg P_1 \leq \ldots \leq \deg P_n$. Then for some integer $k \geq 1$, $\deg P_1 = \deg P_j$ for each $j$ satisfying $1 \leq j \leq kp$.

(Received September 22, 1975.)

*729-A14 BRUCE R. CAIN, Mathematics Department, Emory University, Atlanta, Georgia 30322

Finite equationally complete quasigroups.

Let $Q$ be a finite equationally complete quasigroup. There is a unique simple quasigroup $Q'$ such that $V(Q) = V(Q')$. Every finite member of $V(Q)$ is a direct power of $Q'$. $Q$ is primal if and only if $Q$ is simple and has no proper subquasigroups and no proper automorphisms.

Most of the results given for quasigroups easily generalize to any congruence permutable variety. (Received September 22, 1975.)

*729-A15 LAWRENCE A. LEE, United States Naval Academy, Annapolis, Maryland 21402

Reflectors and chromatically equivalent graphs. Preliminary report.

A reflector of order $k$ is a graph on $n$ vertices, $n \geq k$, with a particular bijection $f$ defined on $k$ of the vertices. It is shown how to apply a reflector of order 4 to construct pairs of chromatically equivalent graphs. A coil of $p$ reflectors of order 4 is defined and used to construct $2^p$ chromatically equivalent graphs. (Received September 22, 1975.)

729-A16 J. BREWER, E. RUTTER, and J. WATKINS, University of Kansas, Lawrence, Kansas 66045

Power series rings over absolutely flat rings. Preliminary report.

Let $R$ be a commutative unitary absolutely flat ring with $X$ an analytic indeterminate.

Proposition 1. If each ideal of $R$ is countably generated, the following are equivalent: (1) $R[[X]]$ is semihereditary; (2) $R[[X]]$ is coherent; (3) weak dimension $R[[X]] = 1$. Corollary 1. Suppose that $R$ has only countably many idempotents. The following are equivalent: (1), (2), (3), above and (4) $R$ is $K_0$-complete; (5) $R$ is a finite direct sum of fields. Proposition 2. Let $S$ denote the maximal quotient ring of $R$. The following are equivalent: (1) and (2) above, (3) Principal ideals of $R[[X]]$ are projective and $R[[X]]$ is Bezout; (4) $R$ is $K_0$-complete and for each ideal $I$ of $R[[X]]$, $IS[[X]] \cap R[[X]] = I$, that is, $R[[X]]$ is 1-pure in $S[[X]]$. Corollary 2. There exists an absolutely flat ring $R$ and a faithfully flat extension $T^*$ of $T$ such that $T[[X]]$ is not 1-pure in $T^*[[X]]$. (Received September 23, 1975.)

729-A17 J. WINSTON CRAWLEY, University of Tennessee, Knoxville, Tennessee 37916

Some Categorical Results for Semigroup Categories. Preliminary report.

A number of categorical results about certain categories of [topological] semigroups are obtained. Among these are:

1. The observation that the dual of a theorem of Isbell yields easily that monomorphisms are injective for a large number of categories; an example yielding the contrary in many other categories is also given.

2. An application of standard "universal mapping" techniques to obtain coequalizers in a number of topological semigroup categories.

3. The application of a theorem of Lallement to show monomorphisms are injective in [topological, compact] regular semigroups.

4. The theorem that subobjects of compact $H$-coextensions of Lawson semi-lattices are regular (and hence epimorphisms are surjective). This utilizes the corresponding results for compact groups due to Poguntke and for compact Lawson semi-lattices due to Hofmann and Mislove. (Received September 23, 1975.)

Analysis

*729-B1 JAMES A. RENEKE, Clemson University, Clemson, S.C., 29631

The existence of realizations of hereditary systems.

The definition of an hereditary system in this paper is motivated by the product integral as developed and exploited by Mac Nerney in his study of Stieltjes
integral equations. The definition is given in terms of a transition function, as contrasted to either the input-output or functional equation formulation, and the problem of realization is to show that the transition function of a system is a product integral which gives the general solution to some functional equation. If the transition function satisfies a Lipschitz type condition then the system is realizable as a kind of integral equation. In the last part of the paper the notion of integral that is employed in the realizations is explored as a representation problem. Three cases are considered; when the underlying function space is the space of quasicontinuous functions, the space of continuous functions, and the space of absolutely continuous functions.

(Received June 30, 1975.)

*729-B2 JOHN HADDOCK, Memphis State University, Memphis, Tennessee 38152.
Liapunov functions, Liapunov functionals and convergence of
solutions of functional differential equations.

Sufficient conditions are given for convergence of solutions of retarded
functional differential equations via both Liapunov functions and Liapunov
functionals. Advantages of each technique will be discussed and the theorems
will be applied to obtain various new stability results for scalar functional
differential equations of the form \( x = F(t, x) + G(t, x_t) \). The work concerning
Liapunov functions was done jointly with Professor S. R. Bernfeld, University
of Texas at Arlington. (Received August 25, 1975.)

729-B3 RICHARD DATKO, Georgetown University, Washington, D.C. 20057.
Stability of
Linear Differential-Difference Equations.

A necessary and sufficient condition is given for the uniform asymptotic
stability of neutral differential-difference equations of the form
\[
\frac{d}{dt} \left[ x(t) - \sum_{j=1}^{m} B_j x(t-h_j) \right] = \sum_{j=0}^{m} A_j(t) x(t-h_j),
\]
where it is assumed that \( |A_j(t)| \leq M \) for all \( t \) in \( \mathbb{R}^+ \). This condition
is that
\[
\int_0^\infty \| x(t, t_0, \phi) \|^2 dt \leq M \| \phi \|^2 \quad \text{uniformly for all } t_0 \geq 0.
\]
The above condition can be translated in terms of Liapunov functionals.
(Received August 28, 1975.) (Author introduced by John A. Burns.)

*729-B4 KENNETH B. HANNSGEN, Virginia Polytechnic Institute and State University,
Blacksburg, Virginia, 24061, Uniform \( L^1 \) behavior for an integrodifferential
equation with parameter.

For the family of real integrodifferential equations
\[
u'(t) + \lambda \int_0^t \left[ c + a(t - s) \right] u(s) \, ds = 0, \quad u(0) = 1
\]
with nonnegative, nonincreasing, convex, strongly positive kernel \( \lambda[c + a(t)] \) depending on the parameter \( \lambda (0 < \lambda \leq \lambda < \infty) \), we show that the solution \( u(t, \lambda) \) satisfies \( |u(t, \lambda)| \leq u^0(t) \), where
\[
\int_0^\infty |u^0(t)| \, dt < \infty \quad \text{and} \quad u^0(\infty) = 0,
\]
provided \( \int_0^\infty a(t) \, dt < \infty \) or \(-a'(t)\) is convex. Strong
positivity is necessary. A result of the same type holds for \( u_t \). Applications to equations in
Hilbert space and to scalar equations with complex parameter are given. (Received August 27,
1975.)
Local existence, continuity, and stability properties of a class of partial functional differential equations will be presented. As a model for this class one may take the equation

$$w_t(x,t) = W_x(x,t) + f(W(x,t-r), W(x,t-r)), \ 0 < x < r, \ t \geq 0$$

$$W(0,t) = W(\pi,t) = 0 \ \ \ \ t \geq 0$$

$$W(x,t) = \phi(x,t) \ \ \ \ 0 < x < \pi, \ -r < t < 0$$

The problem is formulated as an abstract ordinary functional differential equation of the form

$$\frac{d}{dt} U(t) = A U(t) + F(U(t)),$$

where $A$ is the infinitesimal generator of an analytic semigroup of linear operators $T(t), \ t \geq 0$, on a Banach space $X$ and $F$ is continuous with respect to a fractional power of $A$. The solutions are studied as a semiflow of linear or nonlinear operators on $C([0,\pi])$. (Received August 29, 1975.)

Let $\mathbb{N} > 0$ and $N \geq 1$ be chosen and define $X = L^2[0,\pi] \times \mathbb{R}^N$ where functions in $L^2[-r,0]$ map $[-r,0]$ into $\mathbb{R}^N$. Define $M$ and $N$ be bounded linear mappings from $X$ into $X$, let $L$ be an $N \times N$ matrix, and let $F$ map $L^2[-r,0]$ into $\mathbb{R}^N$. Constructive existence results for solutions to the boundary value problem $x(t) = Lx(t) + F(x(t))$, $0 < t < b$ with the boundary conditions $M(x(0), x(\pi)) + N(x(\pi), x(0)) = \{\psi, \kappa\}$ where $x(t) = x(t + \theta)$ for $\theta$ in $[-r,0]$ and $x(0) = x(\pi)$ are given. Two classes of nonlinear mappings $F$ are treated: Lipschitz continuous mappings and $F$'s of the form $F(\phi) = g(\int_{-r}^{0} d\eta(t) \phi(t))$ where $F$ has domain $C[-r,0]$, $g$ is Lipschitz and $\eta:[-r,0] \to L(X,X)$, $\eta(0) = 0$, $\eta$ is of bounded variation and $\lim_{\theta \to r} \int_{-r}^{0} |d\eta| \neq 0$. The second case includes delay equations. (Received August 29, 1975.)

This paper presents sufficient conditions on the coefficients of $L_{2n} y = \sum_{k=0}^{n} (-1)^{n-k} (p_k y^{(n-k)})^{(n-k)}$ which insure that $L_{2n} y = 0$ has conjugate points $\eta(a)$ for all $a > 0$. The main theorem implies that $(-1)^{2n} y^{(2n)} + py = 0$ has conjugate points $\eta(a)$ for all $a > 0$ when $\int_{-a}^{0} p(x)dx = \infty$ for some $a < 2n - 1$ with no sign restrictions on $p(x)$. (Received September 11, 1975.)

Let $(X, \Sigma, \mu)$ be a $\sigma$-finite measure space and $\Gamma = \{T_t : t \geq 0\}$ a strongly continuous semigroup of positive $L_p(\mu)$ operators, $1 \leq p < \infty$. We say that the local ergodic theorem holds for $\Gamma$ if $\lim_{\epsilon \to 0} (1/\epsilon) \int_{-\epsilon}^{\epsilon} f(T_t x) dt = f(x)$ a.e. for $f \in L_p(\mu)$. We present direct proofs of Krengel's and Kubokawa's local ergodic theorems using a method which easily extends to the case of $n$-parameter semigroups. The result obtained in the $n$-parameter case generalizes a theorem of T. R. Terrell [Local Ergodic Theorems for n-Parameter Semigroups of Operators, Lecture Notes in Mathematics, No. 160, 262-278, Springer-Verlag]. (Received September 12, 1975.)
Let $p = \{p_k\}^\infty_{k=0}$ be a sequence of polynomials such that $p_k$ is of degree $k$, $0 \leq k < \infty$. An entire function $f$ is said to belong to the expansion class $F_p$ of the sequence $p$ iff there is a sequence $\{h_k\}^\infty_{k=0}$ of complex numbers such that $\sum^\infty_{k=0} h_k p_k$ is uniformly convergent to $f$ on every compact set. Recent developments have made possible the explicit calculation of expansion classes for a fairly wide collection of polynomial sequences $p$. An unexpected dividend of these results is the discovery of an underlying Banach space structure. Once the function space $F_p$ has been determined, it is often possible to endow $F_p$ with a norm which makes $F_p$ a Banach space, makes $p$ a strong basis for $F_p$, and induces a stronger topology than that of uniform convergence on compact sets. The spaces $F_p$ for which this construction has been carried out are all isomorphic to $c_0$, the space of complex sequences with limit 0, normed with the supremum norm. A typical example is obtained by taking $p$ to be the sequence of Bernoulli polynomials. In this case $F_p$ is the space of all entire $f$ such that $f^{(n)}(0) = o((2\pi n)^{-1})$, $n \to \infty$, the norm is given by $\|f\| = \sup |f^{(n)}(0)/(2\pi n)|$, $0 \leq n < \infty$, and the isomorphism with $c_0$ is established by identifying an entire function $f$ with the sequence $\{f^{(n)}(0)/(2\pi n)\}^\infty_{n=0}$. Equally explicit (but usually more complicated) results are now known for every Appell sequence $p$ whose generating function is meromorphic on its circle of convergence. Similar but less precise results have been obtained in some cases (e.g., the Abel interpolation series) where no useful determination of $F_p$ is available. In certain more general situations, a Banach space structure can be imposed in a natural way on a subspace of $F_p$. This can be done for Abel-Goncarov expansions with parameters in the closed unit disk, and minor improvements are obtained on older results concerning expansion and uniqueness. (Received September 17, 1975.)

Using a function theoretic approach, we consider the interpolation and approximation of axisymmetric harmonic functions in $\mathbb{R}^3$ by axisymmetric harmonic polynomials (A.H.P.'s). The problem dealt with is that of recovering a function which is axisymmetric harmonic on the closure of a region by interpolating along circles contained on the boundary. In the case of the sphere, an Hermite type formula for the error in approximation by A.H.P. interpolation is derived. This is used to find necessary and sufficient conditions on the choice of interpolation circles which yield uniformly convergent A.H.P. interpolants. For axiconvex regions the Bergman $B_3$ integral operator is used to obtain sufficient conditions on the choice of interpolation circles which yield the A.H.P. interpolants uniformly convergent at a geometric rate. (Received September 22, 1975.)

If $m$ and $n$ are positive integers then let $T(m,n)$ denote the inner product space of all (real valued) n-linear functions on $\mathbb{R}^m$ and let $S(m,n)$ denote subspace of $T(m,n)$ consisting of the symmetric n-linear functions. If $A, B \in T(m,n)$ then the inner product of $A$ and $B$ is denoted by $(A, B)$ or $AB$.


$$A^{(n)}(x) = f(x, u(x), u'(x), \ldots, u^{(k)}(x)) \quad (k < n)$$

However, the convergence of the approximations to a solution is proven only in case $k \leq n/2$. Using the improvements in the inequality $\|A-B\| \leq (n+k)^{-1} \|A\|^2 \|B\|^2$, where $B \in S(m,k)$ and $k \geq n$, described in the paper [Lower Bounds for the Norm of the Symmetric Product, to appear in Linear Algebra and its Applications], it can be shown that in many cases the requirement that $k \leq n/2$ can be replaced by the requirement that $k \leq 3n/4$. (Received September 22, 1975.)
We consider the numerical solution of the optimal control problem:

\[ \min J(u,x) = \int_0^T f(u,x,t) \, dt + P(x_T) \]

defined on the solutions of the functional differential equation

\[ x(t) = g(x_t,u_t), \quad x_t = x(t+0). \]

The continuous problem is replaced by finite difference approximations and convergence of the solutions of the discrete problems to the solution of the continuous optimal control problem is considered, both in the sense of the optimal value of the functional and of the optimal control. (Received September 22, 1975.)

Let \( f(z) = \sum_{n=0}^{\infty} a_n z^n \) be an analytic function on the open disk of finite radius \( R \), and let it be of order \( \rho \) and of lower order \( \lambda \), \( 0 \leq \lambda \leq \rho \leq \infty \), (refer Abstract 711-30-8). Define mean values \( I_{p,q}(r) = \frac{1}{2\pi} \int_0^{2\pi} f(re^{it})P \, dt \), \( J_{p,q}(r) = \frac{1}{2\pi} \int_0^{2\pi} [f(re^{it})]^p \, dt \), where \( 0 < R < r \), and \( p \) and \( q \) are any positive numbers. Write \( C(r) = \log( R/(R-r)) \). Further denote by \( A(p,q) \), \( B(p,q) \) respectively \( \lim sup_{r \to R} \), \( \lim inf_{r \to R} \) of the expression \( \{ I_{p,q}(r)/J_{p,q}(r) \} \). The results proved are: Theorem 1. \( \lim sup_{r \to R} \) \( \{ \log\log I_{p,q}(r)/\log C(r) \} = \lambda = \lim sup_{r \to R} \{ \log\log J_{p,q}(r)/\log C(r) \} \), and \( \lim inf_{r \to R} \{ \log\log I_{p,q}(r)/\log C(r) \} = \Lambda = \lim inf_{r \to R} \{ \log\log J_{p,q}(r)/\log C(r) \} \). Theorem 2. \( A(p,q) = \exp(\rho) \) and \( B(p,q) = \exp(\lambda) \). (Received September 23, 1975.)

Numerical Approximation of Nonlinear Functional Differential Equations with \( L^2 \) Initial Functions

Nonlinear operator semigroup theory is used to treat the numerical approximation of autonomous functional differential equations with \( L^2 \) initial functions. The consistency, stability, and convergence of both explicit and implicit schemes are demonstrated and error estimates are established. The stability is obtained easily as a consequence of a renorming of the underlying space. (Received August 12, 1975.)

Consider the state dependent lag functional differential equation (FDE) on \([A,B]\), \( \hat{x}(t) = f(t,x(t),x(\alpha(t,x(t)))) \) where \( \alpha(t,x(t)) \neq t \). It is known that such an equation can propagate a "tree" or directed graph of points where the solution has various derivatives with simple jump discontinuities (see Neves and Feldstein, "Characterization of jump discontinuities for state dependent delay differential equations", J. Math. Anal. Appl. (to appear)). To maintain an \( O(h^p) \) numerical solution (using a fixed step size procedure), the jump points must be known to \( O(h^r) \) where \( r \) can be related to \( p \) and the "jump point tree" (see Neves, Ph.D. Thesis, Arizona State Univ., 1973). In extending numerical procedures to handle 1st order systems of FDE's with multiple lags in each component, one must examine complicated "jump point trees". In turn the iteration needed to approximate each jump point becomes, at best, onerous. The use of automatic numerical procedures can potentially alleviate the necessity to calculate approximate "jump point trees" (see Neves, "Automatic integration of functional differential equations, ACM Trans. on Math. Software (to appear)). A justification of such an approach, in view of state-of-the-art ordinary differential equation software, is given. (Received August 27, 1975.)
A new method is given for solving the exterior Robin problem for the Helmholtz equation. Let $S$ be a smooth, simply connected, compact surface in $\mathbb{R}^3$. An integral representation of the field induced by an exterior source, (regular solution of the Helmholtz equation interior to $S$) is derived which is continuous as the field point approaches $S$ from the exterior. If $S$ is convex, it is proven that for sufficiently small but nonzero $k$, the solution to the integral equation may be found by a standard Neumann series, provided the constant appearing in the boundary condition satisfies a certain inequality. (Received September 8, 1975.)

Denote by $V(t|x_0)$ the set of all conditional probability measures generated by solutions at time $t$ to the $n$-dimensional stochastic control system (*)

$$dx(t) = f(t,x(t),u(t))dt + g(t,x(t))dw(t), \ x(0) = x_0$$

for suitably defined $f$ and $g$ and controllers $u(t)$. $w(t)$ is Brownian motion. Suppose $M$ is the space of all probability measures on $\mathbb{R}^n$. Endow $M$ with the topology of weak convergence. It is shown that $V(t|x_0)$ is a (weakly) compact subset of $M$, and the mapping $t \rightarrow V(t|x_0)$ is continuous (wrt the Hausdorff metric) for any initial $x_0$ with finite second moment. In the event that the system (*) is linear, then a type of "bang-bang" result is obtained. These results generalize those of Teo and Ahmed, Int. J. System Sci. 5 (1974), 67-71. (Received September 2, 1975.)

A relational algebra consists of a set of relations of all degrees (not necessarily binary) and a set of operations on relations. Projection and natural join which correspond to decomposition and synthesis of relations, respectively, are fundamental and significant among the operations. In a relational model of data representation all data are viewed as relations. The retrieval of the desired data, then, is the formation of a new relation from the given collection of relations by using these operations. The recent developments of this important application of relational algebra to high level data structures are reviewed. Other interesting algebraic problems related to the relational model of data bases are discussed. (Received September 12, 1975.)

Gunaydin and Gursey [Phys. Rev. D, 9 (1974), 3387] have suggested a model explaining the nonobservability of quarks and diquarks in terms of the octonian algebra $K$. The model is based on two facts: (1) sets of elements of $K$ are nonassociative and consequently nonobservable; (2) $\text{Aut}(K) = G_2$ which contains $SU(3)$ as a subgroup. Relative to this subgroup $K$ decomposes into a singlet space and a (nonobservable) quark triplet space. We examined a generalization of this model using the sequence of Cayley-Dickson algebras. Since the automorphism group for algebras in this sequence is $G_2$ (up to a factor) the same $SU(3)$ symmetry persists and can be used to construct a theory of invariant interactions. (Received September 18, 1975.)

This paper is concerned with the unsteady flow near a flat plate with harmonically oscillating

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temperature in a rotating system. Both the plate and the semi-infinite expanse of fluid bounded by the plate are in a state of solid body rotation with constant angular velocity $\Omega$ about the $z$-axis normal to the plate. The motion is caused by the action of oscillatory buoyant body forces on the fluid near the plate due to the temperature oscillation of the plate with frequency $\omega$. The problem is solved as an initial value problem to investigate the structure of the unsteady temperature and velocity field together with the associated multiple boundary layers. It is shown that the ultimate steady state solution is attained in the limit $t \to \infty$. This consists of eight boundary layers—six of which are of the same order of magnitude. Some discussion is made about the various aspects of the unsteady and steady flow field. (Received September 19, 1975.)

Logic and Foundations


An intrinsic invariant of the isomorphism classes of analytic sets is described.

Theorem. If $A$ is an uncountable analytic set, then the semigroup, $R(A)$, of all binary analytic relations is a triform as defined by K. Magill.

Corollary: If $A_1$ and $A_2$ are uncountable analytic subsets of the unit interval, then $A_1$ is Borel isomorphic to $A_2$ if and only if the semigroups $R(A_1)$ and $R(A_2)$ are isomorphic.

Theorem. The Axiom of Constructability implies there are at least three isomorphism classes of non-Borel analytic sets. (Received August 20, 1975.)


In 1940, J. C. C. McKinsey [Postulates for the calculus of binary relations, The Journal of Symbolic Logic, 2(1940), 85-97] axiomatized those "algebras" representable as the collection of all binary relations on some set under the ordinary boolean operations and composition. Several years later, C. J. Everett and S. M. Ulam [Projective algebra I., American Journal of Mathematics, 68(1946), 77-88], initiating "a study of logic with quantifiers from a boolean point of view," introduced the notion of an abstract projective algebra. The purpose of this report is to explore the relation between these structures. In particular, we note that every calculus of binary relations is a complete atomic projective algebra and that for certain projective algebras it is possible to define a "product" such that we have a calculus of relations in the sense of McKinsey. (Received September 8, 1975.)

Topology

*729-01* JAMES MARTIN STEPHENS WHITE, JR., Auburn University, Auburn, Alabama 36830. Topics related to homogeneity, Preliminary report.

If $X$ is a topological space and $A, B \subseteq X$, then the function $f$ almost maps $A$ onto $B$ provided $B - f(A)$ and $f(A) - B$ are each nowhere dense in $X$. It is shown that if $G$ is a group of homeomorphisms from $X$ onto $X$ and $H \subseteq X$ such that (1) $\overline{H}$ has nonempty interior (2) if $K \subseteq H$ and $\overline{K} = \overline{H}$ then for some $g$ in $G$, $g(H) = K$ and (3) for each $x$ in $X$ there is a $g$ in $G$ such that $g(H \cup \{x\}) = H$, then for each $x$ and $y$ in $X$ there is a $g$ in $G$ such that $g(x) = y$ and $g$ almost maps $H$ onto $H$ and moreover $\overline{H} = X$. It is also shown that if $X$ is a locally compact connected metric space
and there is a countable collection \( C \) of countable dense subsets of \( X \) such that for each countable dense subset \( A \) of \( X \) there exists a \( B \) in \( C \) and a homeomorphism \( f \) from \( X \) onto \( X \) that almost maps \( A \) onto \( B \), then \( X \) is locally connected at each point of a dense subset of \( X \). Other results are obtained relating to \( N \)-homogeneity in a connected countable dense homogeneous space. (Received June 27, 1975.)

*729-G2 JOHN W. BALES, Auburn University, Auburn, Alabama 36830. Representable spaces and strongly \( N \)-homogeneous spaces.

The statement that the topological space \( X \) is representable means that if \( P \) is a point of \( X \) and \( U \) is an open set in \( X \) containing \( P \) then \( U \) contains an open subset \( V \) containing \( P \) such that if \( Q \) is a point of \( V \) then some homeomorphism from \( X \) onto \( X \) takes \( P \) onto \( Q \) and leaves each point of \( X \) outside \( U \) fixed.

If \( N \) is a positive integer and \( X \) is a topological space, the statement that \( X \) is strongly \( N \)-homogeneous means that if \( A_1, A_2, A_3, \ldots, A_N \) is a sequence of \( N \) points of \( X \) and \( B_1, B_2, B_3, \ldots, B_N \) is a sequence of \( N \) points of \( X \) then there is a homeomorphism \( h \) from \( X \) onto \( X \) such that if \( 1 \leq i \leq N \) then \( h(A_i) = B_i \).

**Theorem:** If \( X \) is a connected representable \( T_1 \) space, no two point subset of which disconnects it, and if \( N \) is a positive integer, then \( X \) is strongly \( N \)-homogeneous. (Received June 27, 1975.)


This paper describes a general construction that destroys normality in non-collectionwise normal spaces. The following corollaries of this construction answer or partially answer a number of open questions; If there is a model of set theory in which every countably paracompact Moore space is normal, then the normal Moore space conjecture is true in that model. MA + \( \neg \)CH implies there exists a countably paracompact Moore space which is not hereditarily countably paracompact. MA + \( \neg \)CH implies there exists a closed map from a countably paracompact Moore space onto a space which fails to be countably paracompact. It is consistent that there exist a countably paracompact, collectionwise Hausdorff, non-normal Moore space. There exists a perfect, \( T_3 \) space which is countably paracompact but not normal.

Other examples are given including a non-normal space constructed with \( \Diamond \) which is countably compact, \( T_3 \), first countable, locally compact, perfect and hereditarily separable. (Received August 7, 1975.)


**THEOREM 1:** If \( X \) is a simple Poincaré complex of formal dimension \( n \), there is a canonically defined element \( k_2 X \in H^2(Z_2; \Omega^3_X) \) such that, if \( m = (M, f, \xi) \) is any (smooth, p.l., or top.) normal map on \( X \) with surgery obstruction \( \sigma m \in L^2_n(X) \), then \( h(\sigma m) = k_2 X \), where \( h: L^2_n(X) \rightarrow H^2(Z_2; \Omega^3_X) \) is the author's generalization of the Hasse-Witt invariant of nonsingular symmetric forms. COROLLARY 2: If \( X \) is simple homotopy equivalent to a closed manifold, then \( k_2 X = 0 \) (a direct proof is available in the smooth, p.l. cases, using dual cell presentations). **THEOREM 3:** If \( f: M \rightarrow X \) is a simple homotopy equivalence of \( n \)-manifolds, then there is defined an element \( j_2^e \in \pi_{n+1}(Z_2; \Omega^3_X) \) such that, if \( \omega \in L^2_n(X) \) and if \( f^*: \pi_n \rightarrow X \) is the result of applying \( \omega \) to \( f: M \rightarrow X \) in \( \pi_n \), the simple homotopy manifold structures on \( X \), then \( j_2^e - j_2^e = h(\omega) \). There are appropriate relative versions of these results, as well as a mild generalization of Theorem 3 to simple Poincaré complexes \( X \) for which \( k_2 X = 0 \). The vanishing of \( k_2 X \) corresponds to the algebraic analogue of the existence of a dual cell structure on a manifold. (Received August 8, 1975.)
Definition. A topological space is said to be isotopically representable if for each \( x \in X \) and \( u \) open in \( X \) such that \( x \in u \), there is an open set \( v \) of \( X \) such that (A) \( x \in v \) which is a subset of \( u \), and (B) if \( y \in v \), there is a homotopy \( F: X \times I \to X \) such that (1) for each \( z \in X \), \( F(z,0) = z \), (2) \( F(x,1) = y \), (3) for each \( z \in X - v \) and \( t \in I \), \( F(z,t) = z \), (4) for each \( t \) in \( I \), \( F_t \) is a homeomorphism from \( X \) onto \( X \). Manifolds are isotopically representable and isotopically representable spaces are locally connected. Theorem. The Hilbert cube is isotopically representable. Theorem. Any product of compact, Hausdorff, isotopically representable spaces is isotopically representable, and any finite product of locally compact, Hausdorff, isotopically representable spaces is isotopically representable. (This is not true if isotopically representable is replaced by representable in either case.) Theorem. A Hausdorff, connected, locally compact, isotopically representable space is homeotopically homogeneous (G.S. Ungar). (Received August 12, 1975.)

Diagonals and separating open covers.

A space \( X \) is said to have a \( G_0 \)-diagonal if the diagonal in \( X \times X \) is a \( G_0 \) set in \( X \times X \). A collection \( \mathcal{B} \) of open subsets of \( X \) is called a \( p \)-base if \( \mathcal{B} \) is point separating, i.e., if for any \( x, y \in X \), \( x \neq y \), there is \( B \in \mathcal{B} \) such that \( x \in B \) and \( y \notin B \). (A \( p \)-base is usually studied with a given structure such as "point countable"). The concepts of a \( G_0 \)-diagonal and of a \( p \)-base have appeared in a wide variety of metrization theorems and other applications in general topology. We discuss several results and open questions related to the above topics. (Received August 12, 1975.)

Symmetrizable and related spaces.

Symmetrizable and other spaces which can be defined by weak graded bases will be discussed. Among the topics to be considered will be products, metrization, compactness, and separability. (Received August 22, 1975.)

This paper will survey some of the principal results, techniques, and open problems in the theory of closed, continuous mappings including:

- properties which are carried from domain to the range of a closed map;
- properties which are carried from range to domain by a closed map;
- spaces which can be characterized as the closed, continuous images of "nice" spaces;
- techniques for constructing closed maps.

Some results on perfect and quasi-perfect maps will also be given. The works of various American, Japanese, and Russian topologists relating to closed mapping theory will be discussed. (Received August 27, 1975.)

Metrization theorems.

This talk will survey certain recent metrization theorems. The work of Reed and Zenor and of Burke, Engelking and Lutzer involves metrization theorems of a classical type. The metrization theorem of Guthrie and Henry also fits into the classical mold, being related to certain work of Nagata during the 1950's, even though its formulation may seem new to most topologists. Two new directions have been introduced into metrization theory by the recent work of Arhangel'skii, Gruenhage, Nyikos and Zenor concerning the rank of a base and by the surprising results of T. and K, Ciba related to Morita's question: Is there a nonmetrizable space \( Y \) such that \( X \times Y \) is normal for every normal P-space \( X \)? (Received August 27, 1975.)
A survey of quasi-metrizable spaces. Recent results, examples and open questions.
(Received August 29, 1975.)

The author presents a discussion of recent results and open questions concerning the application of set-theoretic and consistency techniques to the theory of Moore spaces. The main topics considered are (1) metrization and covering properties, (2) mappings, (3) products, and (4) embeddings. In particular, recent work of Alster, Fleissner, Pol, Przymusinski, Tall, vanDouwen, Wage, Zenor, and the author is discussed. (Received August 29, 1975.)

Dugundji improved Tietze's extension theorem by constructing for each closed subspace $F$ of a metrizable space $X$ a linear function $\phi: C(F) \to C(X)$ satisfying $\phi(f)(x) = f(x)$ for $x \in F$, and range $(\phi(f)) \subseteq$ convex hull range$(f)$. We review recent results concerning the problem to which extend analogous results hold for nonmetrizable spaces, and give a (new) example of a compact Hausdorff hereditarily Lindelöf space for which Dugundji's Theorem does not hold.

We also discuss the related problem of when the open sets of a subspace can be simultaneously extended, indicate applications and prove that if $A$ is any subspace of a stratifiable space $X$, then there is a function $\kappa: \{\text{open sets of } A\} \to \{\text{open sets of } X\}$ such that $A \cap \kappa(U) = U$, $\kappa(U) \cap \kappa(V) = \kappa(U \cap V)$ and $\kappa(\emptyset) = \emptyset$. (Received September 2, 1975.)

In keeping with the format of the program, a selective overview of base of countable order theory is planned. The focal emphasis is on the finite intersection property, how it relates to the defining conditions of monotonicity. The primitive base property, viewed as an abstraction of metrizability, is considered from this standpoint. (A number of background references are given in "Studies in topology", Academic Press, 1975, pp. 581-599.) (Received September 3, 1975.)

A space $X$ is said to be $\sigma$MK provided that $X$ has a countable closed cover $C$ of metrizable subspaces such that if $K$ is a compact subset of $X$, there is a $G \in C$ for which $K \subseteq G$. A Hausdorff space is $\sigma$MK and Fréchet if and only if it is representable as a closed image of a metric space obtained by identifying a discrete collection of closed sets with hemi-compact boundaries to points.
(Received September 2, 1975.)

In this talk I shall give a survey of the theory of 3-manifold groups (a 3-manifold group is a group which is isomorphic to the fundamental group of a 3-manifold) with most emphasis on recent work by P. Shalen and myself. I shall discuss the classification of 3-manifolds via their fundamental
groups, peripheral subgroups of 3-manifold groups, characterization of centralizers of elements in 3-manifold groups, roots and relations in 3-manifold groups and the class of atoridal 3-manifolds. (Received September 18, 1975.)


Let \( \phi: G \times M \to M \) be a smooth, free, orientation-preserving action of the finite group \( G \) on the closed manifold \( M \). If \( M \) bounds an oriented manifold, must \((M,\phi)\) bound as a (not necessarily free) \( G \)-action? The answer is known to be 'yes' if \( G \) is abelian. We sketch some techniques for studying the question if \( G \) is a nonabelian \( p \)-group, and exhibit some cases in which these techniques provide an affirmative answer. (Received September 22, 1975.)


Some cardinal invariants associated with closed subgroups of topological groups are studied. (Received September 22, 1975.)

729-G18 P. TH. LAMBRINOS, University of Thessaloniki, Greece; Kansas State University, Manhattan, Kansas 66506. Locally bounded topological spaces. An arbitrary topological space is called locally bounded if each point has a bounded neighborhood, i.e. a neighborhood contained in some finite union of members of any open cover of the whole space. The class of locally bounded spaces contains properly the class of locally compact spaces and preserves many of their properties, e.g. local boundedness is preserved under products (provided at most finitely many of the coordinate spaces are not compact) and under open continuous surjections and it is weakly hereditary. A minimal locally bounded space is compact if it contains a closed compact subset with non-empty interior. Some similar results are indicated for weaker forms of local boundedness and questions are raised. (Received September 22, 1975.)

729-G19 PETER NYIKOS, University of Illinois, Urbana, Ill. 61801. Base conditions, generalized metric spaces, and metrization. A number of properties a base for a topological space can have are surveyed in relation to "generalized metric" space and metrization theory. Among the properties are: finite and sub-infinite rank [Abstract 726-54-17, these NOTICES 22 (1975) A-526], countable large basis dimension [Abstract 74T-067, these NOTICES 21 (1974) A-450], the ascending chain condition, and the property of being an ortho-base or, more generally, a base of low redundancy. A base \( \mathcal{B} \) for a space is an ortho-base [resp. a base of low redundancy] if for each subcollection \( \mathcal{B}' \) of \( \mathcal{B} \) [resp. each subcollection \( \mathcal{B}' \) which is perfectly decreasing, i.e. for each \( B_1 \in \mathcal{B}' \), there exists \( B_2 \in \mathcal{B}' \) such that \( B_2 \) is properly contained in \( B_1 \)] either (i) \( \mathcal{B} \setminus \mathcal{B}' \) is open or (ii) \( \mathcal{B} \setminus \mathcal{B}' \) is a singleton \( \{p\} \) and \( \mathcal{B}' \) is a local base at \( p \). Among the open problems discussed are whether a paracompact \( M \)-space with a base of finite rank or a well-ranked base is metrizable, and the relationship between metric and perfectly normal spaces, and between \( \beta \)-spaces and Morita \( P \)-spaces, in the presence of certain base properties. (Received September 22, 1975.)

729-G20 ROBERT J. DAVERMAN, University of Tennessee, Knoxville, Tennessee 37916. Embeddings of \((n-1)\)-spheres in \(n\)-space.

This report will survey new results and unsolved problems concerning locally flat embeddings of \((n-1)\)-manifolds in \(n\)-manifolds, primarily for the higher dimensional situation when \( n \geq 5 \). It will include descriptions of the techniques for constructing pathological embeddings, of the local properties generally shared among the embedded manifolds, and of the criteria for determining local flatness. The foundation for such criteria is the equivalence, established independently by A. V. Cernavski and myself,
in the latter case by depending heavily on a partial solution due to T. M. Price and C. L. Seebeck, between the local flatness of the embedding and the local simple connectedness of the complement to the embedded manifold. Based on this equivalence, the report will discuss extensively the validity of higher dimensional analogues to the vast literature pertaining to embeddings of 2-manifolds in 3-manifolds. There is a recent result of this type, analogous to a 3-dimensional result derived by N. Hosay and L. Lininger, that can be announced: if f is an embedding of the (n - 1)-sphere $S^{n-1}$ in $S^n (n \geq 5)$, C denotes the closure of a component of $S^n - f(S^{n-1})$, and $\epsilon > 0$, then there exists an embedding h of C in $S^n$ such that h moves points no more than $\epsilon$ and the closure of $S^n - h(C)$ is an n-cell. (Received September 22, 1975.)

729-G21 HOWARD H. WICKE, Ohio University, Athens, Ohio 45701. An example of a weak e-refinable $\mathbb{S}_1$-compact $T_1$-space which is not metaLindel"of. A simple example is given of a $T_1$ $\mathbb{S}_1$-compact hereditarily weak e-refinable scattered space which is not metaLindel"of. The space is quasi-developable and, since it is scattered, has a monotonically complete base of countable order. It is quasi-regular, but not $T_2$. This shows in particular that weak $\theta$-refinable $\mathbb{S}_1$-compact $T_1$-spaces need not be Lindel"of, although closed and countably compact subspaces of weak $\theta$-refinable spaces are compact [Worrell-Wicke, Can. J. Math. 17 (1965) 820-830]. The space also bears on questions raised by C. E. Aull, J. R. Boone, and J. C. Smith, among others. In particular, $T_1$ weak e-refinable spaces need not be irreducible in contrast to the case [Boone, Notices AMS 22 (1975) 751-51] for weak $\theta$-refinable spaces. By a result of Smith [NOTICES AMS 22(1975) 726-54-9] it follows that the space constructed is not weak $\theta$-refinable even though it is weak $\theta$-refinable. (Received September 23, 1975.)

729-G22 ROBERT C. ESLINGER, The University of the South, Sewanee, Tennessee 37375

Partial Semigroups on a Banach Space.

Let B be a Banach space, D an open subset of B containing 0, and $(x,y) \rightarrow x \cdot y$ an associative multiplication defined from $D \times D$ into B satisfying $x \cdot 0 = 0 = x \cdot x$ for all $x \in D$.

Theorem. Suppose $0 < c < 1/2$ and for all $x$, $y$, and $z$ in D, $||x \cdot y - x \cdot z - (y - z)|| \leq c ||y - z||$ and $||x \cdot y - z \cdot y - (x - z)|| \leq c ||x - z||$. Then there exist a positive number p and a unique continuous transformation $T: [-1,1] \times \{x: ||x|| < p\} \rightarrow D$ such that $T(0,x) = 0$, $T(1,x) = x$, and $T(s+t,x) = T(s,x) \cdot T(t,x)$ whenever $||x|| < p$ and each of s, t, and $s + t$ is in $[-1,1]$. (Received September 23, 1975.)

The November Meeting in Los Angeles, California
November 15, 1975

Algebra & Theory of Numbers

730-A1 MASAO KISHORE, The University of Toledo, Toledo, Ohio 43606. An odd perfect number not divisible by 3 has at least ten prime factors.

If N is an odd perfect number, P. Hagis, Jr. proved [Notices of AMS, January (1975), A-60] that N has at least eight prime factors. If 3|N, H.J. Kanold proved [J. Reine Angew. Math 197 (1957), 82-96] that N has at least nine prime factors. Using computer, we prove that if 3|N N has at least ten prime factors. (Received April 2, 1975.)

730-A2 RUSSELL MERRIS, California State University, Hayward, CA 94542

Relations Among Generalized Matrix Functions.

Let $G$ be a permutation group of degree $m$. Let $\lambda$ be an irreducible (complex) character of $G$. If $A = (a_{ij})$ is an $m$ by $m$ matrix, define
\[ d^G_\lambda(A) = \sum_{\sigma \in G} \lambda(\sigma) \prod_{i=1}^r a_{\sigma(t)}(t). \]

If \( A \) is positive semidefinite Hermitian, write \( A \geq 0 \). Let \( H \) be a subgroup of \( G \). Theorem 1. Let \( \chi \) be an irreducible character of \( H \). If \( A \geq 0 \), then
\[ [G:H] \chi(id)d^H_\lambda(A) = \sum_{n \in \Lambda} \eta_{\chi,H}(n) d^G_\lambda(A), \]
the summation over \( \{ n: (n, \chi)_H > 0 \} \). Theorem 2. Suppose \( \lambda|_H = a_1 \chi_1 + \ldots + a_r \chi_r \), where \( \chi_1, \ldots, \chi_r \) are distinct irreducible characters of \( H \). Then
\[ \lambda(id)d^G_\lambda(A) \leq [G:H] \sum_{i=1}^r \chi_i(id)d^H_\lambda(A) \]
for all \( A \geq 0 \). The cases of equality are determined. (Received August 25, 1975.)

Putcha raised the following question (Proc. Amer. Math. Soc. 47, 1975, January, 49-52).

Let \( S \) be a commutative archimedean semigroup without idempotent. Is a maximal cancellative subsemigroup of \( S \) necessarily an \( \mathbb{N} \)-semigroup? Tamura (Notices Amer. Math. Soc. 162, 1975, June, A484) gave a counterexample and posed the question: Is a maximal cancellative subsemigroup of \( S \) necessarily an \( \mathbb{N} \)-semigroup? The authors give a counterexample. (Received September 18, 1975.)

### Analysis

#### 730-B1

ALLAN FRYANT, U.S. Naval Academy, Annapolis, Maryland 21402 and MORRIS MARDEN, California Polytechnic State University, San Luis Obispo, California 93407.

Green's Function with Ring Pole and Applications to Interpolation.

In this paper axisymmetric harmonic functions defined in rotationally symmetric regions \( \Omega \subset \mathbb{R}^3 \) are expressed in terms of the "Green's function \( G \) for \( \Omega \) with a ring pole," analogous to the classical representation of harmonic functions in terms of the usual Green's function with pole at a point. Bergman integral representations for \( G \) and the axisymmetric Poisson kernel are obtained. An application is made to solving the axisymmetric Dirichlet problem by interpolation to the boundary values. (Received August 4, 1975.)

#### 730-B2

CARLOS A. INFANTEZOTTI, Universidad de la Repúblicade la Republica, Atlántico 1514, Montevideo, Uruguay.

"Convergence Criteria for Alternating Series".

Let \( \sum (-1)^n a_n \) be an alternating series (\( a_n > 0 \)). Then one can write, with notations of K. Knopp "Theory and Application of Infinite Series",
\[ a_{n+1} = \frac{1}{1 - x a_n} \quad \text{with} \quad \frac{P_n(a_n)}{a_n} \geq 0 \quad \text{if} \quad \frac{1}{1 - x a_n} \geq 0, \]
where \( x = \sum a_n \), \( s_n = \sum a_n \) and \( P_n(a_n) = L_{n+1} L_{n+2} \ldots L_1 \).

(\( x \) natural logarithm, \( P_n(a_n) \) improper divergent series, oscillating series). If \( x > 1 \), the convergence is absolute if \( \sum a_n^k \), the convergence is conditional. For \( m = 0 \), one arrives at the Darboux's rule. Similarly
\[ \frac{a_{n+1}}{a_n} = \frac{1}{1 - \frac{P_n(a_n)}{a_n}} \quad \text{with} \quad \frac{P_n(a_n)}{a_n} \geq 0 \quad \text{if} \quad \frac{1}{1 - \frac{P_n(a_n)}{a_n}} \geq 0. \]

(k > 1; absolute convergence; \( \sum a_n^k \) conditional convergence). For \( m = 0 \) one arrives at an analogous of Darboux's rule.

If one employs logarithmic notation and one sets \( R_n(a_n) = P_n(a_n) \) \( \left( \sum a_n^{-1} - \frac{\sum a_n^{-1}}{\sum a_n^{-1}} \right) - a_n^{-1} \),
\[ R_n(a_n) = P_n(a_n) \left( \frac{\sum a_n^{-1} - \frac{\sum a_n^{-1}}{\sum a_n^{-1}}}{\sum a_n^{-1}} \right) \]
then one may deduce \( R_n(a_n) \geq 0 \), \( \frac{P_n(a_n)}{a_n} \) the series \( \sum a_n \) is only improper divergent or oscillating series. (Received September 18, 1975.)

#### 730-B3

DONALD SABASON, University of California, Berkeley, California 94720

Quasicontinuous functions

A function in \( L^\infty \) of the unit circle is said to belong to \( QC \) if both it and its complex conjugate belong to the algebra \( H^\infty + C \). Such a function has the property that, on any arc I
of sufficiently small measure, it takes values that are close to its average value over $I$ except possibly on a set whose measure is small compared to that of $I$. This report will relate the results obtained thus far in an investigation of QC that is still in progress. In particular, partial information will be given about the maximal ideal space of QC and about the sets of uniqueness of QC. (Received September 22, 1975.)

Let $J$ be the subalgebra of $H^0(\partial\Omega)$ generated by the unimodular functions in $H^0(\partial\Omega)$. We prove that $J$ is a logmodular subalgebra of $H^0(\partial\Omega)$, and that $J$ has the same maximal ideal space as $H^0(\partial\Omega)$. The problem of whether $J$ coincides with $H^0(\partial\Omega)$ remains open. (Received September 22, 1975.)

We prove the following theorem which includes as a special case the theorem of Sibony-Wermer.

**Theorem.** Let $M$ be an abstract compact strongly pseudoconvex hypersurface, which admits local coordinates. Then $M$ can be embedded in some $\mathbb{C}^n$. If $F : M \to \mathbb{C}^n$ is a $C^1$ embedding, then the space of holomorphic functions on $F(M)$ is dense in the space of CR functions on $M$. (Received September 22, 1975.)

Some recent (and not so recent) results on A-holomorphic functions will be discussed: variants of an abstract Schwarz's lemma and consequences; some extensions of Radó's theorem. (Received September 22, 1975.)

We characterize those unimodular functions $\varphi$ in $L^0(T)$ which satisfy the condition that $\varphi H^0 + C$ is a closed subspace of $L^0$. A special case is that $\varphi H^0 + A$ is a closed stable subalgebra of $H^0$ provided $\varphi$ is an inner function whose support on the unit has measure zero and is a closed non-stable subalgebra of $H^0$ provided $\varphi$ is an inner function whose support contain the entire unit circle.

The characterization of $\varphi$ involves the distance of $\varphi$ to $H^0$ at each point of the circle. (Received September 22, 1975.)

The evolving size distribution of particles in a coagulating cloud is described by an infinite set of non-linear differential equations due to M. von Smoluchowski:

$$\frac{d\gamma_k}{dt} = \frac{1}{2} \sum_{i,j} B_{ij} \gamma_i \gamma_j - \gamma_k \sum_j B_{kj} \gamma_j,$$

$$\gamma_k(0) = \gamma_k, \quad k = 1, 2, 3, \ldots.$$

The constant coefficients $B_{ij}$ are symmetric and non-negative, and the initial conditions satisfy
\[
\sum_k k^p y_k^p < \infty, \quad p = 0, 1, 2, \ldots.
\]

We show that: a) if \( B_{ij} \leq B_{ij} \) for some \( B \), then these equations possess at least one solution \( y_k \) valid for all \( t \in [0, \infty) \); b) if \( B_{ij} \leq B_{ij} \) for some \( B \), then \( \sum k^p y_k(t) < \infty \) for all \( t \in [0, \infty) \). These results extend work by J. B. McLeod. (Received September 22, 1975.)

RAYMOND D. TERRY, California Polytechnic State University, San Luis Obispo, California 93407. Positive Solutions of the equation \( D^r [r(t)D^s y(t)] = f(t, y(t-T(t)) \). Assume that \( 0 < T(t) < \infty \), \( 0 < -T(t) < \infty \), and \( p(t) > 0 \). Let \( y_k(t) = D^l y(t) \) for \( k = 0, \ldots, n-1 \); \( y_k(t) = D^l y(t) \) for \( k = n, \ldots, 2n-1 \). A solution \( y(t) \) of \( (E) \) is of type \( B_j \) if for \( t \) sufficiently large \( y_k(t) > 0 \) for \( k = 0, \ldots, 2j \) and \((-1)^k y_k(t) > 0 \) for \( k = 2j+1, \ldots, 2n-1 \). If \( y(t) \) is a \( B_j \)-solution on \([T_0, \infty)\), \( 1 \leq j \leq n-1 \) and \( 0 \leq k \leq j \), then there is a constant \( \theta < 0 \) such that \( t^2 y_{2k}(t) \leq \theta y(t) \) for \( t \geq 2(T_0+\theta) \). Use of (i) an auxiliary differential inequality; (ii) a combination of integration by parts and Leibnitz' formula and (iii) an expansion in Taylor series enable us to obtain three separate but interrelated criteria for the exclusion of \( B_j \)-solutions of \( (E) \). A typical result is: Theorem 1. Suppose \( 0 \leq k \leq n-1 \) and

\[
\limsup_{t \to \infty} \frac{\int_{t-T(t)}^t (u-t+\theta(u))^{2n-2k-1} [u-T(u)]^{2k} p(u) du}{(2n-2k-1)! \theta n^{2k} \leq 2(2n-2k-1)! MN^{2k}, \quad k \leq n/2}.
\]

Then \( (E) \) has no solutions of type \( B_k \). (Received September 22, 1975.)

F. DAVID LESLEY, San Diego State University, San Diego, California 92182. Once is not enough. Suppose \( \Gamma \) is a Jordan arc in the complex plane and that \( f \) is continuous on \( \Gamma \) with modulus of continuity \( \omega(t) \). \( \Gamma \) is said to have property \( J \) if for any such function there is a sequence of polynomials \( \{ P_n(t) \} \), \( P_n \) of degree \( < n \), such that \( ||f - P_n|| \leq \omega(1/n) \) as \( n \to \infty \). That is, \( \Gamma \) has property \( J \) if the Jackson theorem, which holds for straight line segments, is true for \( \Gamma \). D.J. Newman has dealt with the problem of characterizing arcs with property \( J \). He shows that \( \Gamma \in \mathcal{C}^1 \) is sufficient and conjectures that \( \Gamma \in \mathcal{C}^1 \) is necessary and sufficient. By deriving a necessary condition on the exterior conformal mapping function and constructing a class of examples, we show that this condition is not sufficient. We also show that if \( J \) \( \Gamma \) is the corresponding property for closed Jordan curves \( \Gamma \) and functions \( f \) which are analytic in the interior of \( \Gamma \) and continuous on \( \text{Int} \Gamma \cup \Gamma \), then \( \Gamma \in \mathcal{C}^1 \) is not sufficient for property \( J \). (Received September 22, 1975.)

JAMES LI-MING WANG, University of California, Los Angeles, California 90024

The Behaviour of the Functions in \( R(X) \) Near a Point

This talk will concentrate upon the behaviour of the functions in \( R(X) \) near a point \( x \) in \( X \). We say that the unit ball of \( R(X) \) admits \( \varphi \) as modulus of approximate continuity at \( x \) if \( |f(y) - f(x)| \leq \varphi(|y-x|) \) for all \( f \in R(X) \), \( ||f|| \leq 1 \) and all \( y \) in a subset having full area density at \( x \). We will examine the relations among modulus of approximate continuity, representing measure and analytic capacity. (Received September 23, 1975.)

SUN-YUNG CHANG, University of California, Los Angeles, California 90024

\( C^* \)-algebras Contained in Subalgebras between \( L^\infty \) and \( H^\infty \)

Let \( B \) be a closed subalgebra of \( L^\infty \) of the unit disc containing \( H^\infty \). Let \( \mathcal{B} \) be the algebra consisting of complex conjugates of functions in \( B \). Descriptions of some subspace \( \mathcal{M}_B \) of \( BMO \) (space of bounded mean oscillation) will be given such that \( \mathcal{M}_B \cap L^\infty = B \cap \mathcal{B} \). A
related problem concerning structure of subalgebras between $L^0$ and $H^0$ raised by D. Sarason will be discussed. (Received September 23, 1975.)

**Geometry**

#730-D1 STEFAN HILDEBRANDT, HELMUT KAUL, University, 5300 Bonn, Germany, and KJELL-OVE WIDMAN, University, 58183 Linköping, Sweden. Dirichlet's boundary value problem for harmonic mappings of Riemannian manifolds. Preliminary report.

Let $\mathcal{M}$ be a compact Riemannian manifold with boundary $\Sigma$, and $\mathcal{M}$ a complete Riemannian manifold without boundary. Suppose that $\mathcal{M}$ and $\mathcal{M}$ are of class $C^3$, and denote the sectional curvature of $\mathcal{M}$ by $K$. Moreover, $\mathcal{K}_M(V)$ stands for the closed ball in $\mathcal{M}$ having radius $M$ and center $V \in \mathcal{M}$.

**Theorem:** Suppose that $K < \kappa \leq \kappa$ for some constant $\kappa > 0$ and let $\Phi: \Sigma \rightarrow \mathcal{M}$ be prescribed continuous boundary values satisfying $\Phi(\Sigma) \subset \mathcal{K}_M(V)$, where $M < \theta \cdot \pi^{-\frac{3}{2}}$. Assume also that the cut locus of $\mathcal{K}_M(V)$ is "sufficiently far away" from $V$. Then there exists a harmonic mapping $U: \mathcal{M} \rightarrow \mathcal{M}$ continuous on $\mathcal{M}$ and of class $C^2$ in int $\mathcal{M}$ such that $U|\Sigma = \Phi$ provided that $\theta \approx 1.15\ldots$ (we conjecture that $\theta = \pi/2$ is the optimal value).

For $\kappa = 0$ one has $M < \infty$, and this result was recently proved by Hamilton, while apparently the case of positive curvature has not been treated. (Received September 2, 1975.)

#730-D2 JOEL L. WEINER, University of Hawaii, Honolulu, HI 96822. Global properties of spherical curves.

Let $S$ be the unit sphere with center at the origin of space. Let $\alpha$ be a closed regular $C^2$ space curve which lies on $S$. Let $\tilde{\Omega}$ denote the convex hull of $\alpha$.

**Theorem.** Suppose $\alpha$ is non-singular, i.e., free of multiple points. If the origin is in $\tilde{\Omega}$ then the geodesic curvature of $\alpha$ changes sign at least four times if $\alpha$ does not contain a great semicircular arc.

This theorem is similar to one proved by W. Fenchel [Math. Ann. 101 (1929)] for such $\alpha$ with at most one double point. A consequence of the above theorem is the following.

**Theorem.** Let $\alpha$ be non-singular and $0 \in \tilde{\Omega}$. If $0$ is not (is, resp.) a vertex of $\alpha$ then there exist at least four (three, resp.) points of $\alpha$ whose osculating plane goes through $0$.

This theorem was proved by B. Segre [Rend. Mat. (6) 1 (1968)] for $C^3$ curves. Other results on the number of points of $\alpha$ whose osculating plane goes through $0 \in \tilde{\Omega}$ are proven.

**Corollary.** Let $\alpha$ be a non-planar closed regular $C^3$ space curve with positive curvature. If $\alpha$ has no pair of directly parallel tangents then the torsion of $\alpha$ changes sign at least four times. (Received September 8, 1975.)

#730-D3 JAMES B. CARRELL, University of British Columbia, Vancouver B.C., and DAVID I. LIEBERMAN, Brandeis University, Waltham MA. Chern classes of the Grassmannians.

Given a holomorphic vector field $V$ on a compact Kaehler manifold $X$, one may obtain considerable information about $X$ by investigating the nature of $X$ about its zeros. Namely, if $Z$ is the (possibly unreduced) subvariety of $X$ associated to the sheaf of ideals $i(V)\mathcal{I}_X$, then the cohomology ring $H^*(X,\mathbb{C})$ is the graded ring arising from a certain filtration of $\Gamma(Z,\mathcal{I}_Z)$. In many interesting cases, such as the grassmannians, $\Gamma(Z,\mathcal{I}_Z)$ is very easy to compute, while $H^*(X,\mathbb{C})$ is much harder. This identification leads to a novel interpretation of the special Schubert classes in terms of the symmetric functions. (Received September 15, 1975.)
We deal with the problem of describing those functions which can arise as Gaussian curvatures of Lorentz metrics on the 2-dimensional torus $T^2$ and the plane $R^2$. Our results illustrate a number of significant differences between the Riemannian case, which has been studied by Kazdan and Warner, and the Lorentz case. The technique we use is that of Kazdan and Warner. We attempt to realize a given function $K$ as the curvature of a Lorentz metric $\hat{g}$ pointwise conformal to the flat metric $g$: $ds^2 = dx^2 - dy^2$, i.e. $g = e^{-2u}\hat{g}$ for some smooth function $u$. For the torus, Kazdan and Warner have shown that the conditions (i) $K$ changes sign on $T^2$ and (ii) $\int_{T^2} KdA < 0$, where $dA$ is the area element of $g$, are necessary and sufficient for $K$ to be such a curvature. In the Lorentz case, we show that (ii) is no longer necessary and that (i) can be replaced by a stronger necessary condition which implies that (i) and (ii) together are no longer sufficient. For $R^2$ we show that any constant function or any function with compact support may be the curvature of a Lorentz metric pointwise conformal to $g$. Finally, if $\Omega$ is any 2-form on $T^2$ whose integral over the torus is zero, then $\Omega$ is the curvature form of a Lorentz metric. (Received September 2, 1975.)

Using an idea in the thesis of R. Brody, three theorems were obtained. Theorem 1. Let $M$ be a closed complex subspace of a complex torus $T$. Then $M$ is hyperbolic if it contains no nontrivial complex subtorus of $T$. Theorem 2. Let $T$ be a simple complex torus, $U$ a nonempty open subset of $T$. Then $T-U$ is hyperbolic. Theorem 3. Let $T$ be a complex torus, $D$ a nonsingular hypersurface in $T$ containing no nontrivial complex subtorus. Then $T-D$ is complete hyperbolic and hyperbolically embedded in $T$. (Received September 23, 1975.) (Author introduced by Professor Nathaniel Grossman.)

Statistics and Probability

From a random sample $X_1, X_2, \ldots, X_n$ there can be constructed $N-K+1$ successive sample means of the form $\bar{X}_n = \frac{1}{n} \sum_{i=1}^{n} X_i$ for $0 \leq n \leq N-K$, where $S_n = \sum_{i=1}^{N-K} X_i$. Erdős and Rényi (1970) analyzed the maximum $\theta(N,K)$ of these $N-K+1$ means. If the distribution from which the sample was selected is normalized and possesses a moment-generating function, then for a wide interval of positive $\lambda$'s they showed that there exist known constants $C(\lambda)$, depending only on $\lambda$ and the distribution, such that $\theta(N, [C(\lambda)\log N]) \sim \lambda$ a.s. as $N \to \infty$. In the present study, an analogous strong limit theorem is developed for the maximum of the $N-K+1$ successive sample medians and, more generally, for all sample quantiles. (Received September 15, 1975.)

Topology

A continuum $M$ is almost chainable if for each positive number $\epsilon$, there exists an $\epsilon$-cover $D$ of $M$ and a chain $C = \{L(i): 1 \leq i \leq n\}$ of elements of $D$ such that no $L(i)$ $(i > 1)$ intersects an element of $D - C$ and every point of $M$ is within $\epsilon$ of some element of $C$. In [Homogeneous continua which are almost chainable, Canad. J. Math. 13 (1961), 519-528] C. E. Burgess proved that every $k$-junctioned tree-like homogeneous continuum is almost chainable. Burgess also showed that a homogeneous continuum is almost chainable if and only if all of its proper subcontinua are pseudo-arcs. In this paper we prove that every homeomorphism of an almost chainable homogeneous continuum into itself has a fixed point. Hence we have another proof of L. Fearnley and J. T. Rogers' theorem, the pseudo-circle is not homogeneous. (Received September 8, 1975.)
MILTON S. PLESSET, Department of Engineering Science, California Institute of Technology, Pasadena, California 91109. Nuclear fission energy - problems and promise.

A large potential source of energy is available in the fission energy release from uranium. The presentation includes a brief discussion of the extent of this resource. The present program for the utilization of this nuclear energy is based on light water reactor systems, and the general features of these systems will be described together with an indication of the role of mathematical analysis in their design. The major emphasis of the presentation, however, will be on the problems of the safety of these nuclear power systems since this area is the one of greatest public concern. An attempt will be made to explain the differences of opinion which exist regarding the safety problems. Of interest also are the limitations on the analytical attempts at resolving some of these safety questions. Examples of the difficulty in the mathematical and physical formulation of these problems will be presented. As a final topic, the liquid metal fast breeder system will be discussed, including some of its associated safety problems. (Received September 26, 1975.)


(Harold Grad, Courant Institute, New York University, New York, New York 10012.)

HAROLD GRAD, Courant Institute, New York University, New York, New York 10012.

Mathematical problems arising in controlled thermonuclear research.

Controlled thermonuclear fusion offers probably the only energy solution with completely inexhaustible fuel and unlimited power capacity, which is relatively clean. The scientific and technological problem consists in magnetically confining a hot, dense plasma (pressure several to hundreds of atmospheres, temperature $10^8$ degrees or more) for an appreciable fraction of a second. The scientific and mathematical foundation is to learn to describe the behavior, such as confinement, stability, flow, compression, heating, energy transfer and diffusion of this medium in the presence of electromagnetic fields just as we can do relatively well for air or steam. Some of the extant theory consists of applications, direct or ingenious, of known mathematical structures in the theory of differential equations and traditional analysis. Some problems lead to differential equations of new type, beyond the familiar subsonic-elliptic and supersonic-hyperbolic connection. Also completely nonstandard concepts with significant theory are being rapidly uncovered (and somewhat less rapidly understood) such as nonelliptic variational equations and new types of weak solutions. If history is a guide, it is these new mathematical structures which one should expect to supply the foundation for the next generations' pure mathematics. Despite the substantial effort over a period of some twenty years, there are still basic and important scientific and mathematical discoveries to be made lying just beneath the surface. (Received September 29, 1975.)


Laser fusion is a scientific and engineering endeavor to obtain useful amounts of energy from thermonuclear fusion reactions taking place in inertially confined microscopic fuel pellets which are heated and compressed by high power laser radiation. Among the problem areas where methods of theoretical physics and mathematical analysis are being successfully applied are the following: laser theory and quantum optics; nonlinear optical propagation and diffraction theory; and hydrodynamic and radiative transport theory. In each of these areas, the physical behavior is described by complex systems of nonlinear partial differential equations. Considerable physical insight has been obtained by asymptotic analyses and explicit solutions of these equations in special limiting cases. A more powerful and general approach which has been developed by the laser fusion research laboratories is to construct large computer codes which take into account the many complicated interacting physical processes. The design of such computer codes requires efficient algorithms for the numerical solution of partial differential equations, optimal use of high-speed computing machine architecture, and effective computer graphics facilities to display the large amount of information produced by these codes. (Received September 29, 1975.)

REFERENCES

The development of midterm energy forecasts for the United States is accomplished under the title of Project Independence Studies of FEA. The analytical effort for Project Independence can be viewed as a large model drawn from the techniques of many disciplines. The structure of the model is overviewed with emphasis on the optimization and fixed point formulations and algorithms. Computational experience is indicated. (Received September 29, 1975.)

purpose of developing intuition is important. In some cases, models will clearly need to allow interaction with people motivated to act the roles of cartel operators, anarchists, law-breakers, and the like.

(Received September 29, 1975.)


2. Large-scale dynamic systems (NASA SP-371), A seminar workshop held at Utah State University, August 12-16, 1974.


SC 76-6 GEORGE B. DANTZIG, Systems Optimization Laboratory, Department of Operations Research, Stanford University, Stanford, California and Shailendra C. Parikh, Graduate School of Business, University of Santa Clara, Santa Clara, California, and Systems Optimization Laboratory, Department of Operations Research, Stanford University, Stanford, California. A model for assessing physical impact on the economy of a changing energy picture.

This dynamic, linear programming model on a pilot scale is an attempt to describe in physical terms many of the technological interactions within and across the sectors of the economy, including a detailed energy sector. The general objective of the model is to determine, in the face of changing energy picture, what the country could achieve in physical terms over the long term. In the model, a 23-sector input-output matrix represents various industrial processes of the economy. The net output from the industry, together with net imports, meets the national bill-of-goods for consumption, capital formation and government services. The energy demands of the economy are met by the activities of the energy sector. The nature and extent of the capacity expansion in both the energy sector and the rest of the economy are endogenously determined. Finally, the exogenously given workforce provides the manpower necessary to sustain industrial production, energy processing and capacity expansion. The detailed energy sector in the model includes technological description of the raw material extraction and energy conversion processes. Oil and gas exploration and production, oil refining, gas transmission, coal mining, power generation using coal, oil and gas, and coal gasification and liquefaction are among the fossil fuel based processes in the model. Uranium mining, milling, conversion, enrichment and fabrication, light water reactor, fast breeder reactor, and spent fuel reprocessor are among the nuclear fuel based processes in the model.

The operating levels of the processing units are limited in one way or the other by the available capacities and proven reserves in any period. The proven reserves may be augmented by the exploration activity. And, raw material imports/exports make up the difference between the domestic production and usage. Among the linkages that interconnect the energy sector and the rest of the economy are: energy demands of the economy, total manpower available to all sectors (including energy) of the economy, favorable balance-of-payments requirement, and bill-of-goods needed for energy processing and capacity expansion. The model assumes as given some temporal pattern of population growth, workforce availability, and requirements for government services. Initial capacities of various processes are also required. Outputs from the model are a schedule of capacity expansion and the consumption standards achieved. This descriptive model could be used in conjunction with a linear or a nonlinear objective. The objective could be a utility function measuring the standard of living achieved over time. It could also be to minimize dependence on foreign ore, or to maximize energy output, or to maximize employment. Our intent is to develop on a pilot scale a reasonably accurate general description of the American economy and more detailed description of the energy sector in order to facilitate studies of the physical potential of the economy under (i) alternative objectives, (ii) changing availability of various forms of energy, (iii) changing energy conversion technologies, etc. The presentation will include important modelling concepts used in this model and some illustrative numerical results. (Received October 1, 1975.)

The lecture will survey two problems in power production: the optimization arising in the economic dispatch of power, and investment problems in the energy industry. The first problem leads to the minimization of nonlinear functions of hundreds of variables subject to nonlinear constraints; the second problem involves the theory of discrete time optimal control. (Received October 1, 1975.)


What additions to recoverable oil and gas will accrue from an increment of exploratory effort? To answer this question we first construct a probabilistic model of oil and gas discovery from assumptions that describe the manner in which exploration technology and observed statistical regularities of the size of pools interact to generate discoveries. The basic assumptions incorporate certain geological facts and the content of a variety of statistical studies of the discovery process. The parameters of the model are, in general, not known with certainty a priori. We study the joint density of discovery sizes and the (conditional) moments of future discovery sizes given what has been observed as a prelude to statistical estimation of these parameters. For the case of greatest practical interest – lognormal pool size distributions – we compute uniform asymptotic expansions for (1) the joint density of discovery sizes and for (2) the conditional moments of future discovery sizes. Approximate maximum likelihood estimation can be done using (1) and nonlinear least squares estimation can be done using (2). Once the parameters are estimated, a predictive forecast of future discovery sizes can be generated. (Received October 2, 1975.)


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