**CALENDAR OF AMS MEETINGS**

This calendar lists all meetings which have been approved by the Council prior 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. Programs of the meetings will appear in the issues indicated below. First and second announcements of the meetings will have appeared in earlier issues.

Abstracts of contributed papers 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 of papers 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>ABSTRACTS DEADLINE for ISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>765</td>
<td>April 19-20, 1979</td>
<td>New York, New York</td>
<td>EXPIRED April</td>
</tr>
<tr>
<td>766</td>
<td>April 27-28, 1979</td>
<td>Iowa City, Iowa</td>
<td>APRIL 24 June</td>
</tr>
<tr>
<td>767</td>
<td>June 15-16, 1979</td>
<td>Vancouver, Canada</td>
<td>JUNE 12 August</td>
</tr>
<tr>
<td>768</td>
<td>August 21-25, 1979</td>
<td>Duluth, Minnesota</td>
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<tr>
<td></td>
<td>(83rd Summer Meeting)</td>
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<tr>
<td>October 20-21, 1979</td>
<td>Washington, D.C.</td>
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<tr>
<td>November 2-3, 1979</td>
<td>Kent, Ohio</td>
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<tr>
<td>November 16-17, 1979</td>
<td>Riverside, California</td>
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<tr>
<td>January 3-7, 1980</td>
<td>San Antonio, Texas</td>
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<tr>
<td>March 28-29, 1980</td>
<td>Boulder, Colorado</td>
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<tr>
<td>April 25-26, 1980</td>
<td>Davis, California</td>
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<tr>
<td>August 18-22, 1980</td>
<td>Ann Arbor, Michigan</td>
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<tr>
<td>January 7-11, 1981</td>
<td>San Francisco, California</td>
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<tr>
<td>(87th Annual Meeting)</td>
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Deadlines listed above for abstracts are also the deadlines for other information intended for publication in the same issue: news items and announcements of special meetings. There are separate deadlines for classified advertising and for abstracts of papers presented to the Society for publication by title (rather than for presentation in person at a meeting). They are as follows:

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>BY TITLE ABSTRACTS</th>
<th>CLASSIFIED ADVERTISING</th>
</tr>
</thead>
<tbody>
<tr>
<td>APRIL 1979</td>
<td>February 20</td>
<td>March 9</td>
</tr>
<tr>
<td>JUNE 1979</td>
<td>April 17</td>
<td>April 27</td>
</tr>
<tr>
<td>AUGUST 1979</td>
<td>June 5</td>
<td>June 22</td>
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**OTHER EVENTS SPONSORED BY THE SOCIETY**

- **June 19-30, 1979**
  Seminar/Workshop on Algebraic and Geometric Methods in Linear Systems Theory
  Harvard University, Cambridge, Massachusetts
  Announcement appears February 1979 p. 96

- **June 25-July 20, 1979**
  Summer Research Institute on Finite Group Theory
  University of California, Santa Cruz, California
  Announcement appears February 1979 p. 96

- **August 19-20, 1979**
  AMS Short Course: Operations Research: Mathematics and Models
  University of Minnesota, Duluth, Minnesota
  Announcement appears April 1979
MEETINGS OF THE SOCIETY
Honolulu, March 30, 84 (Abstracts A-232)
New York City, April 19, 93
Iowa City, April 27, 94
Vancouver, June 15, 95
Summer Seminar/Workshop, June 19, 96
Summer Research Institute, June 25, 96
Invited Speakers, 95; Special Sessions, 101

BÔCHER AND STEELE PRIZES

102 QUERIES
104 1980 NSF BUDGET
106 ANNUAL AMS SURVEY: Second Report
  Employment, Faculty Mobility, Enrollment, 106
  Two-Year Colleges, 113
105 LETTERS TO THE EDITOR
118 NEWS & ANNOUNCEMENTS
123 SPECIAL MEETINGS
128 NEW AMS PUBLICATIONS
130 MISCELLANEOUS
  Personal Items, 130; Deaths, 130; Visiting
  Mathematicians, 130; Backlog of Mathematical
  Research Journals, 131; Assistantships and
  Fellowships (Supplement), 132
138 AMS REPORTS & COMMUNICATIONS
  Recent Appointments, 138; Reports of Meetings:
  Claremont, 138; Syracuse, 139; Charleston, 140;
  Chicago, 140; Biloxi (Council and Business
  Meetings), 141
142 AMS BOOKS IN MECHANICS
  A-191 ABSTRACTS
  A-253 ADVERTISEMENTS
Program for the 764th Meeting

April 1, 1979. The sessions will take place in Kuykendall Hall.

The period Tuesday through Friday, March 27-30, will be largely devoted to a Symposium on The Geometry of the Laplace Operator, and these sessions will be held in St. John's Hall. Support is anticipated under a grant from the National Science Foundation. The topic for the symposium was selected by the Committee to Select Hour Speakers for Far Western Sectional Meetings, consisting of Paul C. Fife (chairman), David M. Goldschmidt, Robert Osserman, Rimhak Ree, and Kenneth A. Ross. The Organizing Committee for the symposium, responsible for selecting the speakers and arranging the program, consists of David Beecher and Robert Osserman (cochairmen), Victor Guillemin, Henry P. McKean, Jr., Karen Uhlenbeck, Joel Weiner, and Alan Weinstein.

Also by invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. HENRY A. DYE of the University of Southern California, Los Angeles, will lecture at 11:00 a.m. on Friday; the title of his address is "Orbit equivalence in ergodic theory." WILLIAM A. HARRIS, Jr., of the University of Southern California, will speak at 11:00 a.m. on Saturday. The title of his talk is "Laplace integrals and factorial series in singular differential and difference equations." Both lectures will be in the Kuykendall Auditorium.

By invitation of the same committee, there will be five special sessions of invited twenty-minute papers. All of the organizers are at the University of Hawaii at Manoa except for Arthur A. Sagle, who is at the University of Hawaii at Hilo, CHRISTOPHER J. ALLDAY, HUGH M. HILDEN, and BOB LITTLE are organizing a special session on Geometric topology; the list of speakers includes Christopher J. Allday, Gordon Cameron, Ronald A. Fintushel, Hugh M. Hilden, Dennis L. Johnson, Bob Little, Kenneth C. Millett, Robert A. Oliver, Peter Sie Pao, Nobuyuki Albert Sato, Martin G. Scharlemann, Justin R. Smith, and Ronald J. Stern, RONALD P. BROWN and THOMAS C. CRAVEN are organizing a special session on Quadratic forms; the list of speakers is Lawrence Berman, Craig M. Cordes, Andrew G. Earnest, Richard S. Elman, Alexander J. Hahn, J. S. Hsia, Jerrold L. Kleinste, Tsit-Yuen Lam, Murray Marshall, Bernard R. McDonald, Takashi Ono, Paul Ponomarev, Alexander Prestel, Alex Rosenberg, Daniel B. Shapiro, Olga Taussky-Todd, Adrian R. Wadsworth, and Roger P. Ware. WILLIAM P. HANF and DALE W. MYERS are arranging a special session on Countable models; the list of speakers includes Nigel Cutland, Utrig Flum, Edgar G. K. Lopez-Escobar, Michael Makkai, Johann Andreas Makowsky, Terrence Millar, Anil Nerode, Kenneth Schilling, John S. Schlipf, James H. Schmerl, and Robert L. Vaught. NOBUO NOBUSAWA and ARTHUR A. SAGLE are organizing a special session on Nonassociative algebras and applications; the speakers will be Georgia M. Benkart, Richard E. Block, Morton L. Curtis, Stephen Joseph Doro, Daniel S. Drucker, Robert Greene, John P. Holmes, Erwin Kleinfeld, Robert H. Oehmke, J. Marshall Osborn, Earl J. Taft, David A. Towers, Chester E. Tsai, Gregory P. Wene, David J. Winter, and Kiyosi Yamaguti. L. THOMAS RAMSEY and BENJAMIN B. WELLS, Jr., are arranging a special session on Commutative harmonic analysis with speakers Aharon Atzmon, Gregory F. Bachelis, John J. F. Fournier, John E. Gilbert, Colin C. Graham, Henry Nelson, Edwin Hewitt, Louis Pigno, L. Thomas Ramsey, and Benjamin B. Wells, Jr.

There will be sessions of contributed ten-minute papers. Late papers will be accepted for presentation at the meeting, but will not be listed in the printed program.

REGISTRATION

The registration desk for the Symposium will be located in Room 015 St. John's Hall on Tuesday, Wednesday, and Thursday, and will be open from 8:00 a.m. until 6:00 p.m. on Friday and Saturday, and Sunday. The desk will be located in Room 211 Kuykendall Hall for the AMS meeting. The desk will be open from 8:00 a.m. to noon, and from 1:00 to 4:00 p.m. on Friday and Saturday; on Sunday the hours will be from 9:00 a.m. until noon only. Tourist information will be available at the registration desk. The registration fees for the meeting and symposium are:

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<tr>
<th></th>
<th>Meeting Only</th>
<th>Symposium Only</th>
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<tbody>
<tr>
<td>Nonmember</td>
<td>$5</td>
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<tr>
<td>Member</td>
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<tr>
<td>Student/Unemp</td>
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FOOD SERVICE

The East-West Center Cafeteria in Jefferson Hall will be open from 7:00 a.m. to 1:00 p.m., and from 5:00 p.m. to 7:00 p.m.; the Campus Center Cafeteria will be open from 11:00 a.m. to 1:00 p.m. In addition, several restaurants and fast food establishments on University Avenue are within easy walking distance of campus.

LOCAL TRANSPORTATION AND PARKING

The bus system in Honolulu is quite good. To go from Waikiki to the University of Hawaii, take bus #4 Nuuanu-Dowsett. For the reverse
trip, take bus #4 University-Waikiki. Buses run every fifteen minutes and require 25¢ in exact change.

Persons driving to the campus from Waikiki are advised to proceed northwest on Ala Wai Boulevard and take the first right turn onto McCully Street. Take the first right turn onto Dole Street (just prior to Founder's Gate) and turn right onto Dole Street. Park in the parking structure south of Dole Street and take the elevator to the upper campus. Parking in this structure will be free, but the cost is 50¢ per hour on the upper campus.

Persons driving to the university via the Lunalilo Freeway should take the University Avenue exit and proceed north on University Avenue, then follow the instructions in the preceding paragraph.

PROGRAM FOR THE SYMPOSIUM ON THE GEOMETRY OF THE LAPLACE OPERATOR
All sessions will be held in Room 011 St. John's Hall

TUESDAY, MARCH 27, 8:40 A.M. - 4:30 P.M.

8:40 - 9:30 a.m. Nonlinear stabilization of quasimodes associated with closed geodesics. ALAN WEINSTEIN, University of California, Berkeley, and Rice University

9:40 - 10:30 a.m. Morphology of wave functions in integrable and stochastic systems. MICHAEL BERRY, H. H. Wills Physics Laboratory, Bristol, England

11:00 - 11:30 a.m. Riesz means on certain Riemannian manifolds. PIERRE H. BERARD, Centre National de la Recherche Scientifique, Paris, France

11:40 - 12:10 p.m. Spectra of compact locally symmetric spaces. JOHAN KOLK, University of California, Los Angeles

2:00 - 2:30 p.m. Asymptotics of compressions to spectral subspaces of the Laplacian. HAROLD WIDOM, University of California, Santa Cruz

2:40 - 3:10 p.m. Spectrum of Laplace operators on manifolds of negative curvature. DAVID KAZHDAN, Harvard University

3:40 - 4:30 p.m. Expansions associated to clean intersections. HAROLD DONNELLY, University of California, Berkeley

WEDNESDAY, MARCH 28, 8:40 A.M. - 4:50 P.M.

8:40 - 9:30 a.m. Determinants of Laplacians. I. M. SINGER, University of California, Berkeley

9:40 - 10:30 a.m. Connections with harmonic curvature. H. BLAINE LAWSON, Jr., University of California, Berkeley, and State University of New York, Center at Stony Brook

11:00 - 11:50 a.m. The Laplacian on spaces with singularities. JEFF CHEEGER, State University of New York, Center at Stony Brook

noon - 12:30 p.m. Combinatorial curvature and harmonic cocycles. EUGENIO CALABI, University of Pennsylvania

2:00 - 2:30 p.m. Remarks on curvature functions. JERRY KAZDAN and FRANK WARNER, University of Pennsylvania

2:40 - 3:10 p.m. Some examples of harmonic maps. JAMES EELLS, Mathematics Institute, Coventry, England

3:40 - 4:10 p.m. Some remarks on harmonic maps. S.-Y. CHENG, Princeton University

4:20 - 4:50 p.m. Equivariant harmonic maps. KAREN UHLENBECK, University of Illinois at Chicago Circle

THURSDAY, MARCH 29, 8:40 A.M. - 3:50 P.M.

8:40 - 9:30 a.m. Bounds on the number of eigenvalues of \(-\nabla + V(x)\). ELLIOTT LIEB, Princeton University and Kyoto University, Japan

9:40 - 10:30 a.m. On the estimate of the first eigenvalue of a compact Riemannian manifold. S.-T. YAU, Stanford University

11:00 - 11:30 a.m. On Cheeger's inequality \(\lambda_1 \leq h^2/4\). PETER BUSER, University of Bonn, Federal Republic of Germany

11:40 - 12:10 p.m. Lower bound of the first eigenvalue of the Laplacian. PETER LI, University of California, Berkeley
2:00- 2:30 p.m. Geometric bounds on the low eigenvalues. RICHARD SCHÖN, New York University, Courant Institute of Mathematical Sciences

2:40- 3:10 p.m. Lowest-eigenvalue inequalities. ISAAC CHAVEL, City University of New York, City College

3:20- 3:50 p.m. Extrinsic estimates for $\lambda_1$. ROBERT REILLY, University of California, Irvine

FRIDAY, MARCH 30, 8:40 A.M. - 4:00 P.M.

8:40- 9:30 a.m. Some Dirichlet series whose poles lie along critical lines. DENNIS HEJHAL, University of Minnesota, Minneapolis

9:40-10:10 a.m. On the spectrum of the Laplace operator on compact Riemann surfaces. HEINZ HUBER, University of Basel, Switzerland

2:00- 2:40 p.m. The Laplacian on a geodesically convex manifold with boundary. RICHARD MELROSE, Massachusetts Institute of Technology

2:50- 3:20 p.m. Geometry in the asymptotics of the scattering phase. JAMES RALSTON, University of California, Los Angeles

3:30- 4:00 p.m. Action angle variables for ordinary differential operators. EUGENE TRUBOWITZ, New York University, Courant Institute of Mathematical Sciences

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 the schedule, the time limits will be strictly enforced.

FRIDAY, 8:30 A.M.

Special Session on Quadratic Forms, I, Room 206, Kuykendall Hall

8:30- 8:50 (1) Construction of fields with non-trivial radical. Preliminary report. Professor T.Y. LAM, University of California, Berkeley (764-A27)

9:00- 9:20 (2) Quadratic forms over fields with four quaternion algebras. Professor CRAIG M. CORDES, Louisiana State University, Baton Rouge (764-A14)

9:30- 9:50 (3) Quadratic forms and power series fields. LAWRENCE BERMAN, University of Oklahoma, Norman (764-A36)

10:00-10:20 (4) Applications of pairs of sums of three squares of integers whose product has the same property. Professor OLGA TAUSKY-TODD, California Institute of Technology (764-A6)

10:30-10:50 (5) Ternary quadratic forms and Shimura's correspondence. Professor PAUL PONOMAREV, Ohio State University, Columbus (764-A28)

FRIDAY, 9:00 A.M.

Special Session on Nonassociative Algebras and Applications, I, Room 205, Kuykendall Hall

9:00- 9:20 (6) Engel subalgebra trianguable Lie algebras. Professor DAVID J. WINTER, University of Michigan, Ann Arbor (764-A1)

9:30- 9:50 (7) Lie algebras all of whose proper subalgebras are nilpotent. Preliminary report. Dr. DAVID TOWERS, University of Lancaster, Lancaster, England and University of California, Berkeley (764-A19)

10:00-10:20 (8) The algebraically irreducible representations of certain Lie algebras. Professor RICHARD E. BLOCK, University of California, Riverside (764-A23)

10:30-10:50 (9) Characteristic spaces for semisimple Lie algebras. Professor MORTON CURTIS, Rice University (764-A13)

FRIDAY, 11:00 A.M.

Invited Address, Kuykendall Auditorium

(10) Orbit equivalence in ergodic theory. Professor HENRY A. DYE, University of California, Los Angeles (764-H1)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.
FRIDAY, 1:00 P.M.

Session on Geometry and Topology, Room 203, Kuykendall Hall
1:00- 1:10 (11) The tangent space of an ideal boundary. Preliminary report. Professor LEON W. GREEN, University of Minnesota, Minneapolis (764-D1)
1:15- 1:25 (12) Minimal surfaces characterized by properties of their Gaussian image. Professor DAVID HOFFMAN*, University of Massachusetts, Amherst and Professor ROBERT OSSEMAN, Stanford University (764-D2)
1:30- 1:40 (13) Differential forms and torsion in the fundamental group. Professor BOHUMIL CENKLI*, and Professor RICHARD PORTER, Northeastern University (764-G8)
1:45- 1:55 (14) Determinants of strongly amphicheiral knots are squares. Professor JAMES M. VAN BUSKIRK, University of Oregon (764-G10)
2:00- 2:10 (15) Monotone decompositions of continua. Professor E.J. VUGHT, California State University, Chico (764-G1)
2:15- 2:25 (16) WITHDRAWN

FRIDAY, 1:00 P.M.

Special Session on Nonassociative Algebras and Applications, II, Room 205, Kuykendall Hall
1:00- 1:20 (17) Differentiable power associative multiplications. Professor J.P. HOLMES, Auburn University, Auburn (764-A21)
1:30- 1:50 (18) Groups with triality. Professor STEPHEN DORO, University of Notre Dame (764-A12)
2:00- 2:20 (19) On nonassociative algebras and hadron physics. G.P. WENE, University of Texas, San Antonio (764-A11)
2:30- 2:50 (20) How to diagonalize a linearly recursive sequence. Professor BRIAN PETERSON, San Jose State University and Professor EARL J. TAFT*, Institute for Advanced Study and Rutgers University, New Brunswick (764-A2)

FRIDAY, 2:30 P.M.

Session on Analysis, Room 202, Kuykendall Hall
2:30- 2:40 (21) Most functions are weird. Professor JACK CEDER*, University of California, Santa Barbara and Professor T.L. PEARSON, Acadia University, Wolfville, Nova Scotia, Canada (764-B8) (Introduced by Professor Kenneth A. Ross)
2:45- 2:55 (22) Nearly Borel sets and Borel measures. Professor ROY A. JOHNSON, Washington State University (764-B9)
3:00- 3:10 (23) The structure of C*-algebra bundles. Professor MAURICE J. DUPRÉ, Tulane University (764-B13)
3:15- 3:25 (24) WITHDRAWN
3:45- 3:55 (26) Identities involving Fourier coefficients of automorphic wave forms. Professor V.V. RAO, University of Regina (764-B6)
4:00- 4:10 (27) On evaluation of Riemann zeta-function at even integers via Laplace transform. Preliminary report. Professor S. VERMA, University of Nevada, Las Vegas (764-B16) (Introduced by Professor L.J. Simonoff)
4:15- 4:25 (28) Updating matrix decompositions. Professor JAMES R. BUNCH* and Mr. CHRISTOPHER P. NIELSEN, University of California, San Diego (764-C1)
4:30- 4:40 (29) Convergence criterion for a class of conjugate gradient algorithms in Hilbert space. Dr. JUNIOR STEIN* and Mr. HON-MING CHAN, University of Toledo (764-C2)

FRIDAY, 2:30 P.M.

Special Session on Geometric Topology, I, Room 207, Kuykendall Hall
2:30- 2:50 Introductory remarks and organizational meeting for informal session,
3:00- 3:20 (30) Equivariant Moore spaces. Professor JUSTIN R. SMITH, University of Hawaii (764-G16)
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker/Institution</th>
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</thead>
<tbody>
<tr>
<td>3:30-3:50</td>
<td>3-dimensional manifolds as &quot;Riemann surfaces&quot;. Professor HUGH M. HILDEN, University of Hawaii (764-G15)</td>
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<tr>
<td>4:00-4:20</td>
<td>A note on a theorem of Bott. Professor CHRISTOPHER J. ALLDAY, University of Hawaii (764-G14)</td>
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<tr>
<td>4:30-4:50</td>
<td>Some connections between property R and the Schoenflies problem. Professor MARTIN SCHARLEMANN, University of California, Santa Barbara (764-G9)</td>
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<td>FRIDAY, 2:45 P.M.</td>
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<td>2:45-2:55</td>
<td>Hyperidentities and varieties of varieties. WALTER TAYLOR, University of Colorado, Boulder (764-A34)</td>
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<td>3:00-3:10</td>
<td>Representation of monoids and equational theories. Preliminary report. Dr. STEPHEN WHITNEY, University of Samoa, Apla, Western Samoa (764-A41)</td>
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<td>3:15-3:25</td>
<td>Group characters and metric invariants. Professor PATRICK X. GALLAGHER*, Columbia University and Dr. RONALD J. PROULX, Brighton, Massachusetts (764-A37)</td>
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<tr>
<td>3:30-3:40</td>
<td>Functional topologies with linearly ordered neighborhood bases. Dr. ADOLPH MADER, University of Hawaii and Dr. RAY MINES*, New Mexico State University, Las Cruces (764-A38)</td>
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<td>3:45-3:55</td>
<td>Composition of quadratic forms and a class of hypoelliptic PDE. Dr. AROLDO KAPLAN, University of Massachusetts, Amherst (764-A59)</td>
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<td>4:00-4:10</td>
<td>On some new sequences generalizing the Catalan and Motzkin numbers. Dr. P.R. STEIN and Dr. M.S. WATERMAN*, Los Alamos Scientific Laboratory (764-A4)</td>
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<tr>
<td>4:15-4:25</td>
<td>Coloring n n-sets with n colors. Preliminary report. Dr. MARSHALL CATES, California State University, Los Angeles (764-A10)</td>
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<td>FRIDAY, 3:00 P.M.</td>
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<td>3:00-3:20</td>
<td>Feferman-Vaught-type theorems for topological logic. JÖRG FLUM, Universität Freiburg, West Germany (764-E7) (Introduced by Professor H.D. Ebbinghaus)</td>
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<tr>
<td>3:30-3:50</td>
<td>Consistency properties and back-and-forth arguments for generalized quantifiers. Dr. JOHANN A. MAKOWSKY, Freie Universität, Berlin, Germany and The Hebrew University, Jerusalem, Israel (764-E2)</td>
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<tr>
<td>4:00-4:20</td>
<td>Scott sentences and admissible sets. Professor MICHAEL MAKKAI, McGill University (764-E5)</td>
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<tr>
<td>4:30-4:50</td>
<td>On wellfounded ( \Sigma_1 )-compactness, Preliminary report. Dr. NIGEL CUTLAND*, University of Wisconsin, Madison and Professor MATT KAUFMANN, Purdue University, West Lafayette (764-E3)</td>
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<td>SATURDAY, 8:00 A.M.</td>
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<tr>
<td>8:00-8:20</td>
<td>Alexander polynomials of boundary links. Preliminary report. Mr. NOBUYUKI SATO, University of Texas at Austin (764-G3)</td>
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<tr>
<td>8:30-8:50</td>
<td>Conjugacy relations in subgroups of the mapping class group and a group-theoretic description of the Rochlin invariant, Dr. DENNIS L. JOHNSON, Jet Propulsion Laboratory, Pasadena, California (764-G2) (Introduced by Professor Hugh M. Hilden)</td>
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<tr>
<td>9:00-9:20</td>
<td>The homology 3-spheres with involutions. Professor WU-CHUNG HSIANG, Princeton University and Professor PETER-SIE PAO*, University of Georgia (764-G5)</td>
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<td>9:30-9:50</td>
<td>Psuedo-free circle actions on ( S^5 ). Professor RONALD FINTUSHEL*, Institute for Advanced Study and Professor RONALD STERN, University of Utah (764-G11)</td>
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<tr>
<td>10:00-10:20</td>
<td>Non-linear pseudo-free circle actions on ( S^5 ). Professor RONALD FINTUSHEL, Institute for Advanced Study and Professor RONALD STERN*, University of Utah (764-G12)</td>
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<tr>
<td>10:30-10:50</td>
<td>On the Smith conjecture for homotopy 3-spheres. Professor GORDON CAMERON*, University of California, Berkeley and Mr. RICHARD A. LITHERLAND, University of Cambridge, Cambridge, England (764-G13)</td>
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89
SATURDAY, 8:00 A.M.

Informal Session on the Laplace Operator, Room 201, Kuykendall Hall
Times and speakers to be announced later.

SATURDAY, 9:00 A.M.

Special Session on Countable Models, II, Room 204, Kuykendall Hall
9:00-9:20  (51) Equivalence of intuitionistic semantics I. Dr. E.G.K. LOPEZ-ESCOBAR, University of Maryland, College Park (764-E4)
9:30-9:50  (52) Recursive model theory in recursive algebra. Preliminary report. Dr. C.J. ASH, Monash University, Australia and Professor ANIL NERODE*, Cornell University (764-E11)
10:00-10:20  (53) Borel game operations and the Baire property. Preliminary report, Mr. ROBERT VAUGHT and Mr. KENNETH SCHILLING*, University of California, Berkeley (764-E1)
10:30-10:50  (54) G_6 sets in effective spaces. Professor ROBERT VAUGHT, University of California, Berkeley (764-E10)

SATURDAY, 9:00 A.M.

Special Session on Nonassociative Algebras and Applications, III, Room 205, Kuykendall Hall
9:00-9:20  (55) On generalizations of the metasymplectic geometry. Preliminary report. Professor KIYOSI YAMAGUTI, Kumamoto University, Kumamoto, Japan (764-A31)
9:30-9:50  (56) The center and the centroid of a quadratic Jordan algebra. Professor CHESTER E. TSAI, Michigan State University, East Lansing (764-A30)
10:00-10:20  (57) On finite division rings. Preliminary report. Professor ROBERT H. OEHMKE, University of Iowa (764-A32)
10:30-10:50  (58) Conditions which force the nucleus of an alternative ring to be nonzero. Preliminary report. Professor IRVIN R. HENTZEL, Iowa State University, Professor ERWIN KLEINFELD*, University of Iowa and Professor HARRY F. SMITH, Iowa State University (764-A3)

SATURDAY, 9:00 A.M.

Special Session on Commutative Harmonic Analysis, I, Room 208, Kuykendall Hall
9:00-9:20  (59) Singular continuous measures on the circle with small Fourier-Stieltjes transforms. Professor EDWIN HEWITT*, University of Washington and GAVIN BROWN, University of New South Wales, Sydney, Australia (764-B17)
9:30-9:50  (60) Transforms which almost vanish at infinity. Professor LOUIS PIGNO, Kansas State University (764-B2)
10:00-10:20  (61) Quotients of L_0 and WAP. Professor COLIN C. GRAHAM, Northwestern University (764-B12)
10:30-10:50  (62) Quotient spaces of Fourier transforms. Preliminary report. Mr. BENJAMIN B. WELLS, Jr., University of Hawaii, Honolulu (764-B7)

SATURDAY, 11:00 A.M.

Invited Address, Kuykendall Auditorium
(63) Laplace integrals and factorial series in singular differential and difference equations. Professor WILLIAM A. HARRIS, Jr., University of Southern California (764-B18)

SATURDAY, 1:00 P.M.

Special Session on Countable Models, III, Room 204, Kuykendall Hall
1:00-1:50  (64) Stability, complete extensions, and the number of countable models. TERRENCE MILLAR, University of Wisconsin, Madison (764-E8)
2:00-2:20  (65) N_0-categoricity and partially ordered sets. Professor JAMES H. SCHMERL, University of California, San Diego (764-E6)
2:30-2:50  (66) Next admissible sets and structures for infinite languages. Preliminary report. JOHN S. SCHLIPF, University of Illinois, Urbana (764-E9)
## Special Session on Nonassociative Algebras and Applications, IV, Room 205, Kuykendall Hall

1:00-1:20 (67) Algebras admitting sl(2) and sl(3) as derivations. Professor GEORGIA BENKART and Professor J. MARSHALL OSBORN*, University of Wisconsin, Madison (764-A20)

1:30-1:50 (68) Derivations and automorphisms of nonassociative matrix rings. Professor GEORGIA BENKART* and Professor J. MARSHALL OSBORN, University of Wisconsin, Madison (764-A18)

2:00-2:20 (69) Markov chains and multiplications of M-dimensional matrices. Preliminary report. Dr. ROBERT GRONE, Auburn University, Auburn (764-A9)

2:30-2:50 (70) Graphical evaluation of sparse determinants. Professor DANIEL DRUCKER*, Wayne State University and Professor DAVID M. GOLDSCHMIDT, University of California, Berkeley (764-A25)

## SATURDAY, 1:30 P.M.

### Special Session on Commutative Harmonic Analysis, II, Room 208, Kuykendall Hall

1:30-1:50 (71) Cocycles in function theory. Mr. HENRY HELSON, University of California, Berkeley (764-B5)

2:00-2:20 (72) Banach algebras with Rider subalgebras. Professor GREGORY F. BACHELIS*, Wayne State University and Professor JOHN E. GILBERT, University of Texas at Austin (764-B1)

2:30-2:50 (73) On constructions of bounded functions with some prescribed Fourier coefficients. Professor JOHN J. F. Fournier, University of British Columbia (764-B4)

3:00-3:20 (74) Boundary values of absolutely convergent Taylor series. Professor AHARON ATZMON, Technion-Israel Institute of Technology and University of Hawaii (764-B3)

3:30-3:50 (75) Transplantation theorems and $H^p$-theory. Preliminary report, Professor JOHN E. GILBERT, Washington University (764-B10)

4:00-4:20 (76) Three Bohr group questions. Preliminary report. Professor TOM RAMSEY, University of Hawaii, Honolulu (764-B14)

## SATURDAY, 1:30 P.M.

### Special Session on Geometric Topology, III, Room 207, Kuykendall Hall

1:30-1:50 (77) Periodic fixed point free diffeomorphisms of $\mathbb{R}^n$. Professor ROBERT OLIVER, Stanford University (764-G4)

2:00-2:20 (78) Fibered general position in the smooth category. Preliminary report. Professor KENNETH C. MILLETT, University of California, Santa Barbara (764-G7)

2:30-2:50 (79) Minimal immersions of low dimensional manifolds. Professor ROBERT LITTLE, University of Hawaii (764-G17) (Introduced by Professor Christopher J. Allday)

## SATURDAY, 2:00 P.M.

### Special Session on Quadratic Forms, II, Room 206, Kuykendall Hall

2:00-2:20 (80) Relative SAP field extensions. Preliminary report. Professor R. ELMAN, University of California, Los Angeles, Professor T.Y. LAM, University of California, Berkeley, Professor ALEXANDER PRESTEL, Universität Konstanz, West Germany and Professor A. R. WADSWORTH*, University of California, San Diego (764-A33)

2:30-2:50 (81) Quadratic forms and profinite 2-groups. Professor ROGER WARE, Pennsylvania State University, University Park (764-A24)

3:00-3:20 (82) The Hasse and u-invariants. Preliminary report. Professor RICHARD ELMAN*, University of California, Los Angeles and Professor ALEXANDER PRESTEL, Universität Konstanz, West Germany (764-A26)

3:30-3:50 (83) Unimodular quadratic forms over global fields. Professor J. S. HSIA, Ohio State University, Columbus (764-A7)

4:00-4:20 (84) One-class spinor genera of definite quadratic forms. Dr. ANDREW G. EARNEST, University of Southern California, Los Angeles (764-A35)

4:30-4:50 (85) Bilinear terms in Pfister form formulas. Preliminary report. Professor DANIEL B. SHAPIRO, Ohio State University, Columbus (764-A17)
The behaviour of quadratic form invariants under algebraic extensions. Preliminary report. ALEXANDER PRESTEL, Universität Konstanz, West Germany (764-A40) (Introduced by Professor Ronald P. Brown)

SATURDAY, 3:00 P.M.

Informal Session on Geometric Topology, Room 207, Kuykendall Hall

This session will be organized at the Special Session on Geometric Topology on Friday at 2:30 p.m.

SUNDAY, 8:30 A.M.

Special Session on Quadratic Forms, III, Room 206, Kuykendall Hall

8:30- 8:50 (87) On the Mordell-Weil rank of elliptic quartic curves. Dr. TAKASHI ONO, Johns Hopkins University (764-A5)

9:00- 9:20 (88) Unipotent transformations in orthogonal groups. Professor A.J. HAHN, University of Notre Dame (764-A6)

9:30- 9:50 (89) The orthogonal group and Witt ring over a full ring. Professor BERNARD R. McDONALD, University of Oklahoma (764-A22)

10:00-10:20 (90) Succinct and representational Witt rings. Professor J. KLEINSTEIN*, State University of New York at Stony Brook and Professor A. ROSENBERG, Cornell University (764-A16)

10:30-10:50 (91) Witt rings and orderings of higher levels, Preliminary report. Professor J. KLEINSTEIN, State University of New York at Stony Brook and Professor A. ROSENBERG*, Cornell University (764-A15)

11:00-11:20 (92) Rings of Witt type. Preliminary report. Professor MURRAY A. MARSHALL, University of Saskatchewan (764-A29) (Introduced by Professor Ronald P. Brown)

Eugene, Oregon

PRESENTERS OF PAPERS

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

* Invited one-hour lecturers

* Special session speakers

* Allday, C.J. #32
* Anderson, L.R. #25
* Atzmon, A. #74
* Bachielis, G.F. #72
* Benkart, G. #68
* Berman, L. #3
* Block, R.E. #8
* Bunch, J.R. #28
* Cameron, G. #50
* Cates, M. #40
* Ceder, J. #21
* Cenkl, B. #13
* Cordes, C.M. #2
* Curtis, M. #9
* Cutland, N. #44
* Dore, S. #18
* Dupre, M.J. #23
* Drucker, D. #70
* Dye, H.A. #10
* Earnest, A.G. #84
* Elman, R. #82
* Fintushel, R. #48
* Flum, J. #41
* Fournier, J.J.F. #73
* Gallagher, P.X. #36
* Gilbert, J.E. #75
* Graham, C.C. #61
* Green, L.W. #11
* Grone, R. #69
* Hahn, A.J. #88

* Harris, W.A., Jr. #63
* Hewitt, H. #71
* Hewitt, E. #59
* Hilden, H.M. #31
* Hoffman, D. #12
* Holmes, J.P. #17
* Hisa, J.S. #63
* Johnson, D.L. #46
* Johnson, R.A. #22
* Kaplan, A. #38
* Kleinfeld, E. #58
* Kleinfield, J. #90
* Lam, T.Y. #1
* Little, R. #79
* Lopez-Escobar, E.G.K. #51
* Makkai, M. #43
* Makowsky, J.A. #42
* Marshall, M.A. #92
* McDonald, B.R. #89
* Millar, T. #64
* Millett, K.C. #78
* Mines, R. #37
* Nerode, A. #52
* Oehmke, R.H. #57
* Oliver, R. #77
* Ono, T. #87
* Osborn, J.M. #67
* Pao, P.-S. #47
* Pigno, L. #60
* Ponomarev, P. #5
* Prestel, A. #86
* Ramsey, T. #76
* Rao, V.V. #26
* Rosenberg, A. #91
* Sato, N. #45
* Scharlemann, M. #33
* Schilling, K. #53
* Schlipf, J.S. #66
* Schmerl, J.H. #65
* Shapiro, D.B. #85
* Smith, J.R. #30
* Stein, J. #29
* Stern, R. #49
* Taft, E.J. #20
* Taussky-Todd, O. #4
* Taylor, W. #34
* Towers, D. #7
* Tsai, C.E. #56
* Van Buskirk, J.M. #14
* Vaught, R. #54
* Verma, S. #27
* Vought, E.J. #15
* Wadsworth, A.R. #80
* Ware, R. #81
* Waterman, M.S. #39
* Wells, B.B., Jr. #62
* Wene, G.P. #19
* Whitney, S. #35
* Winter, D.J. #6
* Yamaguti, K. #55

Kenneth A. Ross
Associate Secretary
New York City, April 19–20, 1979, Biltmore Hotel

Second Announcement of the 765th Meeting

The seven hundred sixty-fifth meeting of the American Mathematical Society will be held at the Biltmore Hotel, Madison Avenue at 43rd Street, New York City, on Thursday and Friday, April 19 and 20, 1979.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there will be five invited one-hour addresses and six special sessions of twenty-minute papers. Three of the invited addresses and a special session will be devoted to the theme "Probability theory and applications to contiguous branches of mathematics." The invited addresses will be presented by RICHARD M. DUDLEY, Massachusetts Institute of Technology, who will speak on "Empirical measures on Vatnik-Cervonenkis classes"; EUGENE B. DYNKIN of Cornell University, who will speak on "Markoff processes and random fields arising in quantum field theory"; and RICHARD F. GUNDY of Rutgers University, the title of whose lecture will be announced in the April issue of the NOTICES.

A special session is being organized by HARRY KESTEN of Cornell University and DONALD DAWSON of Carlton University on Probability theory inspired by applications; the list of speakers includes Maury Bramson, Richard Ellis, Stewart Ethier, Uriel Frisch, Leonard Gross, Gregory Lawler, Charles Newman, George Papanicolaou, Murad Taqqu, John Wierman, and Sandy Zabel.

The second theme is "Algebraic geometry," and the invited speakers are HEISUKE HIRONAKA of Harvard University, who will speak on "Recent progress in the study of singularities"; and GEORGE R. KEMPF of Johns Hopkins University, whose address will be on "Inversion of Abelian integrals." Professors Hironaka and Kempf are also organizing a related special session on Algebraic geometry; the speakers will be announced later.

Five additional special sessions are being organized. HAROLD M. HASTINGS of the University of Georgia is organizing a special session on Homotopy theory; the speakers will include: Steven Ferry, Peter Freyd, Ross Geoghegan, Jack Hollingsworth, Tsau-Young Lin, S. Lomonaco, Jr., and John McCleary. GANGARAM S. LADDE, State University of New York, College at Potsdam, is organizing a special session on Mathematical modelling; the speakers include: Jerome Eisenfeld, Lev Ginsburg, Lewis Gross, and Okan Gurel. GERARD J. LALLEMENT of Pennsylvania State University is organizing a special session on Algebraic and topological semigroups; the list of speakers includes John F. Berglund, Karl Bylleen, George Graham, Hugo D. Junghenn, John Luedeman, Kenneth Magill, Saraswathi Subhiaig Magill, S. Margulis, William Nico, M. Putcha, Howard Straubing, Takayuki Tamura, and Charles Wells. LOUIS F. McAULEY of the Institute for Advanced Study and State University of New York, Center at Binghamton, is organizing a special session on Monotone and open mappings; the speakers include P. T. Church, Alan J. Coppola, Wayne Lewis, Joseph Martin, Eric E. Robinson, Michael Starbird, Gerard Venema, John J. Walsh, David C. Wilson, and Edythe Woodruoff.

There will also be sessions for contributed ten-minute papers. If necessary, late papers will be accepted for presentation at the meeting, but these cannot be listed in the printed program.

The Council of the Society will meet at 1:00 p.m. on Friday, April 20, in Suite H at the Biltmore Hotel.

REGISTRATION

The registration desk will be located in the Vanderbilt Suite on the first floor of the Biltmore Hotel, and will be open from 8:00 a.m. to 4:30 p.m. on Thursday, and from 8:00 a.m. to 3:00 p.m. on Friday. The registration fees will be $5 for nonmembers, $3 for members, and $1 for students or unemployed mathematicians.

ACCOMMODATIONS

A block of rooms has been set aside at the Biltmore Hotel for use by participants attending the meeting. Persons planning to stay at the Biltmore should make their own reservations with the hotel and should be sure to mention the mathematics meeting in order to obtain the special rates, which are $36 for single occupancy or $42 for double occupancy. For your convenience, a reservation form will be found on page A-190 in the January issue of the NOTICES, or you may call the room reservations office at the Biltmore, telephone 212-687-7000.

TRAVEL

The Biltmore Hotel is located on Madison Avenue at 43rd Street, on the east side of New York City. Walkways from Grand Central Station connect with the hotel, and signs are posted directing persons to the hotel lobby.

Those arriving by bus at the Port Authority Bus Terminal may take the Independent Subway System, a taxi, or bus to the hotel. There is shuttle bus service directly to Grand Central Station from LaGuardia, Kennedy, and Newark Airports, and starters will direct passengers to the correct bus.

Persons arriving by car will find several parking garages in the area, in addition to the garage at the Biltmore Hotel. Parking service can be arranged through the hotel doorman. The present rate for parking in the hotel garage is $12.50 for each 24-hour period, and there is an additional charge for extra pickup and delivery service if it is required. The parking fee is subject to New York City taxes.

MAIL ADDRESS

Registrants at the meeting may receive mail addressed to them in care of the American Mathematical Society Meeting, Biltmore Hotel, Madison Avenue at 43rd Street, New York, New York 10017.

Raymond G. Ayoub
Associate Secretary
University Park, Pennsylvania
The seven hundred sixty-sixth meeting of the American Mathematical Society will be held on Friday and Saturday, April 27-28, 1979 at the University of Iowa, Iowa City, Iowa. The sessions of the meeting will be held on the third floor of the Iowa Memorial Union, which will also be the headquarters hotel for the meeting.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings there will be four invited one-hour addresses. CHARLES C. CONLEY of the University of Wisconsin, Madison, will address the Society at 11:00 a.m. on Friday; his topic will be "The 'gradient' structure of a differential equation." WOLFGANG R. HAKEN of the University of Illinois, Urbana, will speak at 1:45 p.m. on Friday; the title of his talk will be "On the homeomorphism problem for three-manifolds." JUDITH D. SALLY of Northwestern University will give an hour talk at 11:00 a.m. on Saturday on the subject "The Hilbert function of a local ring." B. A. TAYLOR of the University of Michigan, Ann Arbor, will speak at 1:45 p.m. on Saturday; his topic will be "Algebras of entire functions: Some problems from harmonic analysis."

By invitation of the same committee, there will be seven special sessions of selected twenty-minute papers. DANIEL D. ANDERSON of the University of Iowa is organizing a special session on Commutative ring theory, to be held Friday; the tentative list of speakers includes David F. Anderson, David E. Dobbs, Jonathan S. Golan, James A. Huckaba, Jacob R. Matijevic, and Ira J. Papick. KENT R. FULLER of the University of Iowa is organizing a special session on Noncommutative ring theory, to be held Saturday; the tentative list of speakers includes Goro Azumaya, John A. Beachy, Carl Faith, Joel K. Haack, Israel N. Herstein, Lawrence S. Levy, Richard D. Resco, and Robert B. Warfield, Jr. WILLIAM H. JACO of Rice University is organizing a special session on Three-dimensional manifold theory, to be held both Friday and Saturday; the tentative list of speakers includes Selman Y. Akbulut, Joan S. Birman, Benny D. Evans, Charles D. Feustel, Deborah L. Goldsmith, C. M. Gordon, Michael Handel, John P. Hempel, William H. Jaco, S. J. Lomonaco, Jr., Herbert C. Lyon, Robert Myers, Frank A. Raymond, Peter B. Shalen, Jonathan K. Simon, Jeffery L. Tollefson, and Wilbur Whitten. JAMES D. KUELBS of the University of Wisconsin, Madison, and WALTER V. PHILIPP of the University of Illinois, Urbana, are organizing a special session on Probability on Banach spaces, to be held both Friday and Saturday; the tentative list of speakers includes Alejandro de Acosta, Alexandra Bellow, Chandrakant M. Deo, Evarist Giné, Marjorie J. Hahn, James D. Kuelbs, Hui-Hsiung Kuo, Vidyadhar S. Mandrekar, Michael B. Marcus, Gregory J. Morrow, Arnold L. Neidhardt, Walter V. Philipp, M. Ann Piech, Louis Sucheston, J. Jerry Uhl, Jr., Wojbor A. Woyczynski, Sandy L. Zabell, and Joel Zinn. RICHARD P. McGEHEE of the University of Minnesota is organizing a special session on Celestial mechanics, to be held Saturday; the tentative list of speakers includes Edward A. Belbruno, Robert L. Devaney, Martin P. Kummer, James A. Murdock, Julian I. Palmore, and Robert Shelton. PAUL S. MUHY of the University of Iowa is organizing a special session on Operator theory, to be held Friday; the tentative list of speakers includes John W. Bunce, Alan Hopenwasser, Palle E. T. Jorgensen, David R. Larson, Richard I. Loebl, William L. Paschke, Jean N. Renault, Phillip M. Unell, and Warren R. Wogen. JOHN C. POLKING of Rice University is organizing a special session on Several complex variables, to be held Saturday; the tentative list of speakers includes Albert Boggess, Daniel M. Burns, Jr., David Catlin, John P. D'Angelo, Michael B. Freeman, Hugo Rossi, and David S. Tartakoff.

There will also be sessions of contributed ten-minute papers as needed. The abstract deadline was February 27, 1979.

REGISTRATION

The registration desk will be located on the third floor of the Iowa Memorial Union, and will be open from approximately 8:30 a.m. to 4:30 p.m. on Friday and from 8:00 a.m. to 3:00 p.m. on Saturday. The registration fee will be $5 for nonmembers, $3 for members, and $1 for students and unemployed mathematicians.

ACCOMMODATIONS

Sixty guest rooms will be available in the Iowa House, located in the western part of the Iowa Memorial Union. The present rates are $15.50 for single rooms and $20 for double rooms, plus a 3% tax. Requests for reservations should mention the AMS meeting and should be addressed to Center for Conferences and Institutes, Iowa Memorial Union, Iowa City, Iowa 52242; telephone (319) 353-5505.

Guest rooms will also be available at the Highlander Inn, Iowa City, Iowa 52240, on Interstate 80 at Iowa 1. The current rates are $21 for single rooms and $25 for double rooms, plus 3% tax.

FOOD SERVICE

The following eating establishments will be available in the Iowa Memorial Union: The River Room Cafeteria will be open from 7:00 a.m. to 7:00 p.m. on Friday and from 7:30 a.m. to 11:00 a.m. on Saturday. The Meal Mart snack bar will be open from 9:00 a.m. to 10:00 p.m. on Friday and from 11:00 a.m. to 10:00 p.m. on Saturday. The State Room provides table d'hôte dining on Friday from 11:30 a.m. to 1:15 p.m. Beer will be available in the Wheel Room of the Union.
PARKING

For those staying in Iowa House, free parking is available in the parking ramp east of the Union. Others attending the meeting may park there for a modest fee if space is available.

TRAVEL AND LOCAL INFORMATION

Iowa City is on Interstate 80 and is within 300 miles driving distance from such cities as Chicago, Kansas City, Milwaukee, Minneapolis, Omaha, and St. Louis. The University is near the center of Iowa City about three miles south of Exit 244 of Interstate 80. The Iowa Memorial Union is at the corner of Madison and Jefferson Streets, on the east bank of the Iowa River.

Although Iowa Airlines and Horizon Airways offer direct service to Iowa City from some Iowa cities (including Des Moines), Iowa City is not served directly by any major airline. Many of those attending the meeting will find it convenient to take either Ozark Air Lines or United Airlines to Cedar Rapids, 18 miles north of Iowa City, and take a limousine from there to Iowa City; limousine service is available after each flight.

Nearby points of interest, other than the University itself, include Plum Grove in Iowa City (the restored home of the first governor of the Iowa Territory), the Hoover Birthplace and Presidential Library (ten miles east of Iowa City in West Branch), and the Amana Colonies (twenty miles west of Iowa City).

Vancouver, June 15–16, 1979, University of British Columbia

First Announcement of the 767th Meeting

The seven hundred sixty-seventh meeting of the American Mathematical Society will be held at the University of British Columbia in Vancouver, Canada, on Friday and Saturday, June 15 and 16, 1979. The meeting will be held in conjunction with sectional meetings of the Mathematical Association of America (MAA) and the Society for Industrial and Applied Mathematics (SIAM).

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. The hour lectures will be given by THEODORE T. FRANKEL of the University of California, San Diego, and by OSCAR E. LANFORD III of the University of California, Berkeley.

By invitation of the same committee, there will be at least three special sessions. The titles of the sessions and the names of the organizers are: Probability, PRISCILLA E. GREENWOOD; Representations and ring theory, STANLEY S. PAGE; Mathematical physics, LON M. ROSEN. All of the organizers are at the University of British Columbia. Persons submitting abstracts for the meeting who feel their papers are suitable for one of these special sessions should indicate this clearly on the abstract form, and mail it so as to reach the office of the American Mathematical Society in Providence by April 3, 1979.

There will also be sessions of contributed ten-minute papers. Abstracts should be sent to the American Mathematical Society, P.O. Box 6248, Providence, RI 02940, so as to arrive by the deadline of April 24, 1979. Late papers will be accepted for presentation at the meeting, but will not be listed in the printed program.

Information concerning travel and accommodations will appear in the April issue of the Notices, The complete program will appear in the June Notices.

Invited Speakers at AMS Meetings

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

New York, New York, April 1979
Richard M. Dudley
Eugene B. Dynkin
Richard F. Gundy

Iowa City, Iowa, April 1979
Charles G. Conley
Wolfgang R. G. Haken

Vancouver, Canada, June 1979
Theodore T. Frankel

PAGE; Mathematical physics, LON M. ROSEN. All of the organizers are at the University of British Columbia. Persons submitting abstracts for the meeting who feel their papers are suitable for one of these special sessions should indicate this clearly on the abstract form, and mail it so as to reach the office of the American Mathematical Society in Providence by April 3, 1979.

Duluth, Minnesota, August 1979
Alan Hatcher
James I. Lepowsky
I. I. Piatetski-Shapiro
Herbert E. Scarf
Jacques Tits
Eugene Trubowitz
W. Stephen Wilson

Kent, Ohio, November 1979
Kyung W. Kwun
Daniel R. Lewis

Eugene, Oregon
Kenneth A. Ross
Associate Secretary

95
The Society will sponsor a seminar/workshop on Algebraic and Geometric Methods in Linear Systems Theory to be held June 19-30, 1979 at Harvard University, Cambridge, Massachusetts. The cochairmen of the conference are Roger Brockett, Harvard University; C. I. Byrnes, Harvard University; and Clyde Martin, Case Western Reserve University. The conference will bring together researchers in control and its advanced developments, and will be held with the financial support of Ames Research Center of the National Aeronautics and Space Administration, and the NATO Advanced Study Institute Programme.

About three-quarters of the time will be devoted to a series of high level pedagogical lectures on the mathematics of linear systems theory, intended as an introduction to some of the advanced techniques in linear systems. The tentative list of speakers includes H. Rosenbrock who will lecture on developments in transfer function techniques; M. Wonhama who will give a series of lectures on "System design via controllability subspace techniques"; Y. Rouchaleau and C. I. Byrnes will share responsibility for a series of lectures on "Systems over rings"; Professor Byrnes will also share responsibility with M. Hazewinkel and C. Martin for a set of lectures on "Linear systems and algebraic geometry"; P. Fuhrmann will give a set of lectures on infinite dimensional systems; and J. C. Willems will expand the scope of the lectures by discussing linear stochastic systems. The remaining time will be devoted to presentation of research results and needs by other participants.

Funds for participant support will be limited, and it is hoped that a number of participants who wish to attend will obtain their own sources of support. Those wishing to take part in the seminar/workshop and/or be considered for financial assistance should write to Clyde Martin, Department of Mathematics, Case Western Reserve University before April 1, 1979. Those who wish financial support should write as soon as possible.
The Bôcher Memorial Prize, which is awarded at five-year intervals, is supported by the Bôcher Memorial Fund established in 1920 with gifts in memory of Maxime Bôcher (1867-1918), who served the Society as its tenth President (1909, 1910). The Bôcher Prize is now supplemented by a prize from the Leroy P. Steele Fund. The thirteenth award of the Bôcher Prize is to Alberto P. Calderón, Louis Block Professor of Mathematics, University of Chicago, "for his fundamental work on the theory of singular integrals and partial differential equations, and in particular for his recent paper 'Cauchy integrals on Lipschitz curves and related operators,' Proceedings of the National Academy of Sciences, USA, volume 74, number 4, pages 1324-1327, April 1977."

Leroy Powell Steele, a graduate of Harvard College (B.A., 1923), died January 7, 1968 and bequeathed the bulk of his estate to the American Mathematical Society to be used for the award from time to time of prizes in honor of George David Birkhoff, William Fogg Osgood and William Caspar Graustein. The fourteenth and fifteenth Steele Prizes are awarded to Salomon Bochner, Edgar Odell Lovett Professor of Mathematics, Rice University, and to Hans Lewy, Professor Emeritus, University of California, Berkeley.

Professor Bochner's award is for the "cumulative impact of the total mathematical work of the recipient, high level of research over a period of time, particular influence on the development of a field, and influence on mathematics through Ph.D. students." The fields cited are probability theory, Fourier analysis, several complex variables, and differential geometry. The students cited are Calabi, Cheeger, Furstenberg, Gunning, Helgason, and Hunt.

Professor Lewy's award is "for a paper...which has proved to be of seminal or lasting importance in its field, or a model of important research." Three papers in two fields of research were cited:


The three prizes, currently totaling fifteen hundred dollars each, were presented at the prize session held at the Annual Meeting of the Society in Biloxi, Mississippi, January 25, 1979, on which occasion the recipients were given the opportunity to speak in response to the awards. Professor Bochner spoke informally, acknowledging the award of his Steele Prize. Professors Calderón and Lewy spoke about their scientific work. The texts of their remarks are reproduced below.

The prizes were awarded by the Council of the American Mathematical Society, based on recommendations made by committees appointed for this purpose. The committee for the Bôcher Prize for 1979 consisted of Paul J. Cohen, Donald S. Ornstein (chairman), and Walter Rudin. During 1978, the Committee on Steele Prizes consisted of Edward B. Curtis, Irving Kaplansky, H. Blaine Lawson, Hans Samelson, Stephen S. Shatz, Joseph R. Shoenfield, Frank Spitzer, Joseph L. Taylor, Raymond O. Wells, Jr., and Hans F. Weinberger (chairman).

**Alberto P. Calderón**

It certainly is a great honor to be awarded the Bôcher Prize. I wish to express my deep gratitude for having been chosen to be its recipient for 1979. In responding on these occasions it has been customary to describe briefly at least some of the work for which the prize is awarded. I will do this, confining myself to discussing only the most recent work mentioned in the citation.

I will begin by considering a problem related to the Cauchy integral on Lipschitz curves, which may appear at first sight to have little or no connection with singular integrals and partial differential equations, but which has suggested the most effective method to deal with them so far. The problem is that of showing that singular integral operators (or pseudo-differential operators of nonpositive order)—sufficiently general to permit their use in treating linear differential operators with nonsmooth coefficients—still have the properties that make them an effective tool. More specifically, the question is this: Do singular
integral operators that can be used in dealing with differential operators with Lipschitzian coefficients have the property that they can be composed modulo smoothing operators by simply multiplying their symbols? The simplest case (to which, fortunately, the general case can be reduced without much difficulty) is the following: Let \( H \) denote the Hilbert transforms of functions on the real line and let \( A \) denote operator multiplication by the bounded Lipschitzian function \( a(x) \); is it then true that \( HA - AH \) is a smoothing operator in \( L^2 \)? Equivalently, does the principal value integral

\[
(1) \quad P.V. \int_{-\infty}^{+\infty} \frac{a(x) - a(y)}{(x-y)^2} f(y) \, dy
\]

with \( a(x) \) Lipschitzian define a bounded operator in \( L^2 \)? This question was answered affirmatively nearly fifteen years ago by using complex variable techniques and the equivalence of the \( L^1 \) norms of the Lusin area function and the Hardy-Littlewood maximal function associated with a function that is analytic in a half-plane; this equivalence was also obtained at that time.

The integral (1) is a special case of the following:

\[
(2) \quad P.V. \int_{-\infty}^{+\infty} \frac{1}{x-y} F \left[ \frac{a(x) - a(y)}{x-y} \right] f(y) \, dy
\]

where \( a(x) \) is again Lipschitzian and \( F \) is analytic. This integral has several interesting specializations other than (1). Consider, for example,

\[
(3) \quad \frac{df(x)}{dt} = \frac{1}{2\pi} P.V. \int_{-\infty}^{+\infty} \frac{a(x) - a(y) - (x-y)a'(y)}{(x-y)^2} f(y) \, dy
\]

which gives, if they exist, the boundary values of the logarithmic potential of a double layer distributed on the graph of the function \( a(x) \), and is a simple expression in terms of integrals like (2). Integrals like this, and their generalizations to several variables, can be used effectively in the study of boundary value problems for the Laplace and other elliptic equations.

Another example is the integral of Cauchy type

\[
(4) \quad P.V. \int_{\Gamma} \frac{f(w)}{w-z} \, dw, \quad w \in \Gamma,
\]

where \( \Gamma \) is the graph of the function \( a(x) \), which also can be expressed in terms of integrals like (2).

A natural approach to (2) would be to expand \( F \) in power series as

\[
(5) \sum_{n=0}^{\infty} c_n P.V. \int_{-\infty}^{+\infty} \frac{1}{x-y} \left[ \frac{a(x) - a(y)}{x-y} \right]^n f(y) \, dy;
\]

thus the study of (1) can be regarded as the first step in the study of (2). Unfortunately, the complex method employed originally in the treatment of (1) fails utterly when applied to terms of (5) with \( n \geq 1 \). It was not until 1975 that the case \( n = 2 \) was finally resolved by R. Coifman and Y. Meyer. Shortly after that they showed that each of the terms of (3) represents a bounded operator in \( L^p \), \( 1 < p < \infty \). Their method actually yielded more general results applicable to pseudo-differential operators of classical type, but, unfortunately, their estimates for the norms of the terms of (5) did not permit one to sum the series. People working in this area had been aware of the fact that the study of (2) could be reduced to that of (4), and therefore it came as a surprise when soon after it was realized that (4) could be treated by a method similar to that used in treating (1). Suppose one introduces a family of curves \( \Gamma_t \), \( \Gamma_t \) being the graph of the function \( ta(x) \), \( 0 \leq t \leq 1 \), and considers the integral

\[
(6) \quad A_t f = P.V. \int_{-\infty}^{+\infty} \frac{f(y)}{t(x) - z_t(y)} \, dy,
\]

where \( z_t(x) = x + t a(x) \), and which for \( t = 1 \) is essentially the same as (4). If one assumes that \( a(x) \) is in \( C_0^\infty \), in which case \( A_t \) is well defined and bounded in \( L^2 \), and succeeds in estimating the norm of \( A_t \) in terms of \( \| a' \|_\infty \) and \( t \) alone, then the existence and boundedness of (4) as an operator in \( L^2 \) can be obtained by using standard techniques. If one differentiates (6) with respect to \( t \), one obtains the integral

\[
(7) \quad \frac{dA_t}{dt} f = P.V. \int_{-\infty}^{+\infty} \frac{a(x) - a(y)}{[z_t(x) - z_t(y)]^2} f(y) \, dy
\]

which clearly resembles (1). Now this similarity is not merely superficial. In fact, the complex variable techniques used in treating (1) combined with more recent results on weighted norm inequalities between the area function of Lusin and the Hardy-Littlewood maximal function due to B, Muckenhoupt, R. P. Gundy and R. L. Wheeden, as well as the fact that the function mapping the upper half-plane conformally on the portion of the plane above \( \Gamma_t \) has a derivative whose boundary values have modulus in the class \( A_2 \) of Muckenhoupt with constant depending only on \( \| a' \|_\infty \), yield an estimate of the norm of (7) in terms of the norm of (6), namely

\[
\left\| \frac{dA_t}{dt} \right\| \leq c(1 + \| A_t \|)^2
\]

where \( c \) depends only on \( \| a' \|_\infty \). For \( t = 0 \), the operator \( A_t \) is the ordinary Hilbert transform. Thus, integrating this differential inequality one obtains an estimate for \( \| A_t \| \) depending only on \( \| a' \|_\infty \), and from this follows the existence of (4) as an operator in \( L^p \) and an estimate for its norm, provided that \( \| a' \|_\infty \) does not exceed a certain positive constant \( \alpha \).

Having established this, one obtains the continuity in \( L^p \) of operators of the form (2) and generalizations of these to several variables.

With these results it is possible, for example, to treat in detail boundary value problems for the Laplace equation in \( C^\infty \) domains and Lipschitzian domains with small local oscillation of the plane tangent to the boundary, as E. Fabes, M. Jodeit and N. M. Rivière have done. Other applications worth mentioning are the existence almost everywhere of (4), with \( \Gamma \) merely
rectifiable and $f$ integrable with respect to arc length, and a proof by D. E. Marshall of an old conjecture of Denjoy concerning the analytic capacity of subsets of rectifiable curves.

Notwithstanding all this work, there remain important problems in this area which seem to be beyond the scope of the methods sketched here. For example, is it true that (2) represents a bounded operator in some of the $L^p$ provided that $a(x)$ is Lipschitzian and the quotient

$$\frac{a(x) - a(y)}{x - y}$$

remains in a compact subset of the domain of analyticity of $F$? In particular, does (4) represent a bounded operator in $L^2$ without restriction on the size of $\|a\|_{\Omega}$?

An affirmative answer to these questions would have important consequences in the theory of boundary value problems for elliptic equations in general Lipschitzian domains.


**Biographical Sketch**

Alberto P. Calderón was born September 14, 1920, in Mendoza, Argentina. He holds a Civil Engineer degree from the University of Buenos Aires (1947) and a Ph.D. from the University of Chicago (1950). He was a visiting associate professor at Ohio State University (1950–1953), a member of the Institute for Advanced Study (1953–1955), and associate professor of mathematics at the Massachusetts Institute of Technology (1955–1959). He has been professor of mathematics at the University of Chicago since 1959; in 1968 he was appointed to the Louis Block Professorship.

Professor Calderón was a member-at-large of the Council of the AMS (1965–1967), AMS Committees on which he has served include the Transactions and Memoirs Editorial Committee (Associate Editor, 1959–1964); the Organizing Committee for the Symposium on Singular Integrals (Chairman, April 1966); the Nominating Committee for the 1968 Election; the Colloquium Editorial Committee (1971–1976); the Organizing Committees for the 1971 Summer Research Institute, and the July 1978 Summer Institute on Harmonic Analysis in Euclidean Spaces and Related Topics.

Professor Calderón gave an invited address at the summer meeting of the Society in University Park, Pennsylvania (August 1957) and has spoken at symposia on Partial Differential Equations (Berkeley, April 1960) and on Singular Integrals (Chicago, April 1966), and at the International Congress of Mathematicians in 1966 (Moscow) and 1978 (Helsinki). He delivered the Colloquium Lectures on the topic "Singular Integrals" at the summer meeting of the Society in Ithaca (August 1965).

Professor Calderón was elected to membership in the National Academy of Sciences in 1968. His interests include Fourier series, harmonic analysis, ergodic theory, functional analysis, singular integrals, and partial differential equations. He has been a member of the Society since 1949.

**Salomon Bochner**

Salomon Bochner was born in Cracow in Austria-Hungary on August 20, 1899. He received a Ph.D. from the University of Berlin, and was lecturer at the University of Munich from 1927–1932. In 1933 he joined Princeton University, starting out as an associate, and becoming Henry Burchard Fine Professor in 1959. He retired from Princeton in 1968 and has since then been Edgar Odell Lovett Professor at Rice University. Professor Bochner was an International Education Board Fellow at Copenhagen, Oxford and Cambridge Universities (1925–1927). He has been consultant to the Los Alamos Project at Princeton University (1951–1952) and to the National Science Foundation and Air Research and Development Command (1952–1962). He was also visiting professor at the University of California in 1953, and a member (part time) at the Institute for Advanced Study (1946–1948).

Professor Bochner was vice president of
Professor Bochner has given addresses at the Conference on Theory of Integration, Chicago, 1941, and at the International Congress of Mathematicians in 1950. He gave invited addresses at New York (October 1942) and at Kingston, Ontario (August-September 1953). He delivered the Colloquium Lectures at the 1956 Summer Meeting of the Society in Seattle.

He has been a Consulting Editor for the McGraw-Hill Encyclopedia of Science and Technology since its inception, and he was an Editor of the Dictionary of the History of Ideas (Scribner, 1973).

Professor Bochner is a member of the National Academy of Sciences. His research interests include probability theory, harmonic analysis, complex manifolds, complex variables, complex and almost periodic functions, Fourier analysis. He has been a member of the Society since 1934.

Hans Lewy

The Cauchy-Kovalevski theorem (C.-K.) is the fundamental theorem in the study of partial differential equations. It concerns analytic equations and their local-analytic solutions. In an attempt to see more clearly how dropping this double analyticity hypothesis would affect the local existence of solutions, I undertook the work for which you kindly awarded a Steele prize.

The simplest case to consider, of course, is the linear case: the simplest case is \(n = 3\), \(f = 0\), since the case \(n = 2\) leads to the well-studied elliptic system occurring in the quasi-conformal mapping of the plane. Even if the \(A_j(x), j = 1, 2, 3\), are real and real-analytic, the solution \(u\) need not be analytic, as is well known. In the general case of truly complex-valued, real-analytic \(A_j(x), one can construct by C.-K., two independent solutions \(z_1, z_2\). They define a patch of a 3-dimensional surface \(S\) of \(C^2\), and every third local-analytic solution \(u(x)\) then turns out to be the trace on \(S\) of a holomorphic function of \(z_1, z_2\) with \((E)\) serving as the tangential linear combination of the Cauchy-Riemann equations with respect to \(z_1, z_2\). If we drop the hypothesis of the analyticity of \(u(x)\), however, it could be expected—and it was proved—that, in general, \(u\) can still be extended as a holomorphic function of \(z_1, z_2\), but only on one side of \(S\), in an open set of \(C^2\) depending on the domain of existence of \(u(x)\) but not on the particular solution \(u\).

Next, let the \(A_j(x)\) be no longer analytic; here C.-K. no longer yields the solutions \(z_1, z_2\), but one obtains the same result by postulating their existence. Will there always be such \(z_1, z_2\), however? In the search for an answer, I tried a continuity method in which the \(A_j = A_j(x, t)\) are made to depend upon a real parameter \(t\), and which reduces, for \(t = 0\), to the simplest possible case, namely linear coefficients. This in turn leads to the corresponding inhomogeneous \((E)\) with \(f(x)\) no longer analytic but still \(C^\infty\). I was surprised to notice that the existence of even a single solution to this equation imposes a severe restriction on \(f(x)\); in fact, one can choose \(f(x) \in C^\infty\) such that no \(C^\infty\). I then tried to generalize the homogeneous \(n = 3\) case described earlier to \(n = 4\). Given are the three independent solutions \(z_1, z_2, z_3\) of
(E), which becomes the tangential linear combination of the Cauchy–Riemann equations on a 4-dimensional surface of $\mathbb{C}^2$ (codimension 2), parametrized by $x_1, \ldots, x_4$. Does there exist an open set of $\mathbb{C}^3$ into which all solutions $u(x)$ of (E), existing in the same domain of $\mathbb{R}^4$, can be continued as holomorphic functions of $z_1, z_2, z_3$?

All I could do at that point was to construct an example which confirmed that conjecture.

The papers alluded to above go back some twenty years. Fortunately, these and related problems have found an echo in the minds of some powerful analysts, who have immensely enlarged the scope of these problems and who have provided answers which have gone beyond my most daring hopes and which are basic to the theory of partial differential equations.

BIOGRAPIICAL SKETCH

Hans Lewy was born in Breslau, Germany, on October 20, 1904. He received a Ph.D. from the University of Göttingen in 1926. He was Privat-docent at the University of Göttingen from 1927–1933, and associate at Brown University from 1933–1935. He was lecturer at the University of California, Berkeley, 1936 to 1937, and advanced from assistant professor to professor there between 1937 and 1972. He has been professor emeritus at Berkeley since 1972. Professor Lewy has held Rockefeller Foundation fellowships at the University of Rome (1929–1930) and the University of Paris (1930–1931).

Professor Lewy was a member of the AMS Subcommittee on Preparation for Research of the War Preparedness Committee in 1941 and 1942. He was an AMS representative to the Division of Physical Sciences (1964–1967) and to the Division of Mathematics of the National Research Council (1965–1967). He has been on the Editorial Boards of the Indiana University Mathematical Journal and of the Annali della Scuola Normale di Pisa. He accepted invitations to address the Society at the California Institute of Technology (November 1945), and at the Annual Meeting in Berkeley (December 1954). He also presented an invited address at the International Congress of Mathematicians in 1950.

Professor Lewy is a member of the Mathematics Section of the National Academy of Sciences (U.S.A.) and of the Accademia dei Lincei (Rome). His major research interests include calculus of variations, partial differential equations, and hydrodynamics. He has been a member of the Society since 1934.

Organizers and Topics of Special Sessions

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

765th Meeting
Donald Dawson and Harry Keaten
Harold M. Hastings
Hiroaki Hironaka and George R. Kempf
Gangaram S. Ladde
Gerard J. Lalemment
Louis F. McAuley

766th Meeting
Daniel D. Anderson
Kent R. Fuller
William H. Jaco
James P. Kuelbs and Walter V. Philipp
Richard P. McGehee
Paul S. Muhly
John C. Polking

767th Meeting
Priscilla E. Greenwood
Stanley S. Page
Les M. Rosen

Lawrence W. Baggett and Arlan B. Ramsay
Alan Day and Walter F. Taylor
Karl E. Gustafson

New York, New York, April 1979
Deadline: Expired

Probability theory inspired by applications
Homotopy theory
Algebraic geometry
Mathematical modelling
Algebraic and topological semigroups
Monotone and open mappings

Iowa City, Iowa, April 1979
Deadline: Expired

Commutative ring theory
Noncommutative ring theory
Three-dimensional manifold theory
Probability on Banach spaces
Celestial mechanics
Operator theory
Several complex variables

Vancouver, Canada, June 1979
Deadline: April 3

Probability
Representations and ring theory
Mathematical physics

Boulder, Colorado, March 1980
Deadline: To be announced

Nonabelian harmonic analysis
Lattice theory and general algebra
Topics in mathematical physics

101
169. N. Tzanakis (8 Solomou Street, Iraklion, Crete, Greece) Is anything known about the solvability or solutions of the diophantine equation
\[ 4x^4 - y^4 = 3z^3, \quad x, y, z \text{ integers} \]
besides the obvious solution \(|x| = |y| = z = 1|?

170. Mariano Gasca Gonzalez (Departamento de Ecuaciones Funcionales, Faculty of Sciences, Granada, Spain) Condition GC for a lattice \(X = \{x_1, \ldots, x_N\}\) of \(N = (r + k)^n\) nodes of \(R^n\) (Chung and Yao, SIAM J. Numer. Anal. 14 (1977), 735–743): Corresponding to each node \(x_i\), there exist \(k\) distinct hyperplanes \(G_{1i}, G_{2i}, \ldots, G_{ki}\) such that \(x_j \in \bigcup_{r=1}^k G_{ir} \iff i \neq j\) for all \(i, j = 1, 2, \ldots, N\). Conjecture for \(n = 2\). Condition GC implies that \(k + 1\) of the \((k + 2)\) points of the lattice are aligned.

It is trivial for \(k = 1, 2\) and I have proved it easily for \(k = 3\). Is it true for \(k > 3\)?

171. David Horowitz (Department of Mathematics, Golden West College, Huntington Beach, California 92647) Can anyone supply information or references for the following problem:

Given a quadratic polynomial \(f(x) = ax^2 + bx + c\), what is the probability that it has two real roots? Two complex imaginary roots?

172. F. S. Cater (Department of Mathematics, Portland State University, Portland, Oregon 97207) Let \(e\) be a real number such that \(0 < e < 1\). Let \(D\) denote the set of all numbers \(d\) such that there exists an infinite sequence \((S_i)\) of Lebesgue measurable subsets of the interval \((0, 1)\) satisfying \(m(S_i) = e\) for all \(i\) and \(m(S_i \cap S_j) < d\) for \(i \neq j\). It is easy to show that \(\text{glb} D > 0\) and \(e^2 \in D\). What is \(\text{glb} D\)? Is \(D\) a closed set? Is anything known about this? (I conjecture that \(e^2 = \text{glb} D\))

173. Herbert E. Salzer (941 Washington Avenue, Brooklyn, New York 11225) For the \(m\)th divided difference \([z_1 \cdots z_m]\) of the analytic function \(f(z) = \sum_{n=0}^\infty a_n z^n\), radius of convergence \(R\), what can be said regarding the convergence of the following formal expression, which is obtained by taking the \(m\)th divided difference of each term of the series for
\[ f(z) = [z_1 \cdots z_m] \]
\[ \sum_{n=m}^\infty a_n \sum_{r=m-1}^n z_1^{n-r-1} \cdots \sum_{s=m-2}^r \sum_{v=0}^s z_m^{r-s-1} \cdots \sum_{u=0}^r \]

174. Dan Zwillinger (California Institute of Technology, Pasadena, California 91125) Can anyone supply a reference for the following game: there are \(n\)-persons in a round-robin game (every person plays against everyone else); with the proviso that each person plays the same strategy against all opponents. The games are not assumed to be zero sum.

175. Palle Jorgensen (Department of Mathematics, Stanford University, Stanford, California 94305) Let \(L_2\) and \(L_\infty\) denote the respective \(L_2\) and \(L_\infty\) spaces on the circle, and let \(H_2 \subset L_2\) be the corresponding Hardy space. Let \(v \in L_\infty\) and assume \(v \neq 0\) a.e. (i.e. \(v \cdot L_2\) is dense in \(L_2\)). Is it always true that \((v \cdot L_2) \cap H_2 \neq 0\)? Is anything known for the corresponding spaces of functions with values in Hilbert space?

RESPONSES

The replies below have been received to queries published in recent issues of the NOTICES. The editor would like to thank all who reply.

151. (vol. 25, p. 252, June 1978, Gray) In reply to J. D. Gray's query about recent work on algebraic equations of the fifth and higher degrees, in my paper Functional equations for solutions of algebraic equations, J. Natur. Sci. and...
Math. 11 (1971), 137–141, I gave linear systems of functional equations satisfied by each branch of the real many-valued solutions of real algebraic equations of any degree. For the quintic, these are a set of fifteen linear functional equations. (Contributed by Mostafa A. Abdelkader)


162. (vol. 25, p. 506, November 1978, Hastings) References for the resolution of the origin, history, and pronunciation of the third or “Robin” boundary condition, may be found in a homework exercise (Problem 1.9.5(c)) in my forthcoming book Introduction to partial differential equations and Hilbert space methods (Wiley). Since the book won’t be out until next year, let us mention a few of the historical facts here.

The pronunciation should be the French one. Robin was a professor in Paris, his favorite subject was thermodynamics, and he died early, in his forties. He published (in his twenties) only two “original” research papers, of length three pages: Les gas parfaits suivient à loi de Dulong et Petit, Société philomathique (about 1877); and Sur la chaleur réellement continue dans les corps et sur la vraie capacité calorifique, Bulletin de la Société philomathique IV (October 25, 1879). As a teacher and scientist, he was a perfectionist. (Contributed by Karl Gustafson)


VECTOR MEASURES

by J. Diestel and J. J. Uhl, Jr.

The first chapter deals with countably additive vector measures, finitely additive vector measures, the Orlicz-Pettis theorem and its relatives. Chapter 2 concentrates on measurable vector valued functions and the Bochner integral.

Chapter 3 begins the study of the interplay among the Radon-Nikodým theorem for vector measures, operators on $L$ and topological properties of Banach spaces. A variety of applications is given in the next chapter.

Chapter 5 deals with martingales of Bochner integrable functions and their relation to dentable subsets of Banach spaces. Chapter 6 is devoted to a measure-theoretic study of weakly compact, absolutely summing and nuclear operators on spaces of continuous functions.

In Chapter 7 a detailed study of the geometry of Banach spaces with the Radon-Nikodým property is given. The next chapter deals with the use of Radon-Nikodým theorems in the study of tensor products of Banach spaces. The last chapter concludes the survey with a discussion of the Liapounoff convexity theorem and other geometric properties of the range of a vector measure.

“... Hopefully the preceding survey of the contents conveys something of the orientation and scope of the book. What it cannot convey, however, is the overall quality of the authors’ presentation. The reviewer does not know of an advanced monograph in mathematics which is written in quite so vigorous and colorful a style. Not only are the chapters clear and interesting, but each ends with an extensive section of notes and remarks. These are a delicious blend of additional facts, proofs, observations and personal anecdotes. This book can be recommended to all workers in functional analysis and is a must for those interested in vector measures and/or Banach space geometry.”

F. Sullivan in Zentralblatt

322 pages
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fiscal 1980, Table I presents data showing the portion of total NSF funds going for support of mathematics. Table II compares support for the Mathematical Sciences Section with the other sections comprising the Directorate of Mathematical and Physical Sciences and Engineering.

In prior years, the mathematical sciences research support has decreased monotonically since 1971. The 1980 budget request interrupts this trend; yet the fraction requested barely surpasses the 1978 actual figure.

Table III brings together figures for the decade 1971 to 1980, published in these reports in February 1975 (actu harassment for 1974 and before), April 1978 (actu harassment for 1975), and the most recent figures given above in Table I. The entries in parentheses convert the amounts to 1967 constant dollars using the wholesale/producer index. (The 1978 conversion is based on the first ten months of the year, and may be subject to later correction.)

Line (6) in Table III reveals that the percentage of research support for mathematics has hovered near or below 3% since 1971, with local maxima in 1975 and 1977. The 1980 request, while higher than most years' actuals, still does not come up to the figure for 1977.

It has been pointed out in some detail by Saunders Mac Lane that the evolution of the NSF budget involves many steps, extending over several years (cf. November 1978 NOTICES, page 488). Table IV brings together the figures for the mathematical sciences research support given in the above tables and in earlier reports previously cited. Note that, on the whole, the budget requests increase from one year to the next, and that the amount designated for the mathematical sciences has tended to decrease as the evolutionary process described by Professor Mac Lane takes place.

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Table I: National Science Foundation Budget

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<td>Note B</td>
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<td>(1) Mathematical Sciences Research Support</td>
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<td>(3) Education, Information, Foreign Currency Program (Note B)</td>
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<td>(4) Program Development and Management (&quot;Overhead&quot;) (Note C)</td>
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<td>(5) Totals</td>
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<td>(6) (1) as % of (1) and (2)</td>
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<td>(7) (1) as % of (5)</td>
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<td>2.54%</td>
<td>2.50%</td>
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</tbody>
</table>

NOTE A: Scientific research and facilities (excluding mathematics), national and special research programs (excluding science information activities), national research centers, and research applied to national needs. Support for mathematics has been excluded, cf. items (1) and (3). The 1976 and 1977 figures include science advisory activities.

NOTE B: The programs in this group are ones in which there is some support for projects in every field, including mathematics. The foreign currency program involves both cooperative scientific research and the dissemination and translation of foreign scientific publications. Foreign currencies in excess of the normal requirements of the U.S. are used.

NOTE C: This heading covers the administrative expenses of operating the Foundation; the funds involved are not considered to constitute direct support for individual projects.
### TABLE II: MATHEMATICAL AND PHYSICAL SCIENCES AND ENGINEERING
(Millions of Dollars)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Sciences</td>
<td>$17.3 (9.06%)</td>
<td>$20.1 (8.96%)</td>
<td>$21.4 (8.61%)</td>
<td>$22.8 (8.62%)</td>
<td>$25.5 (8.62%)</td>
</tr>
<tr>
<td>Computer Research</td>
<td>13.2 (6.86%)</td>
<td>15.8 (7.04%)</td>
<td>16.6 (6.68%)</td>
<td>17.4 (6.60%)</td>
<td>19.3 (6.53%)</td>
</tr>
<tr>
<td>Physics</td>
<td>45.2 (23.50%)</td>
<td>53.9 (24.02%)</td>
<td>59.9 (24.10%)</td>
<td>63.0 (23.33%)</td>
<td>65.0 (21.98%)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>34.7 (18.62%)</td>
<td>40.2 (17.91%)</td>
<td>43.1 (17.34%)</td>
<td>45.6 (17.03%)</td>
<td>53.4 (18.06%)</td>
</tr>
<tr>
<td>Engineering</td>
<td>35.8 (18.62%)</td>
<td>41.8 (18.63%)</td>
<td>43.9 (17.67%)</td>
<td>47.6 (17.78%)</td>
<td>54.3 (18.30%)</td>
</tr>
<tr>
<td>Materials Research</td>
<td>46.1 (23.97%)</td>
<td>52.6 (23.44%)</td>
<td>59.9 (24.10%)</td>
<td>63.6 (23.76%)</td>
<td>70.1 (23.81%)</td>
</tr>
<tr>
<td>Regional Instrumentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilities/Industry-University Cooperative Research</td>
<td>-</td>
<td>3.7 (1.49%)</td>
<td>7.7 (2.88%)</td>
<td>7.8 (2.64%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$192.3</td>
<td>$224.4</td>
<td>$248.5</td>
<td>$267.7</td>
<td>$295.7</td>
</tr>
</tbody>
</table>

### TABLE III: TEN-YEAR COMPILATION, NSF BUDGET
(Millions of Dollars)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Mathematical Sciences Research Support 1967 dollars</td>
<td>$12.9 (11.3%)</td>
<td>$13.7 (11.5%)</td>
<td>$14.1 (10.5%)</td>
<td>$14.5 (9.1%)</td>
<td>$16.4 (9.4%)</td>
<td>$17.3 (10.4%)</td>
<td>$20.1 (10.0%)</td>
<td>$21.4 (10.0%)</td>
<td>$22.8 (25.5%)</td>
<td>$25.5 (65.9%)</td>
<td>(-13%)</td>
<td>97.7%</td>
<td></td>
</tr>
<tr>
<td>(2) Other Research Support 1967 dollars</td>
<td>315.5 (277.0)</td>
<td>435.0 (365.4)</td>
<td>483.5 (359.7)</td>
<td>492.5 (308.2)</td>
<td>551.9 (315.7)</td>
<td>592.1 (323.3)</td>
<td>642.9 (331.1)</td>
<td>702.8 (326.8)</td>
<td>759.2 (825.0)</td>
<td>132% (162%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Education, Information, Foreign Currency Program 1967 dollars</td>
<td>145.9 (128.1)</td>
<td>127.4 (107.0)</td>
<td>84.1 (62.6)</td>
<td>104.4 (65.5)</td>
<td>83.0 (47.5)</td>
<td>72.8 (39.7)</td>
<td>83.3 (42.9)</td>
<td>84.3 (39.2)</td>
<td>88.5 (95.9)</td>
<td>-42.2% (-34.3%)</td>
<td>-69.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Program Development and Management (&quot;Overhead&quot;) 1967 dollars</td>
<td>21.8 (19.1)</td>
<td>24.6 (20.7)</td>
<td>23.6 (21.3)</td>
<td>35.2 (22.1)</td>
<td>37.9 (21.7)</td>
<td>42.2 (23.0)</td>
<td>45.5 (23.4)</td>
<td>48.7 (22.6)</td>
<td>57.9 (59.6)</td>
<td>123% (173%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| (5) Totals 1967 dollars | $496.1 (435.6) | $600.7 (504.6) | $610.3 (454.1) | $645.6 (404.8) | $693.2 (396.5) | $724.4 (385.5) | $791.8 (407.8) | $857.2 (398.6) | $928.4 (1,006.0) | $1,006.0 (72.8%) (105%)

(1) as % of (1) and (2) 3.93% 3.05% 2.78% 2.87% 2.89% 2.84% 3.03% 2.95% 2.92% 3.00%

(7) as % of (5) 2.60% 2.28% 2.27% 2.25% 2.37% 2.39% 2.54% 2.56% 2.46% 2.53%

The 22nd Annual AMS Survey was made under the direction of the Society's Committee on Employment and Educational Policy (CEEP), whose members in 1978 were Lida K. Barrett (chairman), Alan J. Goldman, Arthur P. Mattuck, Hugo Rossi, Martha K. Smith, and Robert J. Thompson. A Data Subcommittee of CEEP consisting of Lida K. Barrett, Lincoln K. Durst, Wendell H. Fleming (chairman), Arthur P. Mattuck, and Donald J. Albers as a consultant for two-year colleges, designed the questionnaires with which the data were collected. The committee is grateful to members of the AMS staff, especially Marcia A. Almeida, for the diligence and efficiency with which the data were collected and compiled. Comments or suggestions regarding this program may be directed to the subcommittee.

Employment of Mathematical Sciences Doctorates, Faculty Mobility, Enrollment Trends, Fall 1978

by Wendell H. Fleming

This is one of a series of annual reports on trends in the job market for Ph.D.'s in the mathematical sciences. The report begins with an update of the fall 1978 employment status of new 1977-1978 doctorates. This is followed by a discussion of trends in the academic job market for mathematicians in four-year colleges and universities, based on 1978 AMS Survey data on faculty mobility, and concludes with information on enrollments and staff size. An accompanying article is concerned with two-year colleges.

The past year 1978 was the best among recent years for the employment of mathematical science Ph.D.'s. Among the contributing factors was a strong job market in the business-industry sector. There was also some increase in the number of teaching positions, mainly in departments which offer at most masters degrees—Groups M and B in the classification below. (However, the percentage increase in number of full-time faculty members was less than the percentage increase in course enrollments.) Another factor was the continuing decline in the number of "pure mathematics" doctorates. The Survey data indicate that nearly all new 1977-1978 Ph.D.'s, and also nearly all untenured faculty members terminated after academic year 1977-1978 found either another teaching position for fall 1978 or nonacademic employment. On the other hand, the number of junior faculty members competing for permanent positions continues to exceed the number of such openings.

In this article departments in mathematical sciences in U.S. and Canadian universities and four-year colleges are classified as below. The first six groups consist of departments that have doctoral programs, of which Groups I-V are U.S. departments. (The numbers indicate how many departments were queried in the 1978 Survey.)

- **Group I**: the top 27 ACE ranked mathematics departments.
- **Group II**: the other 38 ACE rated mathematics departments.
- **Group III**: 90 mathematics departments not included in the ACE study.
- **Group IV**: 66 statistics, biostatistics and biometry departments.
- **Group V**: 117 other mathematical science departments (includes 71 in computer science).
- **Group VI**: 35 Canadian departments in the mathematical sciences.
- **Group M**: 379 departments with masters' programs (of which 16 are Canadian departments).
- **Group B**: 1,066 departments which offer at most bachelor's degrees (of which 35 are Canadian departments).

Notes: 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.

Response rates varied from one group to another, with the largest response rate from Groups I, II, and III. Of an estimated total of about 17,850 full-time U.S. mathematical sciences faculty members, over 10,000 are members of departments which responded to the survey.

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 on Education, Washington, D.C., 1970, 115 pp. The information on mathematics was reprinted by the Society and may be found on pages 338-340 of the February 1971 issue of the NOTICES.
FALL 1978 EMPLOYMENT STATUS OF 1977-1978 NEW DOCTORATES

Table 1 contains the fall 1978 employment status by type of employer and field of degree for 952 new mathematical science doctorates who received the degree between July 1, 1977 and June 30, 1978. This updates the corresponding table on p. 396 of the October 1978 NOTICES, using more recent information provided by departments and recipients of the degrees. The first row "University" in Table 1 refers to those 1977-1978 new doctorates employed by departments in Groups I-V. The second row "College" refers to those employed by U.S. departments in Groups M and B.

The total of 952 degrees included in Table 1 does not include 63 doctorates reported late; see Supplementary List, January 1979 NOTICES, pp. 76-77. Trends in the number of new doctorates, in various fields and in the kinds of positions they take were reported in the October 1978 NOTICES, pp. 398-399. Among the more striking trends is a continuing decline in the number of "pure mathematics" doctorates. The percentage of the new mathematical science doctorates who take jobs in business and industry is steadily increasing. On the other hand, the percentage who are employed as mathematics teachers in Groups M and B departments is steadily decreasing, despite the fact that these departments have experienced growth both in course enrollments and in the number of faculty positions. One apparent reason is that Groups M and B departments do not usually offer the kind of research-oriented environment found in doctorate-granting departments. In addition, many Groups M and B departments currently seek new faculty members with expertise in such applied fields as statistics and computer science. Generally colleges cannot compete with industry for such individuals in terms of salary.

### Table 1

1978-1979 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>Education</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>43</td>
<td>57</td>
<td>31</td>
<td>18</td>
<td>15</td>
<td>48</td>
<td>27</td>
<td>3</td>
<td>29</td>
<td>20</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>40</td>
<td>31</td>
<td>19</td>
<td>5</td>
<td>6</td>
<td>20</td>
<td>12</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>11</td>
<td>160</td>
</tr>
<tr>
<td>Two-year college and high school</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Other academic departments or research institutes</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>71</td>
<td></td>
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<td>1</td>
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<td>19</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Business and Industry</td>
<td>9</td>
<td>15</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>49</td>
<td>17</td>
<td>28</td>
<td>12</td>
<td>166</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>7</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>15</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>62</td>
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<tr>
<td>Foreign</td>
<td>17</td>
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<td>10</td>
<td>5</td>
<td>2</td>
<td>24</td>
<td>12</td>
<td>3</td>
<td>11</td>
<td>1</td>
<td>5</td>
<td>120</td>
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<tr>
<td>Not seeking employment</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
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</tr>
<tr>
<td>Not yet employed</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
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<td>6</td>
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<tr>
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<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>6</td>
<td></td>
<td></td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
<td>164</td>
<td>80</td>
<td>26</td>
<td>33</td>
<td>174</td>
<td>136</td>
<td>35</td>
<td>113</td>
<td>4</td>
<td>62</td>
<td>952</td>
</tr>
</tbody>
</table>
Size of the Full-Time U.S. Mathematical Sciences Faculty. Table 2 shows the estimated number of full-time doctorate-holding and non-doctorate faculty members in fall 1978, for each of Groups I, . . . , B in the U.S.

Table 2 is an update of earlier estimates. It is based for the most part on department-by-department counts of size of faculty. The estimates for Groups I-IV and M are considered reliable, for Group B slightly less reliable, and least reliable for Group V. The last line of Table 2 shows estimated changes in the number of full-time faculty members between fall 1977 and fall 1978. These estimates are based on 1978 AMS Survey data. They indicate about a 2% increase in the number of doctorate-holding faculty members and an increase in the total (doctorate and non-doctorate) faculty of between 1.5% and 2%. These percentages are slightly greater than in other recent years, but less than the percentage increase in mathematics course enrollments between fall 1977 and fall 1978 reported below. The pressure of enrollment increases in elementary mathematics courses since 1974 has been a positive factor in the academic job market during the late 1970s.

Most of the estimated increase of 300 mathematics faculty positions shown in Table 2 occurred in Groups M and B departments, especially in Group M. There was essentially no change in the number of full-time faculty members in Groups I-III between fall 1977 and fall 1978.

According to CBMS Survey estimates, in 1970-1971 there were about 17,000 full-time mathematical sciences faculty members in the U.S., of whom about 11,000 held doctorates and 6,000 did not (cf. February 1977 NOTICES, p. 105). The number of faculty members without doctorates fell steadily during the 1970s, but now has apparently stabilized at around 3,800. This represents about 21% of all mathematical sciences faculty members in the U.S.

### TABLE 2

Estimated Number of Full-Time Mathematical Sciences Faculty Members in U.S. Four-Year Colleges and Universities, Fall 1978

<table>
<thead>
<tr>
<th>Group</th>
<th>Doctorate-Holding</th>
<th>Nondoctorate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1,200</td>
<td>(&lt;5)</td>
<td>1,200</td>
</tr>
<tr>
<td>II</td>
<td>1,510</td>
<td>50</td>
<td>1,560</td>
</tr>
<tr>
<td>III</td>
<td>2,370</td>
<td>270</td>
<td>2,640</td>
</tr>
<tr>
<td>Total I, II, III</td>
<td>5,080</td>
<td>320</td>
<td>5,400</td>
</tr>
<tr>
<td>IV</td>
<td>750</td>
<td>50</td>
<td>800</td>
</tr>
<tr>
<td>V</td>
<td>1,120</td>
<td>80</td>
<td>1,200</td>
</tr>
<tr>
<td>M</td>
<td>3,950</td>
<td>1,500</td>
<td>5,450</td>
</tr>
<tr>
<td>B</td>
<td>3,150</td>
<td>1,850</td>
<td>5,000</td>
</tr>
<tr>
<td>Total U.S.</td>
<td>14,050</td>
<td>3,800</td>
<td>17,850</td>
</tr>
</tbody>
</table>

| Estimated change from Fall 1977 | +300 | 0 | +300 |

Part-Time Faculty (excluding teaching assistants). Part-time members of the faculty represent only a small proportion of the total in four-year colleges and universities, but the number is increasing. On a full-time equivalent basis, part-time faculty members amount to only 5% of the full-time faculty in Groups I-III, about 15% in Groups IV and V, and slightly over 10% in Groups M and B. The higher percentage reported in Groups IV and V can probably be attributed partly to the frequency of split appointments between Statistics or Computer Science and other departments, as well as the use on a part-time basis of adjunct appointments of people who also hold nonacademic positions. Nearly half of the part-time faculty members in Groups I-V have doctorates, but only a quarter of those in Groups M and B have doctorates. A substantial increase in the number of part-time faculty members from fall 1977 to fall 1978 was reported. For Groups I-III, the increase was over 20%, and occurred mainly in Group III. This is substantially higher than increases reported in previous years. Apparently additional part-time faculty members are being hired to cover teaching assignments in elementary courses, for which additional qualified teaching assistants cannot be found. About a 12% increase in the number of part-time faculty members was reported for Groups M and B, from fall 1977 to fall 1978. Similar increases were reported for Groups M and B for the three previous years, indicating a substantial overall increase in the number of part-time faculty members since fall 1974. For further discussion of part-time employment of Ph. D.'s, see the October 1978 NOTICES, p. 421.
Mathematical Sciences Faculty, Canada.

Table 3 gives an estimate of the number of full-time mathematical sciences faculty members in departments in Canadian four-year colleges and universities in Groups VI, M, and B, in fall 1978.

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>900</td>
</tr>
<tr>
<td>M</td>
<td>250</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>1,350</td>
</tr>
</tbody>
</table>

While the data are less complete for Canadian departments, it appears that about 90% of Group VI faculty members have doctorates. In Canadian Group M departments the percentage is slightly lower, and roughly 70% of Canadian Group B faculty members have doctorates. The total number of faculty members in Canadian departments has remained stable recently.

Newly Hired Faculty Members, Fall 1978. It is estimated from AMS Faculty Mobility Survey data that roughly 1,650 full-time faculty members were newly hired for fall 1978 by mathematical sciences departments in the U.S. This includes about 1,150 doctorate-holding and 500 nondoctorate faculty members. Of the 1,650 newly hired, roughly 500 doctorates and 100 nondoctorates moved from faculty positions in other four-year colleges or universities. The remaining 1,150 new faculty members came directly from graduate school, from outside the U.S., or from other sources. Almost all of those newly hired are nontenured. About 80 individuals, including about 10 without doctorates, were hired with immediate tenure; most of them moved from tenured positions elsewhere.

Table 4 gives estimates of the number of fall 1978 nontenured faculty members hired from various sources, as well as the number continuing from the 1977-1978 academic year in the same department.

Included on the left side of Table 4 as "continuing in the same department" are those who received a doctoral degree during 1977-1978 without changing jobs (perhaps about 100 in number, mostly in Groups M and B departments). According to Table 4 slightly over a quarter of fall 1978 nontenured doctorates were newly hired. This includes both new 1977-1978 Ph.D.'s coming immediately from graduate school, and also Ph.D.'s from previous years moving from other positions. Of the 1,250 nondoctorates without tenure shown at the bottom of Table 4, over 85% are in Groups M and B departments. About 425 nondoctorates were newly hired for fall 1978 in Groups M and B, compared to only about 250 newly hired for fall 1976 two years earlier.

### TABLE 3

<table>
<thead>
<tr>
<th>Group</th>
<th>Estimated Number of Full-Time Faculty Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>900</td>
</tr>
<tr>
<td>M</td>
<td>250</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td>1,350</td>
</tr>
</tbody>
</table>

### TABLE 4

Sources of Nontenured Faculty Members, Fall 1978

<table>
<thead>
<tr>
<th></th>
<th>Doctorate-Holding Faculty</th>
<th>Nondoctorate Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>I-III</td>
</tr>
<tr>
<td>Newly hired from</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate School</td>
<td>440</td>
<td>170</td>
</tr>
<tr>
<td>Another college</td>
<td>450</td>
<td>130</td>
</tr>
<tr>
<td>or university</td>
<td></td>
<td></td>
</tr>
<tr>
<td>faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonacademic</td>
<td>80</td>
<td>15</td>
</tr>
<tr>
<td>employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside U.S.</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Other sources</td>
<td>60</td>
<td>25</td>
</tr>
<tr>
<td>Total newly hired</td>
<td>1,080</td>
<td>360</td>
</tr>
<tr>
<td>Continuing in same dept. from 1977-1978</td>
<td>2,940</td>
<td>910</td>
</tr>
<tr>
<td>Total nontenured faculty members, fall 1978</td>
<td>4,020</td>
<td>1,270</td>
</tr>
</tbody>
</table>

1 Part-time to full-time in the same department, from postdoctoral or two-year college position, etc.
Faculty Members Leaving Full-Time Positions. About 1,350 individuals left full-time faculty positions held during 1977-1978, including about 600 who moved to another four-year college or university mathematical science department. Table 5 shows an estimate of the fall 1978 status of the other 750. The estimates in Tables 4 and 5 were obtained by extrapolating from Faculty Mobility data provided by departments. Of the estimated total of 17,850 full-time U. S. mathematical sciences faculty members in Table 2, over 10,000 are members of departments which responded. The response rate was best from Groups I-III departments (119 departments of 155). There are some indications that the extrapolated estimates may be slightly high for Groups M and B departments.

The numbers in parentheses in the right-hand column of Table 5 refer to those leaving who were tenured.

The number of faculty members leaving for nonacademic positions has steadily increased recently. The number 370 in Table 5 is about 35% higher than the corresponding number two years ago. The fact that about 65 tenured faculty members are included among those moving to nonacademic jobs indicates that nonacademic employment is becoming more widely regarded as an attractive alternative to teaching. One probable reason is better salaries offered in industry. After subtracting the 120 in Table 4 hired from nonacademic positions, one still has a current net outflow of 250 per year to business, industry, and government.

Tables 1 and 5 indicate that nearly all mathematical science Ph. D.'s seeking employment in the U. S. for fall 1978 found it, with a fair number moving from academic to nonacademic positions. A combination of factors made 1978 a favorable year. The nonacademic job market was stronger than in previous years, and there was a 1.5% to 2% increase in the number of faculty positions. In addition, there were somewhat fewer new Ph. D.'s seeking employment.

Tables 4 and 5 show a rough balance between the numbers of faculty members newly hired from outside the U. S. and those leaving the U. S. The job market for mathematicians is international. There might in the future be a net flow from the U. S., should (for example) increasing numbers of mathematicians of foreign birth now in the U. S. find more attractive positions in the countries of their origin. The data, however, indicate that this is not currently a significant consideration in the U. S. job market for mathematicians.

Tables 1 and 5 indicate that fewer than 20 doctorates in the mathematical sciences took positions in two-year colleges and high schools (this does not include some with doctorates in mathematics education). A recent report by Robert McKelvey, et al., "An inquiry into the graduate training needs of two-year college teachers of mathematics," published by the Rocky Mountain Mathematics Consortium indicates that this number might be increased, were some doctoral programs in mathematics better oriented toward the needs of two-year colleges. (A summary of the findings of this report is being prepared for possible publication in the NOTICES.)

It should be emphasized that Table 5 refers to U. S. departments in all Groups I, II, ..., B. For Groups I-III departments, about 70 faculty members left through retirement or death between fall 1977 and fall 1978. About 50 in Groups I-III left for nonacademic positions, including only about 5 with tenure.

Frequency of Nontenured Faculty Members Leaving After Only One or Two Years (Groups I-III). Among nontenured doctorate-holding faculty members leaving Group I departments, about 10% were reported as leaving after only one year in the department, with an additional 45% leaving after two years. However, among those leaving Groups II and III departments about 30% left after only one year in the department, and an additional 30% left after only two years.

### TABLE 5
Estimated Number of Full-Time 1977-1978 Faculty Members No Longer Employed in U. S. Mathematical Sciences Departments

<table>
<thead>
<tr>
<th>Fall 1978 Status</th>
<th>Doctorate-Holding</th>
<th>Nondoctorate</th>
<th>Total</th>
<th>(Total Tenured)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retired or died</td>
<td>90</td>
<td>90</td>
<td>180</td>
<td>(175)</td>
</tr>
<tr>
<td>Nonacademic employment</td>
<td>270</td>
<td>100</td>
<td>370</td>
<td>(65)</td>
</tr>
<tr>
<td>Two-year college/high school</td>
<td>5</td>
<td>25</td>
<td>30</td>
<td>(5)</td>
</tr>
<tr>
<td>Left U. S.</td>
<td>35</td>
<td>5</td>
<td>40</td>
<td>(15)</td>
</tr>
<tr>
<td>Graduate/professional school</td>
<td>15</td>
<td>50</td>
<td>65</td>
<td>(0)</td>
</tr>
<tr>
<td>Seeking employment</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>(0)</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>20</td>
<td>45</td>
<td>(20)</td>
</tr>
<tr>
<td></td>
<td>450</td>
<td>300</td>
<td>750</td>
<td>(280)</td>
</tr>
</tbody>
</table>
There were altogether about 70 nontenured doctorates leaving Group I departments, with about 190 leaving Groups II and III departments, between 1977-1978 and 1978-1979. Of these 260 individuals, about 156 moved to other colleges and universities. While some left before their appointments expired, the data indicate a high frequency of one-year and two-year nonrenewable positions. The Council of the AMS recently passed a resolution urging departments to avoid the systematic use of one-year nonrenewable appointments. See the April 1978 NOTICES, p. 201, and related comments, February 1978, p. 119.

Promotions to Tenure. From Faculty Mobility data it is estimated that about 450 doctorate-holding faculty members received tenure in their institutions between fall 1977 and fall 1978. These included about 130 in Groups I-III, 45 in Groups IV and V, and 275 in Groups M and B. About 280 of the 450 who were newly tenured can be regarded as replacements for tenured faculty members shown in Table 5 as no longer employed in a mathematical science department. The other 170 represent growth in the number of tenured positions. A similar number of 450 to 550 were estimated last year as having received tenure between fall 1976 and fall 1977.

A very rough estimate can be made of the proportion of Ph. D.'s receiving tenure who entered the pool of the nontenured doctorate faculty a few years earlier. This estimate involves individuals entering in various (undetermined) years, as well as extrapolations from Faculty Mobility data; hence, it cannot be very precise. In nearly the current form, Faculty Mobility data go back to fall 1973. The number of Ph. D.'s entering the pool of the doctorate faculty in fall 1973 was estimated by R. D. Anderson at somewhat over 800, including 700 new doctorates in the mathematical sciences and mathematics education plus over 100 from other sources (but excluding foreign visitors). See the November 1973 NOTICES, p. 351. For simplicity, assume that all were initially nontenured. If 1973 is taken as fairly typical of the years immediately preceding it, then it appears that somewhat over half of the Ph. D.'s entering during that period later received tenure.

Of more interest to currently nontenured faculty members and to graduate students are the prospects for tenure in the years ahead. New legislation on mandatory retirement has introduced uncertainties about the probable number of retirements during 1982-1987. (A recent AAUP report on this subject is summarized in p. 122.) The author believes that until after 1987 the annual number of replacements for tenured faculty members due to deaths and retirements will not much exceed the present level of around 200. If inflation becomes more serious in the U.S., the number could be significantly less. Fewer faculty members will risk early retirement; and those reaching age 65 after July 1, 1982 will have the option of postponing retirement to age 70, if physically able to do so.

The long-range demand for applied mathematicians, computer scientists, and statisticians in government and industry is expected to remain strong, although the nonacademic job market is subject to cyclic fluctuations of considerable magnitude. If academic salaries continue to decline, in terms of constant dollars, then tenured faculty members may leave for nonacademic positions at a somewhat greater rate than the 65 per year in Table 5. However, this trend (if it occurs) is likely to have least effect on the number of tenured openings in Groups I-III.

An estimate of about 300 permanent positions per year during the early-to-mid 1980s, to replace tenured faculty members leaving, has been made previously in this series of reports. The evidence currently available suggests that this estimate is still reasonable. For Groups I-III departments only, the corresponding estimate is 75 to 100 replacements for tenured faculty members per year.

The number of Ph. D.'s entering the pool of the nontenured doctorate faculty has now declined to the 650-700 range, from over 800 in 1973. If the number of promotions to tenure per year in the period around 1985 should, in fact, turn out to average about 300 per year, then slightly fewer than half those Ph. D.'s entering the pool in 1978 would eventually get tenure. The number of tenured openings is also influenced by expansion or contraction. While enrollments in elementary mathematics increased again this year, college enrollments overall seem to have peaked. Mathematics enrollment declines must be expected during the 1980s, as the college age population declines steadily. There is little prospect of further expansion of mathematics departments during the 1980s. Indeed, cutbacks will be probable should "taxpayers' revolts" now underway in several states become widespread, resulting in severe limits on funds for publicly supported colleges and universities. It appears that tenure percentages are stabilizing in the 75% to 80% range. They are unlikely to go higher, unless cutbacks reduce the number of nontenured positions.

A bit more optimism seems in order regarding the long-term employment prospects for students just now at the point of entering graduate school. For those who get the Ph. D. around 1985 and then seek academic positions, the first crucial stages will be in the mid-to-late 1980s, at the times of initial hiring and of first reappointment. The number of replacements for tenured and nontenured faculty members will probably then be below the level of 750 per year shown in Table 5. However, unless one takes an extremely pessimistic view, there should still be several hundred openings per year at the assistant professor level, counting positions in all types of departments (I, II, ..., B). The crucial tenure decision would normally come around 1990, for students entering graduate school in 1979 who get the Ph. D. and then take an academic job. Starting about then, the annual number of retirements will begin to increase substantially. There will be in any case a great need for new faces, as the many faculty members hired during the period of growth in the 1960s reach late middle age.
There has been for several years a steady decline in the number of new "pure mathematics" Ph.D.'s, with the current rate of decline about 8% per year. This decline is expected to continue, though probably at a slower rate. The number of graduate students in Groups I-III departments has also been steadily declining, currently at a rate of about 2% per year. There were about 450 new "pure mathematics" Ph.D.'s in 1977-1978, counting those shown in Table 1 and a few reported late. This number may well decline to a level somewhere around 300 by the mid-1980s. This trend should lead in the long run to less competition for tenured positions in mathematics departments emphasizing research in areas of mathematics not traditionally identified with some application. The number of such openings will depend on how well the case is made for support of basic mathematical research.

The proportion of mathematical sciences Ph.D.'s employed in business, industry, and government is increasing. Among recent Ph.D.'s employed in the U.S., nearly half hold non-academic jobs, counting both those taking such positions immediately after the Ph.D. and those moving later from academic to nonacademic employment. Relatively few mathematicians with nonacademic jobs are in laboratories emphasizing basic research. A much larger number are working as "practitioners" of applied mathematics, on problems of more immediate concern to their employers. A great deal of the recent growth in the applied mathematical sciences is in one way or another, related to the revolution in computer technology. The growth has occurred not only in computer science itself, but also in such areas as the coding and statistical analysis of large sets of data, modelling of complicated physical phenomena, and the study of large scale systems in engineering or management science. Present indications are that it is in such directions that growth in mathematics-related employment opportunities is to be expected during the years immediately ahead.

Trends in Course Enrollments and Staff Sizes. There have been substantial increases in mathematics course enrollments recently. Table 6 shows percentage increases in one year, fall 1977 to fall 1978, and also over the four-year period, fall 1974 to fall 1978.

Table 6 shows an average annual increase in course enrollments of about 4.5% over the past four years in Groups I, II, and III departments, with a larger average increase of over 6% per year in Groups M and B. In contrast, the average increase in the number of faculty members has been less than 1% per year in Groups I, II, and III departments since fall 1974; for Groups M and B, the average increase in the faculty has been about 2% per year since fall 1974, if part-time positions are converted into full-time equivalents in calculating this percentage. In Groups IV and V departments, the number has increased at about 3% per year over the same period, with less than 1% per year among the Canadian departments in Group VI. The total number of teaching assistants has not changed significantly since fall 1974, except for an increase of around 5% to 6% per year in Groups IV and V departments.

These data show a significant increase during the last four years in overall faculty load, measured in course enrollments per full-time faculty member. However, when measured in terms of the average number of sections taught per full-time equivalent faculty member, there have been only slight increases since fall 1974. The increases in loads have occurred mainly through increased average class sizes.

Table 7 shows percentage changes in course enrollments by type of course from fall 1977 to fall 1978 reported by Groups I, II, III, M, and B departments.

**TABLE 6**

<table>
<thead>
<tr>
<th>Groups</th>
<th>1977 to 1978</th>
<th>1974 to 1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, II, III</td>
<td>3%</td>
<td>18%</td>
</tr>
<tr>
<td>IV</td>
<td>3%</td>
<td>24%</td>
</tr>
<tr>
<td>V</td>
<td>5%</td>
<td>36%</td>
</tr>
<tr>
<td>VI</td>
<td>5%</td>
<td>28%</td>
</tr>
<tr>
<td>M</td>
<td>6%</td>
<td>24%</td>
</tr>
<tr>
<td>B</td>
<td>5%</td>
<td>26%</td>
</tr>
</tbody>
</table>

*Enrollments in this type of course amount to less than 2% of total course enrollments for this group of departments.*

**TABLE 7**

Percent Change in Course Enrollments, by Type of Course

<table>
<thead>
<tr>
<th>Type of Course</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Below calculus</td>
<td>-1.2%</td>
</tr>
<tr>
<td>First-year calculus</td>
<td>8.5%</td>
</tr>
<tr>
<td>Statistics</td>
<td>*</td>
</tr>
<tr>
<td>Computer science</td>
<td>*</td>
</tr>
<tr>
<td>Other undergraduate</td>
<td>.8%</td>
</tr>
<tr>
<td>Graduate courses</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Fall 1977 to Fall 1978
Table 7 shows a significantly greater increase in calculus enrollments among all groups of departments than in courses below calculus. Overall, enrollment increases occurred in all types of courses, including graduate courses. In Groups I, II, and III departments about 30% of course enrollments are in first-year calculus, and over 40% of course enrollments are in courses below calculus. For Groups M and B departments, slightly under 20% of course enrollments are in first-year calculus, and about 50% of course enrollments are in courses below calculus.

In the 1978 Survey, departments were also asked to report numbers of their junior and senior majors. Small increases were reported by most groups of departments, with an overall increase of some 2% to 3%. However, the number of majors in Group V departments increased by about 25% in one year, with computer science accounting for a large part of the increase.

Two-year College Survey

by Wendell H. Fleming

The Annual American Mathematical Society Survey monitors trends in both two-year and four-year colleges regarding mathematics enrollments, the composition of mathematics faculties, faculty mobility, and faculty salaries. Summaries and analyses of Survey results are published each year in the February and October issues of the NOTICES of the American Mathematical Society. The present article is a report of results from the 1978 Survey of two-year colleges, and includes 3-year trends (1975-1978) observed from the last three Annual Surveys. The Survey data summarized below were provided by over 250 two-year college mathematics departments (or departments including mathematics faculty). The questionnaire was sent to 975 departments, including all those listed in the Mathematical Sciences Administrative Directory published by the American Mathematical Society each year. (The 1978 questionnaire was distributed in September and requested current data for the fall term.) The departments responding to the survey questionnaire were self-selected, and do not represent a scientifically chosen random sample. While the trends reported below are consistent from year to year, one should be cautious about extrapolating to all two-year colleges.

In the years before 1975 two-year college mathematics in the U.S. underwent remarkable growth. According to the 1975-1976 Conference Board of Mathematical Sciences Survey, mathematics enrollments grew by 50% from fall 1970 to fall 1975. During the same 5-year period the full-time mathematics faculty increased by 22% and the part-time mathematics faculty by 54%. Since 1975, however, AMS Survey data indicate only modest growth. Among departments responding to the AMS Survey, mathematics course enrollments increased at the rate of 3% per year during the 3-year period, fall 1975 to fall 1978. This is about the same rate of increase as for two-year college enrollments as a whole, during the same three years. The number of mathematics faculty members increased only slightly, at roughly 1½% per year between fall 1975 and fall 1978.

Course enrollments. Table 1 shows, in the center column, a percentage breakdown of fall 1978 mathematics enrollments by type of course. The right-hand column in Table 1 shows the percent change in enrollments for each type of course over the 3-year period, fall 1975 to fall 1978.

<table>
<thead>
<tr>
<th>Type of course</th>
<th>Percent of fall 1978 enrollment</th>
<th>Percent change in enrollment, 1975-1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic</td>
<td>12%</td>
<td>+20%</td>
</tr>
<tr>
<td>Elementary and intermediate algebra</td>
<td>31%</td>
<td>+10%</td>
</tr>
<tr>
<td>Basic concepts for general math.*</td>
<td>7%</td>
<td>-10%</td>
</tr>
<tr>
<td>Math, for elementary teachers</td>
<td>2%</td>
<td>-18%</td>
</tr>
<tr>
<td>Precalculus</td>
<td>17%</td>
<td>+10%</td>
</tr>
<tr>
<td>Calculus</td>
<td>10%</td>
<td>+12%</td>
</tr>
<tr>
<td>Computing</td>
<td>2%</td>
<td>+65%</td>
</tr>
<tr>
<td>Elementary statistics</td>
<td>4%</td>
<td>+20%</td>
</tr>
<tr>
<td>Business, vocational or technical math.</td>
<td>11%</td>
<td>+2%</td>
</tr>
<tr>
<td>Other courses</td>
<td>4%</td>
<td>+4%</td>
</tr>
</tbody>
</table>

*Structure, logic, basic skills, operations.

Overall, two-year college mathematics course enrollments increased by about 9% (3% per year) between fall 1975 and fall 1978, among departments responding. Table 1 shows that the increase was uneven among different types of courses, with declines in courses in basic concepts and in mathematics for elementary teachers. Computing showed a dramatic 65% increase, though still contributing only 2% to the total. Enrollments in calculus courses for engineers

and for those in the physical sciences increased more rapidly than in calculus courses for those in the social and life sciences or business.

Two-year college mathematics faculty. Table 2 shows numbers of full-time mathematics faculty members by sex, tenure status (doctorate-holding vs. nondoctorate) in departments providing usable responses (255 of 976 departments).

About 66% of 1978-1979 faculty members included in Table 2 are tenured. About one-quarter of the departments reported that there is no formal tenure system in the institution.

The 1975-1976 CBMS Survey gave estimated numbers of 5,944 full-time and 3,411 part-time mathematics faculty members in U.S. two-year colleges, as of fall 1975. AMS Survey data show a slight increase in the number of full-time faculty members, from fall 1975 to fall 1978 (roughly 1.1% increase per year). During the same three-year period, the number of part-time faculty members reported decreased by about 4% (slightly over 1% decline per year).

About 75% of part-time mathematics faculty members in the reporting departments also hold another job full-time. This includes about 38% who are high school teachers, 12% with another full-time, two-year college position, and 25% employed by business, industry, or government.

As noted above, mathematics course enrollments increased at about 3% per year during 1975-1978. The number of sections of mathematics courses taught increased at about 2% per year from 1975 to 1978. Measured in terms of the ratio of either course enrollments per faculty member or sections per faculty member, there has been an overall increase in teaching load. About one-quarter of all sections of mathematics courses are taught by part-time faculty members.

Of the full-time mathematics faculty members for 1978, about 24% are women, according to Table 2. In fall 1975, about 20% of the full-time faculty members were women. Of the part-time mathematics faculty members reported for fall 1978, about 36% are women, compared to 27% reported for fall 1975.

About 13% of the two-year college mathematics faculty members reported for fall 1978 have doctoral degrees, compared to 11% reported for fall 1975 by the CBMS Survey. No increase in the size of the doctorate-holding faculty was reported for fall 1978, in contrast to previous years.

About 6% of current full-time two-year college mathematics faculty members were reported as newly hired for fall 1978. Only about one-sixth of those newly hired came directly from graduate schools. Nearly three-fourths of those newly hired came from teaching positions in four-year colleges, other two-year colleges, secondary schools, or part-time in the same department. (New faculty members were drawn about equally from each of these four sources.) Only about 7% of newly hired faculty members came from nonacademic positions, compared to 12% two years earlier. This probably reflects the unusually strong demand in industry during 1978 for computer scientists, statisticians, and applied mathematicians, and the more attractive salaries frequently offered by industry.

Among those full-time members of the faculty reported as leaving between fall 1977 and fall 1978, about 25% retired or died. Another 25% took nonacademic jobs, while another 40% moved to other full-time teaching positions. About 10% returned to graduate school or to part-time work.

Salary data. The Survey questionnaires asked for information on salaries including a minimum, median, and maximum salary figure both for staff members with doctorates and for those without doctorates. Annual salaries of full-time faculty members for the academic year of 9-10 months were sought. In Table 3 the data in the parentheses give the range of the middle fifty percent of salaries reported. The figures outside the parentheses represent the minimum and maximum salary listed by any reporting institution.

<table>
<thead>
<tr>
<th>TABLE 3 – SALARIES (in hundreds of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977–1978</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Nondoctorate</td>
</tr>
<tr>
<td>Doctorate</td>
</tr>
</tbody>
</table>

<p>| 1978–1979                                  |
|                                           |</p>
<table>
<thead>
<tr>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondoctorate</td>
<td>73(122–169)</td>
<td>144–192</td>
</tr>
<tr>
<td>Doctorate</td>
<td>106(155–204)</td>
<td>160–217</td>
</tr>
</tbody>
</table>

114
LETTERS TO THE EDITOR

EDITORS’ NOTE: The author of the following letter states that he has long been a student of Jewish history as well as the political history of the Soviet Union.

1. The accusations of antisemitism in Soviet higher education, in the letter signed by a group of esteemed mathematicians, which appeared in the NOTICES of November, 1978, are drastic and shocking. I submit, however, that sadly, those accusations are based upon a rather narrow aspect of a much broader situation in Soviet higher education which, when understood, yields a different perspective of the matter.

It is stated in the letter that Jewish students are barred from entry into the higher educational institutions at Moscow, Leningrad, Kiev, and Odessa. These four cities, mentioned in the letter, are, not accidently, the largest centers of concentration of Jews in the Soviet Union. The more general fact is that an analogous situation pertains to the entire higher education student body, at present of the order of six million, in the Soviet Union.

The essential fact is that large numbers of students of non-Russian ethnic populations, Ukrainians, white Russians, Lithuanians, Uzbeks, etc., are barred, for political reasons, from entry into the higher educational institutions in their own non-Russian ethnic republics, while on the other hand large numbers of Russian students are barred from the higher educational institutions in Russian cities, such as Moscow and Leningrad. The other aspect is that the non-Russian students have no special difficulty entering into all other Soviet higher educational institutions except those situated in their own ethnic republic. And likewise, the students of Russian ancestry have no difficulty entering into the higher educational institutions in the non-Russian ethnic republics. Analogously, the Jewish students can enroll in all other higher educational institutions in the Soviet Union except in the cities of large Jewish concentration. And the totality of Soviet higher educational institutions, overwhelmingly devoted to the natural sciences, number in the thousands.

2. This state of affairs in the Soviet higher educational system goes way back to the early 1930s and has been known for a long time to some researchers in the West. For instance, in a book on the subject entitled, "Education and Professional Employment in the USSR" authored by Nicholas DeWitt, then with the Russian Research Center of Harvard University, and published under the auspices of the National Science Foundation in 1961, DeWitt wrote:

"... this provides further statistical proof that substantial numbers of students of non-Russian nationalities are enrolled in higher educational establishments outside their own republics, and at the same time a substantial proportion of the higher education students in each republic are of Russian rather than local nationality...", p. 356.

And further:

"...It is known that from the very inception, in the early 1930s, of the planning system for the training of professional personnel there existed so-called 'inter-regional balances' governing admissions of new students and the placement of graduates. This was tantamount to a system of geographic and nationality quotas...", p. 357.

DeWitt writes of "cultural Russification". In reality the aim is a much broader one.

3. The policy underlying the student "population exchange" in the Soviet Union is an old one, going back centuries in Russia. The policy aims at the solution of the major political problem in Czarist Russia since the 17th century and still extant in the Soviet Union today. This is the historical problem of the territorially concentrated non-Russian multi-national entities. It was this historically shaped political phenomenon in Russia which constituted the constant source of centrifugal political forces in the empire, and was the major cause for the maintenance of autocratic centralized rule in Czarist Russia, as it is still true to a considerable extent in the Soviet Union today.

Since the 17th century a major policy of Russian rulers was not merely cultural Russification but, far more importantly, the assimilation of the non-Russian national minorities with the Russians as well as between themselves. The essential tool was population exchange. Young Russians were induced via lucrative positions to settle permanently and raise a family in non-Russian minority territories, such as the Ukraine, while non-Russians were induced in turn to settle in Russian cities.

By and large, the Soviet leaders continued this policy to an even greater extent particularly via placement of the new graduates from the higher education and secondary technical institutions. In addition, however, the Soviet policy makers, starting in the early 1930s, accelerated and are continuing to accelerate ever more so the process via an ever increasing tempo of intermarriage of the young, i.e., intermarriage via mixing of students in the higher educational institutions. The irreversible assimilation through

Letters submitted for publication in the NOTICES are reviewed by the editorial committee whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and the publication of the earliest issue of the NOTICES in which it could appear. The committee adopted a policy that the NOTICES does not ordinarily publish complaints about reviews of books or articles, although, following an instruction from the Council, rebuttals and correspondence concerning reviews in the Bulletin will be considered for publication. Letters submitted for consideration by the editorial committee should be mailed to the Editor of the NOTICES, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.
intermarriage is achieved by mixing the students in accordance with established quotas calculated so that the probability of a student meeting a potential mate of a different nationality is maximized (optimized, within realistic constraints). The students being at the age when, to repeat a Biblical phrase, "One leaves father and mother and adheres to the mate," nature does the rest.

At present about 1/3 of the young in the Soviet Union receive a higher education, overwhelmingly (over 80%) in the natural sciences. If about 1/2 of the students (in the last year or two) of the specialized secondary technical institutes are added, the total is about 50% of the youth. And it is this total of about one-half of the youth that the Soviet policy makers have at their disposal to manipulate for the purpose of maximizing intermarriage. Moreover, this group of 50% of Soviet youth, overwhelmingly educated in the natural sciences, constitute the elite in Soviet society. Inasmuch as at most only about 2% of the youth in prerevolutionary Russia were enrolled in higher educational institutions, this exceptional tool for rapid assimilation through intermarriage of the young, was beyond the grasp of the Czarist rulers.

The essential and ultimate aim of the Soviet political leaders is to reduce the territorially concentrated ethnic populations to relatively small minorities in their respective republics. This aim is apparently being achieved fairly rapidly. It seems that in the eastern Ukraine and in eastern White Russia, in Uzbekistan and in other minority republics, the native minorities are dwindling rapidly. In the Baltic lands and in the western Ukraine the assimilation of the population is not that advanced, since these lands were annexed to the Soviet Union only at the end of World War II.

It is a foregone conclusion that scientists who occupy important positions in the Soviet higher educational system, such as the eminent mathematicians Vinogradov and Pontryagin, have a full understanding of the basic policy and carry it out. Possibly, they even rationalize that the reduction of the ethnic groups everywhere to small minorities in the lands of their ancestors, will ultimately allow decentralization of power in the Soviet Union, following at last the historically evolved pattern in the western, particularly in the Anglo-Saxon countries.

4. The Soviet Jews, a population of about two million at present, are not a territorially concentrated ethnic group and do not constitute any political danger and never did. And yet, the Soviet policy is to assimilate, and this in a most rapid manner, the majority of Jews in the country through intermarriage of the young. Hence the policy of blocking the enrollment of Jewish students in the universities in the centers of major Jewish concentration, at Moscow, Leningrad, Kiev, and Odessa. On the other hand, Jewish students are welcome for instance at the University of Novosibirsk. For the probability of "Jewish boy meets Jewish girl", which is to be minimized, is certainly much smaller at Novosibirsk than at Moscow.

The motivation for the policy of assimilation of the Soviet Jews is due to the utilization of the Jews, going back to the time of Lenin, as the vanguard in the vast scientific-technical renaissance started in the Soviet Union six decades ago. On the eve of World War II, about 500 students out of 100,000 of the total population studied in the higher educational institutions in the Soviet Union, while about 4,500 out of 100,000 of the Jewish population were enrolled in those institutions. The rate of utilization of the Jewish group, as compared to the non-Jewish population, in the Soviet scientific-technical renaissance, was therefore of the order of 10:1 and, as compared to some other ethnic groups, was even higher. Since at the time the Jews constituted about 2% of the total Soviet population, the Jewish students constituted about 20% of the entire student enrollment in the country. This was not a small factor underlying the Nazi policy of the murder of the Jews in Europe, above all in the Soviet Union.

The utilization of the Jewish group at a rate of 10:1 as compared to the non-Jewish population in the sphere of higher education in the Soviet Union, started in Lenin's time, was not something completely new in the history of the Jews in Europe, particularly since the advent of the Industrial Revolution. In the Russian universities in 1890 (and in some other German states) the number of students per 100,000 of the population of the respective denominations were: Catholic - 33, Protestant - 58, Jews - 519, with the Catholics, Protestants, and Jews comprising about 40%, 58% and 2% of the total population respectively. Thus toward the end of the 19th Century the rate of the utilization of the Jewish group in higher education (and in the professions) in Prussia was also 10:1 as compared to the non-Jewish population. By and large the same was true at the time also in some other German states and somewhat later also in the other two countries with the largest Jewish concentration in Europe, Austria-Hungary and Russia.

Today about 2,400 out of 100,000 of the general population are enrolled in the Soviet higher education institutions, while about 4,500 of Jewish students out of 100,000 of the Jewish population—which is about the maximum possible and had already been reached nearly forty years ago—are enrolled in the same.

Since, due primarily to rapid assimilation, the Jews at present constitute only about 0.75% of the total Soviet population, the Jewish students today constitute about 1.5% of the total number of students in the Soviet higher educational institutions vs. 20% forty years ago. The Jews no longer constitute a vanguard in the scientific-technical renaissance in the Soviet Union, as they did forty years ago, or even as they did for a number of years after World War II.

But certain accumulated effects of the past are still extant. The Soviet policy makers sought in every way to obliterate the perception of the general population of the enormous role of the Jews in the vast scientific-technical revolution in the Soviet Union since the time of Lenin. But it was, of course, not possible to conceal the phenomenon 100%. The envy naturally gave rise to hatred of the Jews. Given the sad centuries-old history of political antisemitism in Czarist Russia, particularly in the Ukraine, the hatred toward the Jewish scientists presumably became even more inflamed.
Since the role of Jews as the vanguard in the scientific renaissance is over, the Soviet authorities are now moving to eliminate the accumulated effect of the past, which is presumably conceived as an hindrance to the basic policy of general assimilation. Hence the policy to assimilate the Jews most rapidly through intermarriage, with perhaps 10% of the "hopeless" Jews eliminated through emigration—voluntary, or in some cases perhaps even forced. In particular, since Jewish names in the scientific sphere are a concrete reminder of the past, there is now great pressure being exerted upon the scientifically trained with typically Jewish names to change them.

By and large this seems to be, at least in general outline, the situation in the Soviet higher educational system. It is not at all simple, and many seemingly strange acts are the results of a basic and far reaching political policy rather than antisemitism.

M. Yachter
Cranbury, N. J.

NOTE: The following pair of letters was submitted by Professor Lang for publication in the NOTICES. The material in the November 1978 issue, referred to in these letters, appears on pages 481–488. Additional material on the same subject will be found on pages 489–494 of the November 1978 issue, on pages 61–63 of the January 1979 issue, and on pages 118–121 of this issue of the NOTICES.

2 November 1978

Dear Dr. Atkinson,

In the presentation given to the mathematical community in the November NOTICES of the AMS, you state:

But there is within the mathematical community a general consensus that, ... another mathematical science research institute, similar but not identical to the famous Institute for Advanced Study, should be established.

As we all know, this assertion is false. It may have been your opinion once, but very likely does not reflect your opinion now. It should not have been printed without an appropriate explanation of the way things evolved, honestly and straightforwardly. Sending such an explanation for publication in the next issue of the NOTICES would be extremely desirable.

In a similar vein, the purpose of the presentation was not only to "inform" the community as stated in the opening box signed by Krumhansl, but also to "consult" the community, and unfortunately, one has to wait till p. 488 to get assured that our views will be "carefully considered." Again this reflects an evolution in the thinking of people at NSF, and it is unfortunate that both "consultation" and "information" could not have had equal status in the box. Of such things misunderstandings are made.

I hope you will send a brief statement to take care of both points. Thanks in advance.

Serge Lang
Yale University

November 17, 1978

Dear Professor Lang:

Thank you for offering me the opportunity to comment on the history of the proposed Mathematical Sciences Research Institute.

The material in the November 1978 NOTICES of the AMS is presented in chronological order, with the earliest documents appearing first. Unfortunately, this may not be evident since the dates no longer appear on some of the documents. My statement "there is within the mathematical community a general consensus..." was contained in a memorandum presented to the National Science Board in March 1978. This statement seemed to be correct at the time, given the discussions within the NSF Mathematical Sciences Advisory Panel, letters received in response to the news item in the January 1978 Mathematical Intelligencer, reaction to the presentation by Dr. William H. Pell at the Atlanta meeting of the AMS and other available information. Our perception was that the mathematicians' reservations had to do with the priority to be assigned to such an institute.

However, in view of the ensuing debate I agree that my statement does not have the same currency today. In this regard, I shall explicitly state the message which we hoped to convey via the materials printed in the NOTICES: we did become aware of the differences of opinion on the Institute and have sought further advice from the community on research priorities. Dr. Krumhansl and I will continue to keep you and your colleagues informed of our activities on this matter and other future issues.

Please feel free to quote from this letter as you see fit.

Richard C. Atkinson
Director, N.S.F.
NEWS AND ANNOUNCEMENTS

NSF SUPPORT OF MATHEMATICAL SCIENCES

The following letter was written by Dr. James A. Krumhansl, Assistant Director for Mathematical and Physical Sciences and Engineering of the National Science Foundation. It has been distributed widely to heads of departments in the mathematical sciences in U.S. colleges and universities. The text of the announcement to which Dr. Krumhansl refers, follows his letter.

Dear Colleague:

The enclosed announcement, Alternative Modes of Support in the Mathematical Sciences, was part of a presentation made by Dr. John R. Pasta, Division Director, Mathematical and Computer Sciences, It was made on my behalf at the annual winter meeting of the American Mathematical Society and the Mathematical Association of America last month. The announcement reflects my feelings on the relationship between solicited and unsolicited proposals by the mathematical sciences community and the need for imaginative proposals of all kinds to provide as many options as possible. Only in this way can we maintain the first-rank position of the mathematical sciences in this country. You may be assured that such proposals will receive careful consideration in determining the future directions of mathematical sciences support in the Directorate. The proposals will serve the additional purpose of identifying the concerns and remedies recommended by the community. I see this mechanism as a means of establishing a closer working relationship between the National Science Foundation and the mathematical sciences community.

Sincerely yours,

J. A. Krumhansl

Announcement to Members of the Mathematical Sciences Community

Subject: Alternative Modes of Support in the Mathematical Sciences

1. Purpose. In response to a need perceived and expressed by the Mathematical Sciences Advisory Subcommittee and by an important segment of the U.S. mathematical sciences community, the National Science Foundation announces its intent to explore modes of research support alternative to the individual mathematical sciences research project grant.

2. Applicability. This announcement embraces all program activities of the Mathematical Sciences Section as set forth in its various announcements, except proposals for postdoctoral research fellowships, which are covered in publication NSF 78-68, and proposals for a Mathematical Sciences Research Institute, which is the subject of the publication NSF 78-77. This issuance is not meant to discourage requests of the customary project type, which have proved so effective in the past, nor is there any wish to erode in any serious way the mechanisms now in place. It is unlikely that evaluation of projects can be carried out in a competitive way for funding before Fiscal Year 1980.

3. Policy. The Foundation is the agency charged with the responsibility for preserving and maintaining the strength and vitality of the country's mathematical research apparatus, a structure which has evolved over the past several decades to the first rank. In carrying out this task, the Foundation continually reviews and reassesses its programs and processes. The research scene in the mathematical sciences has changed over the past decade for a number of reasons—some demographic, some economic, and some from temporal anomalies in funding patterns. It is the problems arising from these changes in the research environment that the Foundation is bound to address.

4. Method. Suggestions for alternate modes of support should be in the form of proposals. Owing to the exploratory, innovative nature of these submissions, there is no prescribed format and no deadline, but the NSF publication "Grants for Scientific Research," NSF 78-41, should be used to provide general guidelines.

5. Content. Freedom in method of presentation and subject material is to be the rule. On the other hand, the proposal must contain clear statements of what problem is being addressed, evidence that such a problem exists and is a clear threat to maintenance of present or future research effectiveness, and cogent arguments that the proposed solution is an effective and economical way of dealing with the problem. It is desirable that a global or extensible view of the problem be addressed, although it is understood that the strengths peculiar to the submitting institution will shape the proposal.

6. Expected Consequences. Although the Mathematical Sciences Section has always wished to encourage imaginative proposals of this type, the budgetary constraints and the nature of earlier research activities militated against support of these variant modes and favored maintaining the more usual grant mechanisms. The current budgetary picture does not preclude response to properly documented problems of serious nature. We now ask the mathematical sciences community to apply their individual and collective efforts, guided by their own perceptions, to help the National Science Foundation in its goal to maintain U.S. supremacy in the mathematical sciences. In its turn, the Foundation's staff will reciprocate in as thoughtful and responsive a way as possible within the boundaries of budgetary constraints and NSF regulations.

7. Inquiries. Questions about this announcement should be directed to:

Mathematical Sciences Section
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550
202-632-7377
ELECTION RESULTS

In the election of 1978, George D. Mostow was elected to the position of vice-president for a term of two years. In this position he is an ex officio member of the Council. There were five persons elected to positions of member-at-large of the Council for a term of three years, namely, Chandler Davis, Robert P. Gilbert, Johan H. B. Kemperman, Karen Uhlenbeck, and Daniel H. Wagner. All candidates for uncontested offices were elected. These were as follows:

Secretary: Everett Pitcher
Associate Secretary: Raymond G. Ayoub
Treasurer: Frank T. Birtel
Associate Treasurer: Franklin P. Peterson
Publication Committees:
Bulletin: Isadore M. Singer
Colloquium: John W. Milnor
Mathematical Reviews: Elwyn R. Berlekamp
Mathematical Surveys: Donald W. Anderson
Mathematics of Computation: Daniel Shanks
Proceedings: Lawrence A. Zalcman
Transactions and Memoirs: Michael Artin
Steven Orey
R. O. Wells, Jr.

The term of the Secretary, Associate Secretaries, Treasurer, and Associate Treasurer is two years. The term of the editors is three years except for the editors of the Proceedings and the Transactions, where it is four. All are ex officio members of the Council.

Robert G. Bartle and Carl M. Pearcy were elected to the Committee to Monitor Problems in Communication. That Committee subsequently elected George B. Seligman to be its Chairman, as such he is an ex officio member of the Council.

The members elected Alex Rosenberg to be a Trustee for a term of five years.

There were four members elected to the Nominating Committee, namely, Richard D. Anderson, Judy Green, Paul R. Halmos, and Victor L. Klee, Jr.

RESOLUTION ON NSF SUPPORT

At its meeting on January 23, 1978, the AMS Council passed the following resolution:

"After deliberation of various new modes of National Science Foundation support that would contribute most to the health and excellence of American mathematics, the Council of the American Mathematical Society has reached a broad consensus on the following ordered list of priorities:

1. Expansion of the new postdoctoral fellowship program for Ph.D.'s within five years of their degrees. This program might include postdoctoral research instructorships at universities which have strong mathematicians on their faculties. The total number of new awards of these types added to the existing number of research instructorships at strong mathematics departments should permit one hundred appointments of new Ph.D.'s annually.

2. A postdoctoral program for mathematicians of Ph.D. age exceeding five years.

3. Increased numbers of summer mathematics institutes, special year programs in topics which are ripe for development, and other forms of mathematical sciences research institute concepts.

4. Enrichment of grants and increasing the number of grants."

BLIND REFEREEING

No Longer Mandatory for Proceedings

The Council adopted the following policy at its meeting of 23 January 1979.

1. Blind refereeing is abolished as a policy for the Proceedings of the American Mathematical Society.

2. Any author who so requests and who provides a blind copy of a manuscript submitted to the Proceedings, will have the manuscript refereed blind.

Effective immediately, a manuscript newly submitted to the Proceedings will be refereed blind if and only if it is accompanied by a blind copy for the referee.

NSF POSTDOCTORAL FELLOWSHIPS

At its November 1978 meeting, the National Science Board approved a postdoctoral fellowship program in the mathematical sciences, to begin in the fall of 1979. The fellowships will be for periods of one or two years, will carry a yearly stipend of $15,000, and can be held at the institution chosen by the fellow. Selections are based mainly on the ability of the applicant, the likely impact on the future scientific development of the applicant, and the scientific quality of the research likely to emerge. Details were described in the Mathematical Sciences Postdoctoral Research Fellowships 1979 Announcement (publication NSF 78–68), which was widely distributed by the NSF to U.S. colleges and universities. Deadline for application was February 1, 1979. There will be approximately fifteen fellowships awarded; they will be announced by March.

Applications were evaluated, under a contract with the NSF, by a panel of fifteen mathematical scientists appointed by the American Mathematical Society, the Institute of Mathematical Statistics, and the Society for Industrial and Applied Mathematics.
A MATHEMATICAL SCIENCES RESEARCH INSTITUTE
(Excerpts from NSF Project Solicitation)

I. Introduction. In order to preserve and strengthen the intellectual vigor of the nation’s current effort in the mathematical sciences, the Foundation is considering the establishment, on a five-year trial basis, of an institute for research in the mathematical sciences. The primary purpose of this institute will be to stimulate research in diverse problem areas among both able mature mathematicians and promising young mathematicians from all parts of the country. The solution of research problems is frequently rendered easier by the coordinated efforts of groups of mathematical scientists, sometimes from the same and sometimes from different subfields of the mathematical sciences. At the same time, the knowledge and research expertise of the participating scientists are enhanced, and the boundary of mathematical knowledge in the field of research problems is pushed forward in something approaching a maximally efficient way.

II. Description of the Institute. The Institute under consideration will operate throughout the year and provide an environment in which mathematical scientists from different subdisciplines, locations, and age groups can interact. While providing an atmosphere conducive to the general exchange of mathematical ideas, its principal focus would be on concentrated activity in a few areas of great current mathematical interest. Such attention to some selected areas might extend through several years, while other areas might warrant attention for a shorter time.

Areas of applied mathematics as well as core mathematics would be expected to receive attention. Even in years in which the major activity of the Institute is in an area of core mathematics, it is expected that application of that core subdiscipline would be encouraged. Areas of concentration would be announced well in advance.

The advantages of the Institute’s being located near a major resource or resources of mathematical research are obvious. This might mean that the Institute would be located on a campus or at a nearby off-campus location. The leadership of the Institute would be provided by a director and perhaps an associate director, as well as a governing committee. There would be approximately forty (40) members of the Institute at any one time, all temporary. Of these, perhaps eight would be major research figures, about twice that number strong, well-established researchers, and the remainder, postdoctorals or their equivalents who have given unequivocal evidence of strong research capability. Foundation estimates indicate that the cost of operating the Institute will be approximately 1.5 million dollars per year. However, proposers should describe programs with budgets necessary to accomplish the aim of the project.

III. Description of Foundation Support. Initial funding would be provided in FY 1980. The Foundation contemplates making one award; however, the Foundation reserves the right to make no award. Funding is proposed at approximately 1.5 million per year for a trial period of up to five years. Continued support would be subject to the availability of funds and an annual review of satisfactory progress.

Funds provided by the Foundation would cover, in large part, the salaries as well as travel and living expenses of nongovernment visitors, secretarial and related costs, computing and library expenses, and costs of office space.

While cost sharing is not mandatory, it is not precluded.

IV. Proposal Submission Information.
A. Who May Submit. Proposals are invited from U.S. academic or nonacademic, profit or nonprofit organizations, or combinations thereof. Categories of applicants are discussed more fully in NSF 78-41A, Grants for Scientific Research. However, participation in the preparation of proposals by a group of institutions in a consortium-like arrangement has some advantages.

B. Timing of Submission. Proposers should notify the Foundation by April 1, 1979, of their intent to submit a proposal.

Proposals must be received at the National Science Foundation on or before August 1, 1979. Twenty copies of the formal proposal should be addressed to:

Central Processing Section, Room 223
Mathematical Sciences Research Institute, MCS
National Science Foundation
Washington, D.C. 20550

C. Important Considerations. Research areas of specific problems in the mathematical sciences which appear to be ripe for exploitation or in need of concerted effort form suitable subjects for the attention of the Institute. It is anticipated that the Institute will deal with two or three areas (perhaps related) at a given time and that attention will shift gradually to other areas as time passes. In order to allow the choice of areas of emphasis to be mathematically rather than administratively driven, the selection procedure should be based upon written proposals to the Institute from groups of mathematicians who see a particular need and wish to participate in development of the areas.

The question of the extent to which the research efforts of the Institute should be administratively connected to the nearby universities or other resource institutions is left open. While it is felt that physical proximity to lecture rooms, library, etc., is important, it is not necessary that the Institute be housed on campus. If so located, it may be wise to have some physical separation from the institution’s department of mathematics. All of these remarks gain added force if the Institute is to be administered by a consortium.

Particular care must be given to the choice of the Institute director who must have the unalloyed respect and confidence of the mathematical sciences community. He must be known as an able administrator with a wide acquaintance.
with mathematicians throughout the world.

Overall scientific guidance of the Institute should be provided by a committee of scientists from several institutions, not necessarily colleges or universities.

D. Proposal Content. The proposal should state what is hoped will be accomplished and propose a plan for its accomplishment. The personnel involved in the project should be named and the extent of their commitment to it indicated. Information on the central figures who will participate in the project should be included. A description should be given of the proposed method of directing the project, choosing topics for study (see C), getting the project started, maintaining continuity, and choosing visiting participants. The degree to which participation in the project would be open to scientists throughout the community should be explained. A method of disseminating research results throughout the mathematical community should be described. A plan for evaluating the extent to which the Institute met its goal, together with a contingency plan for an orderly phase out, should be included.

The proposal should indicate arrangements for secretarial and related assistance, for office space, and for the use of existing library and computer facilities or the provision for new ones. No major capital expenditures are envisioned. The anticipated expenses of the project and the plan for dealing with them (including other sources of support) should be discussed in detail.

E. Proposal Evaluation. Evaluation of competing proposals will be administered by the Foundation's Mathematical Sciences Section. An award will be made only if a proposal of sufficient merit is received; that is, NSF reserves the right to make no award.

1. Evaluation criteria of approximately equal weight will include:

(a) the qualifications of the scientific personnel involved in guiding the project, including those of the proposed director;
(b) the nature of the commitment of the proposed leadership;
(c) the estimated quality of the research to be produced;
(d) the ability of the proposers to attract high quality scientific membership with appropriate interests;
(e) the suitability of location with regard to contact with leading mathematical scientists and access to computing and library facilities, office space, and housing;
(f) the suitability of the method of directing the project, choosing topics for study (see C), getting the project started, maintaining continuity, and choosing participants;
(g) the suitability of the plans for opening the project to scientists throughout the scientific community and disseminating research results;

(h) the suitability of the plan for evaluating the extent to which the Institute met its goal, together with the contingency plan for an orderly phase out;
(i) the cost of the project.

2. Proposals for the Mathematical Sciences Research Institute will be compared not only with each other but also be compared with proposals for other options in support of mathematical research and, in particular, for those encouraging development of recent recipients of the doctorate. These options may consist of, but are not restricted to, more postdoctoral research support, group support of postdoctoral research support, peripatetic institutes, and special research years.

Further details on the form in which proposals should be submitted together with special NSF requirements for organizations which have not received NSF support within the last two years, are given in the booklet Project Solicitation, A Mathematical Sciences Research Institute (Closing Date: August 1, 1979), from which the preceding paragraphs were extracted. Copies of the complete booklet may be requested from the Mathematical Sciences Section, National Science Foundation, Washington, D.C. 20550.

USPEHI COMMUNICATIONS TRANSLATED

A letter to the Editor in the November 1978 issue of the NOTICES (p. 496) reported that the present English translation of Uspehi Matematicheskii Nauk does not include the Uspehi section of short communications, so that this material "has been almost inaccessible to anyone outside the USSR." The English translation of Uspehi is published by the London Mathematical Society (LMS) under the title Russian Mathematical Surveys. The Publications Secretary of the LMS reports that the London Mathematical Society was aware of this situation, and arrangements had already been made for translations of the short communications to be included in the Russian Mathematical Surveys starting with volume 33 (1978).

AAAS MASS MEDIA

SCIENCE FELLOWS PROGRAM

The American Association for the Advancement of Science (AAAS) has announced its 1979 Mass Media Science Fellows Program for outstanding natural and social science graduate-level students.

Fellows will work as reporters, researchers, and production assistants for ten weeks during the summer at radio stations, television stations, newspapers, and magazines throughout the U.S. They will have the opportunity to participate in the news-making process, to increase their understanding of editorial decision-making and information dissemination, and to develop skill in conveying to the public a better understanding and appreciation of science and technology. Stipends and travel allowances are paid by the AAAS. The application deadline is March 10, 1979. Further information may be obtained from: Lyn Chambers, Project Director, Mass Media Science Fellows Program, AAAS, 8th Floor, 1776 Massachusetts Avenue, N.W., Washington, DC 20036.
An amendment to the 1967 Age Discrimination in Employment Act was passed during the 1978 session of the U.S. Congress. With certain exceptions, this legislation prohibits private and nonfederal-government employees from retiring an individual involuntarily before age 70. The new law became effective on January 1, 1979. However, a 3½ year delay was allowed in case of tenured faculty members in colleges and universities. After July 1, 1982 all faculty members may postpone retirement to age 70.

The American Association of University Professors (AAUP) formed a Special Committee on Age Discrimination and Retirement, concerned with this matter. A report by the Special Committee entitled "The Impact of Federal Retirement-Age Legislation on Higher Education" appeared in the AAUP Bulletin, September 1978, pp. 181-192. About two-thirds of the faculty members in four-year colleges and universities are in institutions which presently have retirement ages of 65 or earlier. Hence, there is potentially a significant effect on the annual number of retirements, particularly during the transition period 1982-1987. Various studies indicate a trend toward earlier retirement, which would mitigate the effect on new hiring of increasing to 70 the mandatory retirement age. For instance, in 1976 about one-third of TIAA-CREF annuities began before age 65. Inflation has seriously eroded the annuity income of already-retired faculty members, and appears to be the major obstacle to increasing the number of early retirements.

The AAUP report considers several models for estimating the effects of changing the mandatory retirement age on hiring of new faculty members, assuming in one model constant total faculty size and in another constant total faculty compensation budget. If constant total faculty size is assumed, an overall reduction in new hires of about one-third by 1987 is indicated, with less severe effects in subsequent years. There would be a more serious negative effect on new hiring if constant total compensation, rather than constant size of faculty, is assumed.

The effect of the new legislation will fall unevenly on institutions, depending on whether their faculties are relatively young or more mature. The AAUP report concludes that the aggregate effect is scarcely so drastic as to constitute a serious challenge to academic tenure. Perhaps more important than the effect of the change in retirement age is the need for institutions to adapt to significant and continuing changes in their faculty age distributions. The impact of these changes far overshadows those produced by the retirement-age change. At the same time, these latter changes simply add to the magnitude of such an adjustment.

The AAUP report does not consider possible variations according to discipline. The 1975-1976 CBMS Survey gave a breakdown by age for the mathematical sciences faculty (see the February 1977 Notices, p. 106). As of fall 1975, CBMS estimated that approximately 30% of the 17,000 individuals constituting the U.S. mathematical sciences faculty were 45 years of age or older:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 and over</td>
<td>850</td>
</tr>
<tr>
<td>55 to 59</td>
<td>850</td>
</tr>
<tr>
<td>50 to 54</td>
<td>1500</td>
</tr>
<tr>
<td>45 to 49</td>
<td>1850</td>
</tr>
</tbody>
</table>

It is persons from these age groups who will reach the mandatory retirement age of 70 before the year 2000.

The American Council on Education recently published a report "Finance and Employment Implications of Raising the Mandatory Retirement Age for Faculty" (Policy Analysis Service Reports, volume 4, number 1, December, 1978). It appears to take a somewhat more pessimistic view than the AAUP report does of the probable effect on new hiring during the mid-1980s.

Wendell H. Fleming

OPENINGS FOR PROGRAM DIRECTORS AT NSF

The Division of Mathematical and Computer Sciences of the National Science Foundation will have openings for Program Directors in two programs: the Classical Analysis Program and the Statistics Program. These positions begin September 1, 1979, for a period of one or two years. They are excepted from the competitive civil service. Applicants should have a Ph.D., in the appropriate field, plus at least six years of successful scientific research experience, a broad general knowledge of the field and some administrative experience are also required. Send biographical summary and statement of interest to Division of Personnel and Management, Attention EX-76-10, Section II, Room 212, National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550.

JOHN H. BARRETT MEMORIAL LECTURES

The John H. Barrett Memorial Lectures will be given this year on May 10, 11, and 12 at the University of Tennessee, Knoxville, by Professor Fred Brauer of the University of Wisconsin. The general title of the lectures will be "Some questions in differential and integral equations arising from populations growth problems."

Several other invited lectures are planned including one by Professor Constantin Corduneanu who is visiting the University of Tennessee this year. Sessions of contributed papers will be held on May 11. Abstracts should be sent to John S. Bradley, Department of Mathematics, University of Tennessee, Knoxville, Tennessee 37916.
SPECIAL MEETINGS

THIS SECTION contains announcements of meetings of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

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

IN GENERAL, announcements of meetings held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadline dates for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. All communications on special meetings should be sent to the Editor of the NOTICES, care of the American Mathematical Society in Providence.

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

Program: The year will be devoted partly to algebraic geometry (in particular vector bundles of low rank on projective spaces) and partly to operator theory (in particular invariant subspaces).
Organizers: Dan Laksov, Per Enflo.
Deadline for Applications: Applications for participation and financial support should be sent on a special form by April 1, 1979. Limited funds are available for grants.
Information: Lennart Carleson, Institut Mittag-Leffler, Aurevagen 17, S-18262 Djursholm, Sweden.


MARCH 1979

14-16. Twelfth Annual Simulation Symposium, Causeway Inn, Tampa, Florida. (January 1979, p. 72)
15-17. Algebra and Ring Theory Conference, University of Oklahoma, Norman, Oklahoma. (November 1978, p. 505)
18-23. Conference on Geometry (Foundations) and Differential Geometry, University of Haifa, Haifa, Israel. (October 1978, p. 440)
26-28. Workshop on Continuous Lattices III, University of California, Riverside, California. (January 1979, p. 72)
Principal Lecturer: Roger Brockett, Harvard University.
Program: Professor Brockett will deliver ten lectures during the week. Other lectures on complementary subjects will be given by Wendell Fleming (Brown University), Jerrold Marsden (University of California, Berkeley), Sanjoy Mitter (Massachusetts Institute of Technology), George Papanicolaou (Courant Institute), and Eugene Wong (University of California, Berkeley).
Support: Limited financial aid for participants is expected from the National Science Foundation.
Information: Arthur Krener, Department of Mathematics, University of California, Davis, California 95616.

29-30. Symposium on Applied Mathematics, Oklahoma State University, Stillwater, Oklahoma.
Principal Lecturers: P. J. Davis and H. O. Pollak.
Program: In addition to the principal lectures the program will feature: Papers on differential equations and applications presented by G. J. Etgen, R. C. Grimmer, S. P. Hastings, D. B. Hinton, V. Lakshmikantham, and W. S. Loud; a panel discussion on the mathematics curriculum, moderator T. Cairns, panelists E. Witterholt (Cities Service Co.), D. Pate (FAA), T. Campbell (Tinker AFB), L. Gitzendanner (Magnetic Peripherals Inc.); contributed papers (fifteen minutes) on any aspect of applied mathematics such as recent research in applied mathematics, applications of mathematics in industry, and curriculum development in applied mathematics.
Information: Jeanne L. Agnew, Department of Mathematics, Oklahoma State University, Stillwater, Oklahoma, 74074.

Program: Hour lectures will be given by R. C. Baker (University of Colorado), Paul Erdős (Hungarian Academy of Sciences), Dorian Goldfield (Massachusetts Institute of Technology), Larry Joel Goldstein (University of Maryland), Neil Hindman (California State University, Los Angeles), Marvin I. Knopp (Temple University), John L. Selfridge (Mathematical Reviews), and Harold N. Shapiro (Courant Institute).
Contributed Papers: There will be sessions for fifteen- and thirty-minute presentations of contributed papers. Deadline for abstracts is March 20, 1979.
Support: Some support for travel and subsistence may be available.
Information: Melvyn B. Nathanson, Department of Mathematics, Southern Illinois University, Carbondale, Illinois 62901.

APRIL 1979

2-6. Tenth Southeastern Conference on Combinatorics, Graph Theory and Computing, Florida Atlantic University, Boca Raton, Florida. (January 1979, p. 72)
3-5. 1979 ACM SIGNAM Meeting on Numerical Ordinary Differential Equations, Department of Computer Science, University of Illinois at Urbana-Champaign, Urbana, Illinois. (October 1978, p. 440)

Speakers: Evening lectures will be given by W. Browder (Princeton), K. Roth (Imperial College, London); and H. Bauer (Erlangen/Nürnberg).
Program: There will be lectures in the morning; the afternoon will be reserved for meetings of splinter groups on various branches of mathematics. Attendees are invited to contribute short papers for these sessions.
Information: C. B. Thomas, Colloquium Secretary, Department of Mathematics, University College London, Gower Street, London WC1E 6BT, England.

5. Edinburgh Mathematical Society Meeting, Stirling, Great Britain.
Information: Department of Mathematics, James C. Maxwell Building, The King's Buildings, Edinburgh, EH9 3JZ, Great Britain.

7. Twenty-first Algebra Day, Carleton University, Ottawa, Canada.
Speakers: Bernd Fischer (Institute for Advanced Study); Roger C. Lyndon (University of Michigan, Ann Arbor); Lance W. Small (University of California, San Diego).
Information: John Poland, Department of Mathematics, Carleton University, Ottawa, Ontario, Canada K1S 5B6.


16-20. Conference on Several Complex Variables, Princeton University, Princeton, New Jersey. (January 1979, p. 72)

Program: The emphasis will be on expository talks on current research. The main speaker will be Victor Klee. The minisymposium is sponsored by the Idaho State University Department of Mathematics. Some travel funds are available for speakers and participants. Call for Papers: Abstracts should be sent to the address below.
Information: Steven Anacker, Department of Mathematics, Idaho State University, Pocatello, Idaho 83209.

Information: L. L. Barinka, Babcock & Wilcox, P. O. Box 1260, Lynchburg, Virginia 24505.

30-May 2. Eleventh Annual ACM Symposium on Theory of Computing, Atlanta, Georgia. (November 1978, p. 505)

MAY 1979

1-July 31. Warwick Symposium on Diffeomorphisms with Application to Foliations, Mathematics Institute, University of Warwick, Coventry, England.
Support: Science Research Council.
Program: Visitors will include A. Douady, G. Hector, M. Herman, A. Katok, F. Laudenbach, V. Poenaru, F. Sergaert, D. Sullivan. A more intensive conference will be held during the period July 8-14, 1979.
Information: D. B. A. Epstein, Mathematics Institute, University of Warwick, Coventry CV4 7AL, England.

4-5. Conference on the Scottish Book, North Texas State University, Denton, Texas.
Principal Speakers: S. Ulam, P. Erdős, M. Kac, G. C. Rota, A. Granas, and others.
Program: The Scottish Book is a problem book composed in the 1930's in Lwow, Poland. The problems posed were those which occupied the attention of the group of mathematicians and visitors at Lwow. Most of the problems are due to Banach, Mazur and Ulam. Many others were stated by Eilenberg, Kac, Orlicz, Schauder, Schreier, and Steinhaus. A number of these problems have had a profound influence on mathematics. This conference is devoted to the development and influence of these problems. Ample time will be given for informal discussion.
Information: R. Daniel Mauldin, Mathematics Department, North Texas State University, Denton, Texas 76203.

4-6. Conference in Analysis, Purdue University, West Lafayette, Indiana 47907. (January 1979, p. 72)

Program: The symposium will consist of approximately twelve invited addresses on such topics as numerical methods for computation of fixed points of single- or multi-valued functions, results on existence and stability of fixed points, and applications.
Information: Gladys Moran, Symposium Secretary, Mathematics Research Center, University of Wisconsin-Madison, 610 Walnut Street, Madison, Wisconsin 53706.

14-18. Danish-French Colloquium on Potential Theory, Copenhagen, Denmark.
Organizing Committee: B. Fuglede, C. Berg, G. Forst.
Information: Danish-French Colloquium on Potential Theory, Matematik Institut, Universitetsparken 5, DK-2100 Copenhagen Ø, Denmark.

14-31. First Franco-Southeast Asian Mathematical Conference, Nanyang University, Singapore.
Organizers: Nanyang University and the French Embassy in Singapore, in conjunction with the Southeast Asian Mathematical Society and the Singapore Mathematical Society.
Programme: There will be two research seminars, a Workshop on Combinatorics and Graph Theory and a Workshop on Optimization and Mathematical Programming, to be held from May 14-25, preceding the general conference on mathematics which will be held from May 28-31.
Information: Franco-SEA Conference, Department of Mathematics, Nanyang University, Jurong Road, Singapore 22.

Information: Sekretariatet MIAU/DCAMM Symposium om Anvendt Matematik 1979, Matematisk Institut, Aarhus Universitet, DK-8000 Aarhus C, Denmark.

Tentative Program: H. S. Collins (strict topologies in measure theory), J. Diestel (the Dunford-Pettis property), N. Dunford (applications of operator theory), R. E. Huff (the Radon-Nikodym property), N. J. Kalton (the Orlicz-Pettis property), I. Kluvanek (applications of vector measures), J. J. Uhl, Jr. (the measurability theorem of Pettis).
Information: William H. Graves, Department of Mathematics, University of North Carolina, Chapel Hill, North Carolina 27514.

23-25. Optimization Days 1979, McGill University, Montreal, Canada. (November 1978, p. 505)


26-28. Canadian Mathematical Society 1979 Summer Meeting, University of Saskatchewan, Canada. Invited Speakers: I. Halperin (Toronto) (Jeffrey-Williams Lecturer); B. N. Allison (Alberta); L. W. Baggett (Colorado); J. A. Baker (Waterloo); B. C. Gilligan (Regina); I. Hambleton (McMaster-Princeton); B. Noble (Wisconsin); W. R. Smith (Dalhousie); E. D. Tymchatyn (Saskatchewan); P. Zvengrowski (Calgary). G. L. O'Brien (York) will address a joint session with the Statistical Society of Canada. 

Program: There will be special sessions on Infinite Group Theory (D. Solitar (York), organizer); on Applied Mathematics (R. Manohar (Saskatchewan), organizer); and on Harmonic Analysis (K. F. Taylor (Saskatchewan), organizer).

Call for Papers: Contributed fifteen-minute papers are invited. A summary should be sent before April 30, 1979, to Murray Marshall at the address below.

Information: Y. Cuttle, Department of Mathematics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 0WO.

28-30. Statistical Society of Canada Annual Meeting, University of Saskatchewan, Saskatoon, Canada. Program: Topics will include various areas of statistics and probability theory of interest to statisticians in government, industry or universities. There will be both invited and contributed papers.

Call for Papers: A one-page abstract should be forwarded to the address below before April 1, 1979.

Information: R. J. Tomkins, Program Committee Chairman, Department of Mathematics and Statistics, University of Regina, Regina, Saskatchewan, Canada S4S 0A2.

31-June 6. Seventh Conference of Analytic Functions, Wisia (Carpathian Mountains, Province Bielsko-Biala), Poland. (October 1978, p. 441)

JUNE 1979

4-8. Catastrophe Theory and Its Applications, Salisbury State College, Salisbury, Maryland. Principal Lecturer: Alexander Woodcock. Sponsor: Maryland-DC-Virginia Section of the MAA. Purpose: To make available to teachers in two- and four-year colleges important advances in applicable mathematics.

Information: B. A. Fusaro, Department of Mathematical Sciences, Salisbury State College, Salisbury, Maryland 21801.

5-8. International Conference on Fundamentals of Numerical Computation, Technical University of Berlin, Germany. Program: The following topics will be covered: interval analysis, mathematical foundation of computer arithmetic, rounding error analysis, stability of numerical algorithms. A limited number of short papers will be accepted. Deadline for registration is March 15, 1979.

Invited Speakers: E. Adams (Karlsruhe); R. Albrecht (Innsbruck); J. Herzberger (Oldenburg); D. Klaau (Karlsruhe); U. Kulisch (Karlsruhe); S. M. Markov (Sofia); D. Matsul (Dallas); W. L. Miranker (Yorktown Heights, N.Y.); R. F. Moore (Madison); F. W. J. Olver (College Park); L. B. Rall (Madison); F. Stummel (Frankfurt/Main); Chr. Ullrich (Karlsruhe); J. M. Yohe (Madison).

Scientific Committee: R. Albrecht (Innsbruck); G. Alefeld (Berlin); R. D. Grigorieff (Berlin); U. Kulisch (Karlsruhe); F. Stummel (Frankfurt/Main).


11-13. SIAM 1979 National Meeting, Royal York Hotel, Toronto, Canada. Program: There will be symposia on numerical software, on information networks, and on resource management. The Symposium on Numerical Software will focus on handling problems in many areas of applied mathematics. The organizers are Thomas E. Hull (University of Toronto) and Gene H. Golub (Stanford University). The Information Network Symposium will cover such topics as algorithms, graph theory, information theory, and queueing theory models. The organizer is James McKenna (Bell Laboratories). The Resource Management Symposium will deal with resource depletion and will include such topics as tidal energy systems development, fisheries management, forests management, and problems in discrete optimization. The organizer is Donald A. Ludwig (University of British Columbia).


Information: B. A. Fusaro, Department of Mathematical Sciences, Salisbury State College, Salisbury, Maryland 21801.


Program: A short tutorial course will be given covering a wide range of topics aimed at providing a mathematically mature audience with an overview of the underlying principles of the operation of computers. Topics will include automata and formal languages, programming languages and compilers, computability, analysis of algorithms, information structures, and the design of computing systems. 

Call for Papers: Contributed papers appropriate to the subject are desired. An abstract must be received by May 15, 1979.

Information: Phillip Schmidt, Department of Mathematics and Statistics, University of Akron, Akron, Ohio 44325.

Program: Invited lectures on topics of current research on the relations between finite (simple) groups, finite geometries and combinatorics.
Participation: Limited to about 60 attendees. Some limited financial support will be available.

18-20. Functional Differential and Integral Equations Conference, West Virginia University, Morgantown, West Virginia.
Contributed Papers: Participants desiring to present a short talk should send an abstract by May 10, 1979.
Information: Samuel M. Rankin, III, Department of Mathematics, West Virginia University, Morgantown, West Virginia 26506.

(December 1979, p. 72)

(October 1978, p. 441)

(October 1978, p. 441)

25-29. 1979 International Symposium on Information Theory, Grignano, Italy.
(October 1978, p. 441)

(See ad p. A-264 of this issue.)
Program: The Symposium will review recent major developments in differential geometry and its relation to such areas as nonlinear partial differential equations, complex analysis, algebraic geometry and theoretical physics.
Information: Nora Lee, Department of Mathematics, University of California, Berkeley, California 94720.

Information: G. A. Watson, Department of Mathematics, University of Dundee, Dundee DD1 4HN, Scotland.

Information: J. J. H. Miller or B. Browne, Numerical Analysis Group, Trinity College, Dublin, Ireland.

27-29. LARS/IEEE Symposium on Machine Processing of Remotely Sensed Data, Purdue University, West Lafayette, Indiana.
Information: D. B. Morrison, Laboratory for Applications of Remote Sensing, Purdue University, 1220 Pottery Drive, West Lafayette, Indiana 47906.


2-6. Conference on Low Dimensional Topology, University College of North Wales, Bangor, United Kingdom.

Programme Committee: R. Brown (U.C.N.W.), P. Scott (Liverpool), T. L. Thickstun (U.C.N.W.).
Programme: Topics of interest will be 3- and 4-manifolds, 2-dimensional cell complexes, knots and links, related areas of group theory, hyperbolic geometry.
Residence: 50 places available in a Hall of Residence. Early booking is advisable.
Contributed papers: Abstracts (one page) should be sent preferably not later than May 1, 1979.
Information: T. L. Thickstun, School of Mathematics and Computer Science, University College of North Wales, Bangor LL57 2UW, Gwynedd, United Kingdom.

Information: A. Beauville, Faculté des Sciences, Boulevard Lavoisier, 49045 Angers-Cézex, France.

2-20. Recent Developments in Number Theory, Queen’s University, Kingston, Ontario, Canada.
Principal Speakers: John Coates, Université de Paris Sud, Orsay; Hugh L. Montgomery, University of Michigan, Ann Arbor; Michel Waldschmidt, Université Pierre et Marie Curie, Paris; Enrico Bombieri, Institute for Advanced Study, Princeton.
Program: Part I (July 2-13) consists of three courses of ten lectures each. Professor Coates will speak on p-adic L-functions, Professor Montgomery on the Riemann hypothesis, and Professor Waldschmidt on transcendental numbers. Part II (July 16-20) is a symposium of invited 50-minute lectures and shorter communications, highlighted by a series of five lectures by Professor Bombieri on sieve methods.
Information: Paulo Ribenboim, Department of Mathematics, Queen’s University, Kingston, Ontario K7L 3N6, Canada.

Information and Registration: W. Forster, University of Southampton, Faculty of Mathematical Studies, Southampton, England.

16-20. Sixth International Colloquium on Automata, Languages and Programming, Technical University of Graz, Austria. (January 1979, p. 73)
Topics: Automata theory, formal language theory, mathematical aspects of programming languages, computability theory, computational complexity, analysis of algorithms, semantics of programming languages and data bases, theory of data structures, program verification.

22-August 1. Conference on Noetherian Rings and Rings with Polynomial Identity, Durham, Great Britain.
Information: Department of Mathematics, University of Durham, Durham, DH1 3LE, Great Britain.

22-August 1. Progress in Analytic Number Theory, Grey College, Durham, Great Britain.
Program: Riemann’s zeta function and allied functions; recent advances in the study of prime numbers, of exponential sums and of sieves.
Information: For further information and an invitation write to H. Halberstam, Department of Mathematics, University of Nottingham, Great Britain.
AUGUST 1979


Program: There will be about 18 invited papers as well as sessions for short contributed papers. Major areas include Markov processes; random fields, measures, point processes; stochastic integrals; stochastic modeling, control, estimation, optimization; reliability, and search.


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


Information: G. I. Zapata, Instituto de Matemáática, Universidade Federal do Rio de Janeiro, Caixa Postal 1835, ZC-00, Rio de Janeiro RJ Brazil.

6-16. International Conference in Banach Spaces, Kent State University, Kent, Ohio.

Support: NSF support is anticipated.


Information: J. Diestel, Mathematics Department, Kent State University, Kent, Ohio 44242.


Program: There will be a number of invited one-hour lectures by distinguished mathematicians on various aspects of functional analysis and its applications, to be followed by short discussions. There will also be an opportunity for the presentation of short contributed papers by participants.

Call for Papers: Papers on any aspect of functional analysis or any of its applications are invited. Deadline for abstracts is the end of April 1979.

Information: T. Owusu-Ansah, Symposium on Functional Analysis, Department of Mathematics, University of Science and Technology, Kumasi, Ghana, West Africa.

22-29. The Sixth International Congress of Logic, Methodology and Philosophy of Science, Hannover, Germany.

Program: The theme of the conference will be "the role of mathematics in modern science."

Information: Information on travel assistance for Americans may be obtained from Cheri Hayes, Staff Officer, U.S. National Committee for the International Union of the History and Philosophy of Science, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. For general information, contact Secretariat of the 6. Internationalen Kongresses für Logik, Methodologie und Philosophie der Wissenschaften, Welfengarten 1, D-3000 Hannover 1, Federal Republic of Germany.

23-September 8. IXe Ecole D'Eté de Calcul des Probabilités de Saint-Florent, Université de Clermont, France. (January 1979, p. 52)


Information: R. Finn, Stanford University, Stanford, California 94305, or J. Heywood, Department of Mathematics, University of British Columbia, Vancouver, British Columbia V6T 1W5, Canada.

26-September 1. Second Australian Number Theory Conference, Macquarie University, Sydney, Australia.


Information: J. Loxton, School of Mathematics, University of New South Wales, Kensington, New South Wales, 2033, Australia.

27-31. Tenth International Symposium on Mathematical Programming, Montreal, Canada. (January 1979, p. 52)

27-31. Colloquium on Finite Algebra and Multiple-valued Logic, József Attila University, Szeged, Hungary.

Sponsor: J. Bolyai Mathematical Society.

Purpose: The purpose of the meeting is to bring together mathematicians working in universal algebra, multiple-valued logic, and mathematical foundations of computer science in order to promote better understanding and cooperation.

Information: Béla Csákány, Bolyai Institute, Szeged, H-6720 Hungary, or János Demetrovics, P. O. Box 63, Budapest 112, H-1502 Hungary.

SEPTEMBER 1979

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

Program: Topics will include: statistics in point processes; robustness; small sample asymptotics and saddle point methods; stochastic differential equations; regression analysis and linear models; statistical information theory; statistical methods in medicine; statistics in engineering science; cluster analysis; Monte Carlo methods; exchangeability; new approaches in nonparametric statistics; statistics in quantum physics; statistical problems in graphs. There will be contributed paper sessions.


Deadline for Abstracts: May 1, 1979.

Information: Organizing Committee of the Twelfth European Meeting of Statisticians, P. O. Box 373, 1000-Sofia/Bulgaria.

4-9. Ninth IFIP Conference on Optimization Techniques, Warsaw, Poland. (November 1978, p. 505)


Program: Contributed papers by participants, on lambda-calculus and related topics. Probable participants include D. Scott and H. Barendregt.

Information: R. Hindley, Lambda-Conference, University College, Swansea, SA2 8PP, Great Britain.


OCTOBER 1979

8-10. Session on Physical Systems Science, Denver, Colorado.


Information: Professor A. P. Sage, University of Virginia, Charlottesville, Virginia 22901.


Call for Papers: Papers describing original research in theoretical aspects of computer science are sought.

Instructions for Authors: Authors should send eight copies of a detailed abstract by May 16, 1979, to the address below.

Information: Further information on contributed papers may be obtained from S. Rao Kosaraju, Program Chairman, Department of Electrical Engineering, The Johns Hopkins University, Baltimore, Maryland 21218.

(For late entries, see p. 144)
These notes arose from a series of lectures given by the author at a CBMS regional conference held at Madison, Wisconsin, from August 8–12, 1977. The conference was supported by the National Science Foundation.

The main purpose of the notes was to show how $l$-adic cohomology of algebraic varieties over fields of characteristic $p > 1$ can be used to get information on the representations of finite Chevalley groups.

Contents:

Part 2. The characters $K_p(\theta)$.
Part 4. Some open problems.

Number 39
49 + v pages
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ISBN 0-8218-1689-6; LC 78-24068
Publication date: December 31, 1978
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TOPOLOGICAL DEGREE METHODS IN NONLINEAR BOUNDARY VALUE PROBLEMS
by Jean Mawhin

This volume contains expository lectures from the CBMS Regional Conference held at Harvey Mudd College, June 9–15, 1977. The conference was supported by the National Science Foundation.

The Table of Contents is as follows:
Chapter I. Fredholm mappings of index zero and linear boundary value problems.
Chapter II. Degree theory for some classes of mappings.
Chapter III. Duality theorems for several fixed point operators associated to periodic problems for ordinary differential equations.
Chapter IV. Existence theorems for equations in normed spaces.
Chapter V. Boundary value problems for second order nonlinear vector differential equations.
Chapter VI. Periodic solutions of ordinary differential equations with one-sided growth restrictions.
Chapter VII. Bound sets for functional differential equations.
Chapter VIII. The index of isolated zeros of some mappings.
Chapter IX. Bifurcation theory.
Chapter X. Periodic solutions of autonomous ordinary differential equations around an equilibrium.

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SIAM-AMS PROCEEDINGS
ISSN 0070-5840

FRACTURE MECHANICS
edited by Robert Burridge

This volume contains expanded versions of ten of the twelve invited papers given at a joint AMS/SIAM Symposium on Mathematical Problems in Fracture Mechanics, New York, March 28–29, 1978. The Symposium was supported by the NSF and ERDA. Its purpose was to interest applied mathematicians in this area of mechanics, which is currently of growing interest both in engineering and in the theory of earthquake mechanisms.

The topics discussed in the volume are described in some detail on p. 142 of this issue of the NOTICES.

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LECTURES ON MATHEMATICS IN THE LIFE SCIENCES
ISSN 0075-8223

SOME MATHEMATICAL QUESTIONS IN BIOLOGY. X.
edited by Simon Levin

This volume contains lectures given at a Symposium on Some Mathematical Questions in Biology, held in Washington, D.C., on February 14, 1978, in conjunction with the annual meeting of the American Association for the Advancement of Science. The Symposium was supported by the National Institutes of Health and cosponsored by the Society for Industrial and Applied Mathematics.

The contents of the volume are as follows:
Joseph B. Keller, Stochastic theories of carcinogenesis and population genetics
G. F. Oster and S. M. Rocklin, Optimization models in evolutionary biology
Peter H. Richter, Pattern formation in the immune system
Alan S. Perelson, Optimal strategies for an immune response
H. C. Longuet-Higgins, Perception of melodies

Volume 11
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MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY
ISSN 0065-9266

GLOBAL SUBDIRECT PRODUCTS
by Peter H. Krauss and David M. Clark

This monograph provides a thorough exposition of the discrete sheaf construction as a tool for obtaining subdirect representations as structures of global sections of
sheaves. These subdirect products, called "global," are identified internally as those having a simple closure property. The central result shows, in the context of universal algebra, how global subdirect representations can be uniformly constructed from any subdirect representations satisfying a certain finite patching property. This point of view presents two distinct advantages. First it strips the conventional construction of its most cumbersome and least relevant aspects, thereby revealing much new information about global subdirect products through a conceptually and technically simplified framework. Secondly it pinpoints just what information is needed from special algebra to be able to complete the construction. In the final sections it is shown how many of the most prominent classical sheaf representation theorems become smooth corollaries of the general theorem which require very little (if any!) input from the special algebra involved. "Global Subdirect Products" is highly recommended for the novice looking for an introduction to sheaf representation as well as for the expert looking for a thorough and systematic study of those aspects of the discrete sheaf construction which can be handled in a purely universal algebra setting.

Number 210
109 + iii pages
List price $6.80; Institutional member price $5.10;
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A NEW MATHEMATICAL FRAMEWORK FOR THE STUDY OF LINKAGE AND SELECTION
by S. Shahshahani

A continuous multi-locus model describing the evolution of a large population of a diploid organism is studied. It is assumed that only the forces of natural selection and recombination are operating. The use of a non-Euclidean metric greatly clarifies the dynamical properties of the system of differential equations involved.

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34 + ix pages
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A THEORY OF DIFFERENTIATION IN LOCALLY CONVEX SPACES
by Sadayuki Yamamuro

When \( u \) is a continuous linear map of a locally convex space \( E \) into another locally convex space \( F \), then for any continuous seminorm \( p \) on \( F \) there exists a continuous seminorm \( q \) on \( E \) such that \( q(u(x)) \leq p(u(x)) \) for every \( x \in E \). In other words, every continuous linear map of \( E \) into \( F \) determines a correspondence between the defining families of seminorms on \( E \) and \( F \). In this book, the author adopts this correspondence as the starting point for building a theory of linear maps and then a theory of differential calculus for maps between locally convex spaces.

A correspondence between families of seminorms gives a correspondence between families of (semi)normed spaces, and a calculus in locally convex spaces is reduced by this correspondence to a calculus on (semi)normed spaces.

In this way, one does not need detailed knowledge of traditional theories on locally convex spaces to carry out calculations and all the theorems in the calculus on normed spaces can have their corresponding forms in this theory.

The book consists of six chapters (Linear maps, Differentiation, Inverse mapping theorem, Differential equations, Fredholm maps and analytic maps) and one appendix (Manifolds).

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82 + v pages
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PROCEEDINGS OF THE STEKLOV INSTITUTE

INTERNATIONAL CONFERENCE ON MATHEMATICAL PROBLEMS OF QUANTUM FIELD THEORY AND QUANTUM STATISTICS. PART II. FIELDS AND PARTICLES. MATHEMATICAL QUESTIONS OF QUANTUM STATISTICS.

edited by V. S. Vladimirov

This collection consists of thirty-two of the papers presented at the International Conference on Mathematical Problems in Quantum Field Theory and Quantum Statistics in Moscow in December 1972. The papers are devoted to various aspects of elementary particle theory and mathematical questions of quantum statistics.

Part I is available as Number 135 (1975) of the Russian proceedings.

Russian number 136 (1975)
450 + v pages
List price $60.00; Institutional member price $45.00
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ISBN 0-8218-3036-8; LC 78-6757
Publication date: September 1978
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REFERENCE WORK

FRENCH MATHEMATICAL SEMINARS--A Union List
by Nancy D. Anderson

This list is the only one of its kind in the United States, and has been assembled with the cooperation of 98 participating libraries, including two French libraries. The list provides necessary information to enable librarians to acquire the seminars and also serves to identify copies existing in North America.

The listing includes only seminars (not courses, conferences, or colloquia) held in the French language in any country. Every listing has been verified and is entered in the form most often cited in the literature. Along with the primary entries there is an even greater number of cross-references, which give other forms of the entry as well as issuing body, location of seminar, series, and a main entry in the form used by the Library of Congress. Names and addresses of publishers may also be given.

96 + ix pages
List price $9.20; member price $6.90
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Prepayment is required for all American Mathematical Society publications.
Send for the book(s) above to: AMS, P. O. Box 1571, Annex Station, Providence, RI 02901.
Personal Items

MEL S. BERGER of Yeshiva University has been appointed to a professorship at the University of Massachusetts, Amherst.

CARMEN CHICONE of the University of Wisconsin has been appointed to an assistant professorship at the University of Missouri—Columbia.

MARK Q. JACOBS of the University of Missouri—Columbia has been named to the Luther Marion Defoe Distinguished Professorship.

JACK C. KIEFER of Cornell University has been appointed to a professorship in Statistics at the University of California, Berkeley.

JACOB KOREVAAR, of the University of Amsterdam and the Netherlands Academy of Science, was awarded a Doctor of Philosophy degree, honoris causa, by the University of Gothenburg, Sweden, in October 1978.

WALTER W. LEIGHTON of the University of Missouri—Columbia has been appointed Distinguished Professor Emeritus at that University.

IRA PAPICK of Adelphi University has been appointed to an assistant professorship at the University of Missouri—Columbia.

HERBERT ROBBINS of Columbia University has been appointed to a visiting Leading Professorship in Applied Mathematics and Statistics at the State University of New York at Stony Brook.

H. H. SCHAEFER of the University of Tubingen, presently visiting California Institute of Technology, has been elected a member of the Academy of Science, Heidelberg, Federal Republic of Germany.

ABRAHAM ZAKS, of the Technion-Israel Institute of Technology, has been named this year's recipient of the Mahler Prize for research in Pure Mathematics.

PROMOTIONS

To Associate Professor, Kean College of New Jersey: JANE MALBROCK; University of Missouri—Columbia: JOHN H. REEDER.

To Assistant Professor, University of Missouri—Columbia: JOSEPH CONLON.

Deaths

Dr. KENNETH E. BISHOPP of Rensselaer Polytechnic Institute died in June, 1975, at the age of 66. He was a member of the Society for 44 years.

Professor Emeritus WILLIAM H. FAGERSTROM of City College, CUNY, and Pan American University died on September 10, 1978, at the age of 87. He was a member of the Society for 34 years.

Dr. WALLACE C. G. FRASER of the University of Guelph died on December 2, 1978, at the age of 61. He was a member of the Society for 36 years.

Professor Emeritus MILDRED HUNT of Illinois Wesleyan University died on December 14, 1975, at the age of 87. She was a member of the Society for 51 years.

SISTER MARY FELICE VAUDREUIL of Elm Grove, Wisconsin died on October 26, 1978, at the age of 84. She was a member of the Society for 38 years.

Dr. MARIE M. YEATON of Elyria, Ohio died on March 19, 1978. She was a member of the Society for 50 years.

Visiting Mathematicians—Supplementary List

The list of visiting mathematicians includes both foreign mathematicians visiting the United States and Canada, and U.S. and Canadian mathematicians visiting abroad during the academic year 1978-1979. The original list was published in the October 1978 NOTICES, and supplemented in the November 1978 and January 1979 issues.

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>Lehner, J. (U.S.A.)</td>
<td>Technion-Israel Institute of Technology</td>
<td>Discontinuous Groups and Automorphic Functions</td>
<td>4/79 - 6/79</td>
</tr>
<tr>
<td>Kashyap, Brij R. K. (India)</td>
<td>University of Victoria</td>
<td>Queueing Theory and Special Functions</td>
<td>11/78 - 6/79</td>
</tr>
<tr>
<td>Sheerer, Hans (Federal Republic of Germany)</td>
<td>Northwestern University</td>
<td>Homotopy Theory, Dynamical Systems</td>
<td>1/79 - 3/79</td>
</tr>
<tr>
<td>Toruńczyk, Henryk (Poland)</td>
<td>University of Oklahoma</td>
<td>Topology</td>
<td>5/79</td>
</tr>
<tr>
<td>Vienne, Lucas (France)</td>
<td>San Diego State University</td>
<td>Finite and Permutation Groups</td>
<td>8/78 - 7/79</td>
</tr>
</tbody>
</table>

Visiting Foreign Mathematicians

<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>Lehner, J. (U.S.A.)</td>
<td>Technion-Israel Institute of Technology</td>
<td>Discontinuous Groups and Automorphic Functions</td>
<td>4/79 - 6/79</td>
</tr>
<tr>
<td>Kashyap, Brij R. K. (India)</td>
<td>University of Victoria</td>
<td>Queueing Theory and Special Functions</td>
<td>11/78 - 6/79</td>
</tr>
<tr>
<td>Sheerer, Hans (Federal Republic of Germany)</td>
<td>Northwestern University</td>
<td>Homotopy Theory, Dynamical Systems</td>
<td>1/79 - 3/79</td>
</tr>
<tr>
<td>Toruńczyk, Henryk (Poland)</td>
<td>University of Oklahoma</td>
<td>Topology</td>
<td>5/79</td>
</tr>
<tr>
<td>Vienne, Lucas (France)</td>
<td>San Diego State University</td>
<td>Finite and Permutation Groups</td>
<td>8/78 - 7/79</td>
</tr>
</tbody>
</table>
Backlog of Mathematics Research Journals

Information on the backlog of papers for research journals is published in the February and August issues of the NOTICES with the cooperation of the respective editorial boards. Since some columns in the table are not self-explanatory, we include some details on their meaning.

**Backlog:** This is an estimate of the number of printed pages which have been accepted but are not necessary to maintain copy editing and printing schedules. Observed Waiting Time: The quartiles give a measure of normal dispersion. They do not include extremes which may be misleading.

The observations are made from the latest issue published before the deadline for this issue of the NOTICES. Waiting times are measured in months from receipt of manuscript in final form to publication of the issue. When a paper is revised, the waiting time between an editor's receipt of the final revision and its publication may be much shorter than is the case otherwise, so these figures are low to that extent.

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

<table>
<thead>
<tr>
<th>Journal/Magazine</th>
<th>Number Issues per Year</th>
<th>Approximate Number Pages per Year 12/15/78</th>
<th>BACKLOG 5/31/78</th>
<th>Number Pages to be Published Currently Estimated Time for Paper Submitted (In Months) Q1</th>
<th>Q2</th>
<th>Q3</th>
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<tbody>
<tr>
<td>Acta Informatica</td>
<td>8</td>
<td>752</td>
<td>0</td>
<td>17-18</td>
<td>14</td>
<td>17</td>
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<tr>
<td>Acta Mathematica</td>
<td>2-4</td>
<td>320-640</td>
<td>900</td>
<td>1000</td>
<td>24</td>
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<tr>
<td>American J. Math.</td>
<td>6</td>
<td>1400</td>
<td>500</td>
<td>300</td>
<td>15</td>
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<tr>
<td>Annals of Math.</td>
<td>6</td>
<td>1200</td>
<td>800</td>
<td>800</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Annals of Probability</td>
<td>6</td>
<td>1050</td>
<td>300</td>
<td>240</td>
<td>18</td>
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<tr>
<td>Annals of Statistics</td>
<td>6</td>
<td>1350</td>
<td>400</td>
<td>400</td>
<td>21</td>
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<tr>
<td>Applicable Analysis</td>
<td>4</td>
<td>320</td>
<td>300</td>
<td>400</td>
<td>18</td>
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<tr>
<td>Arch. History of Exact Scis</td>
<td>9</td>
<td>1758</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>9</td>
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<tr>
<td>Arch., of Rational Mech., Anal.</td>
<td>9</td>
<td>874</td>
<td>0</td>
<td>7</td>
<td>12</td>
<td>16</td>
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<tr>
<td>Canad. J. of Math</td>
<td>6</td>
<td>1344</td>
<td>700</td>
<td>1200</td>
<td>16</td>
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<tr>
<td>Comm. Math, Physics</td>
<td>19</td>
<td>1925</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Computing</td>
<td>8</td>
<td>768</td>
<td>250</td>
<td>580</td>
<td>10</td>
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<tr>
<td>Duke Math. J.</td>
<td>4</td>
<td>800</td>
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<tr>
<td>Houston J. of Math.</td>
<td>4</td>
<td>500</td>
<td>50</td>
<td>80</td>
<td>9</td>
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<tr>
<td>Illinois J. Math.</td>
<td>6</td>
<td>704</td>
<td>1094</td>
<td>1100</td>
<td>21</td>
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<td>Indiana Univ. J.</td>
<td>6</td>
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<td>200</td>
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<tr>
<td>Inventiones Math.</td>
<td>18</td>
<td>1759</td>
<td>0</td>
<td>150</td>
<td>5</td>
<td>7</td>
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<tr>
<td>J. Amer. Stat. Assoc.</td>
<td>4</td>
<td>1000</td>
<td>0</td>
<td>0</td>
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<td>9</td>
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<tr>
<td>J. Assoc. for Comp. Mach.</td>
<td>4</td>
<td>700</td>
<td>300</td>
<td>NR*</td>
<td>9</td>
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<tr>
<td>J. Comp. &amp; Sys. Sci.</td>
<td>6</td>
<td>900</td>
<td>200</td>
<td>NR*</td>
<td>12-18</td>
<td>10</td>
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<tr>
<td>J. Diff. Geometry</td>
<td>4</td>
<td>650</td>
<td>980</td>
<td>1300</td>
<td>18</td>
<td>32</td>
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<tr>
<td>J. Math, Physics</td>
<td>12</td>
<td>2400</td>
<td>0</td>
<td>NR*</td>
<td>7</td>
<td></td>
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<tr>
<td>J. Stat. Comp. &amp; Simulation</td>
<td>8</td>
<td>300</td>
<td>0</td>
<td>NR*</td>
<td>6</td>
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<tr>
<td>J, Symbolic Logic</td>
<td>4</td>
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<td>0</td>
<td>0</td>
<td>NR*</td>
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<td>Linear Algebra &amp; Appl.</td>
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<td>1800</td>
<td>350</td>
<td>300</td>
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<td>Linear &amp; Multilinear Algebra</td>
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<td>manuscripta math.</td>
<td>14</td>
<td>1400</td>
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<td>Math. Systems Theory</td>
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<td>384</td>
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<td>1200</td>
<td>0</td>
<td>0</td>
<td>12</td>
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<tr>
<td>Math. of Operations Res.</td>
<td>4</td>
<td>400</td>
<td>8</td>
<td>0</td>
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<td>24</td>
<td>2300</td>
<td>470</td>
<td>470</td>
<td>7</td>
<td>8</td>
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<tr>
<td>Math. Zeitschrift</td>
<td>21</td>
<td>1912</td>
<td>0</td>
<td>7</td>
<td>6</td>
<td></td>
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<tr>
<td>Memoirs of AMS</td>
<td>6</td>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td></td>
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<tr>
<td>Monatshefte für Math.</td>
<td>8</td>
<td>704</td>
<td>400</td>
<td>130</td>
<td>12-12</td>
<td>14</td>
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<tr>
<td>Numerische Math.</td>
<td>10</td>
<td>1100</td>
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<td>0</td>
<td>12-13</td>
<td>11</td>
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<td>Operations Research</td>
<td>6</td>
<td>1200</td>
<td>600</td>
<td>800</td>
<td>20</td>
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<tr>
<td>Pacific J. of Math.</td>
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<td>3600</td>
<td>0</td>
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<td>Proceedings of AMS</td>
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<td>2000</td>
<td>100</td>
<td>0</td>
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<tr>
<td>Quarterly of Appl. Math.</td>
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<td>480</td>
<td>605</td>
<td>0</td>
<td>6-7</td>
<td>9</td>
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<tr>
<td>Rocky Mountain J. of Math.</td>
<td>4</td>
<td>768</td>
<td>713</td>
<td>600</td>
<td>27</td>
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<tr>
<td>Semigroup Forum</td>
<td>4</td>
<td>376</td>
<td>500</td>
<td>99</td>
<td>7-10</td>
<td>7</td>
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<tr>
<td>SIAM J. Appl. Math.</td>
<td>6</td>
<td>1500</td>
<td>240</td>
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<tr>
<td>SIAM J. on Computing</td>
<td>4</td>
<td>640</td>
<td>270</td>
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<td>17</td>
<td>9</td>
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<tr>
<td>SIAM J. Control &amp; Optim.</td>
<td>6</td>
<td>1100</td>
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<td>37</td>
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<tr>
<td>SIAM J. on Math, Anal.</td>
<td>6</td>
<td>1350</td>
<td>450</td>
<td>750</td>
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<td>SIAM J. on Numer. Anal.</td>
<td>6</td>
<td>1260</td>
<td>180</td>
<td>52</td>
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<td>SIAM Review</td>
<td>4</td>
<td>860</td>
<td>0</td>
<td>14</td>
<td>13</td>
<td>19</td>
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<tr>
<td>Transactions of AMS</td>
<td>12</td>
<td>4000</td>
<td>320</td>
<td>500</td>
<td>12</td>
<td></td>
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<tr>
<td>Z. Wahrscheinlichkeitstheorie</td>
<td>19</td>
<td>1672</td>
<td>0</td>
<td>0</td>
<td>9</td>
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</tbody>
</table>

Several journals included in previous lists have not responded to the last two requests for information, and have therefore been omitted from this list.

*No response received.
Assistantships and Fellowships in the Mathematical Sciences in 1979–1980

Supplementary List

The entries below supplement the December 1978 Special Issue of the NOTICES.

Under the DEGREES AWARDED column the following terms have been used:

<table>
<thead>
<tr>
<th>DEGREES AWARDED</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor's by inst.</td>
<td>Number of bachelor's degrees awarded by the institution</td>
</tr>
<tr>
<td>Bachelor's by dept.</td>
<td>Number of bachelor's degrees awarded by the department</td>
</tr>
<tr>
<td>Master's by dept.</td>
<td>Number of master's degrees awarded by the department</td>
</tr>
</tbody>
</table>

Abbreviations Used

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&amp;NT</td>
<td>Algebra and Number Theory</td>
</tr>
<tr>
<td>G&amp;T</td>
<td>Geometry and Topology</td>
</tr>
<tr>
<td>L</td>
<td>Logic</td>
</tr>
<tr>
<td>A&amp;FA</td>
<td>Analysis and Functional Analysis</td>
</tr>
<tr>
<td>P</td>
<td>Probability</td>
</tr>
<tr>
<td>S</td>
<td>Statistics</td>
</tr>
<tr>
<td>CS</td>
<td>Computer Science</td>
</tr>
<tr>
<td>OR</td>
<td>Operations Research</td>
</tr>
<tr>
<td>AM</td>
<td>Applied Mathematics</td>
</tr>
<tr>
<td>ME</td>
<td>Mathematics Education</td>
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</table>

Under the SERVICE REQUIRED column, hours per week section:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>STIPEND</th>
<th>TUITION</th>
<th>SERVICE REQUIRED</th>
<th>DEGREES AWARDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>of financial assistance</td>
<td>amount in dollars</td>
<td>9 or 12 if not included</td>
<td>9 or 12</td>
<td>9 or 12</td>
</tr>
<tr>
<td>(with number anticipated 1979–1980)</td>
<td></td>
<td>months</td>
<td>in stipend (dollars)</td>
<td>type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Academic year</td>
</tr>
</tbody>
</table>

**ALABAMA**

Alabama A & M University, Normal 35762

DEPARTMENT OF MATHEMATICS

Jerry R. Shipman, Chairman

Teaching Assistantship (1) 3500 9 35/or. 20 Teaching

**CALIFORNIA**

California Institute of Technology, Pasadena 91125

DEPARTMENT OF APPLIED MATHEMATICS

G. B. Whitman, Executive Officer

Fellowship (4) 3900 9
Teaching Assistantship (14) 3100–4640 9
Research Assistantship (4) 2055–1270 9

California State Polytechnic University, Pomona 91768

DEPARTMENT OF MATHEMATICS

Carlos Ford-Livene, Chairman

Applications due: 5/15/79 Faculty 40; Published 11

Teaching Assistantship (13) 2700–6600 9 * 3-5 Teaching

*Registration fees $69–$71. In addition, nonresident pays $38 per quarter unit up to a maximum of $570 per quarter.

California State University, Hayward 94542

DEPARTMENT OF STATISTICS

H. Fearns, Chairman

Applications due: 7/20/79 Faculty 9

Graduate Assistantship (5) 1200 12 * 20 Grading

*Resident, fees per quarter: full-time $66; part-time $56. Nonresident fees: $38 per quarter unit with a maximum of $570 per quarter.
San Francisco State University, San Francisco 94132

DEPARTMENT OF MATHEMATICS
James T. Smith, Chairman

Fellowship (6) 3249 9 200–1000 20
Part-time Faculty (6) 2172 9 200–1000 6

University of California, Berkeley 94720

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
David J. Sakrison, Head

Fellowship (15) 1700–4000 9 **
Teaching Assistantship (32) 5382 9 **
Research Assistantship (28) 4248 9 **

*Fellowship: 12/1/78; Assistantship: 2/1/79.
**Resident: $790; nonresident: $2695.

University of California, Irvine 92717

DEPARTMENT OF MATHEMATICS
James J. Yeh, Chair

Fellowship (2) 4200 9
Teaching Fellowship (1) 5382 9
Teaching Assistantship (20) 4248 9
Scholarship (3) 5382 9

*Late applications considered if positions are still available.
## Illinois

**Northwestern University, Evanston 60201**

**DEPARTMENT OF ENGINEERING SCIENCES AND APPLIED MATHEMATICS**

W.E. Olmstead, Director

| Fellowship (6) | 3400–4300 | 9 |
| Research Assistantship (2) | 3600–4000 | 9 |

Applications due: 3/1/79  
Faculty 8; Published 8  
Bachelor's by Inst.  1781  
Bachelor's by Dept.  2  
Master's by Dept.  3  
Ph.D. (1975–1978 incl.)  
AM 2, Total: 2

**University of Chicago, Chicago 60637**

**DEPARTMENT OF STATISTICS**

David L. Wallace, Chairman

| Fellowship (2) | 3500–4125 | 9 |
| Research Assistantship (12) | 3450–4000 | 9 |
| Scholarship (6) | 0–1905 | 10 |

Applications due: 2/28/79  
Faculty 13; Published 12  
Master's by Dept.  4  
Ph.D. (1975–1978 incl.)  
S 6, Total: 6

## Kansas

**University of Kansas, Lawrence 66045**

**DEPARTMENT OF COMPUTER SCIENCE**

Victor L. Wallace, Chairman

| Fellowship (2) | 3900 | 9 |
| Teaching Assistantship (30) | 4150–5000 | 9 |
| Research Assistantship (6) | 4150–4950 | 9 or 12 |

Applications due: 2/15/79  
Faculty 13; Published 10  
Bachelor's by Inst.  4569  
Bachelor's by Dept.  27  
Master's by Dept.  19  
Ph.D. (1975–1978 incl.)

## Kentucky

**University of Kentucky, Lexington 40506**

**DEPARTMENT OF COMPUTER SCIENCE**

F.D. Lewis, Chairman

| Fellowship (1) | 3400 | 9 |
| Teaching Assistantship (12) | 3800–4000 | 9 |
| Research Assistantship (1) | 3800–4000 | 9 |
| Internship (10) | 3800–4000 | 9 |

Applications due: *  
Faculty 11; Published 9  
Bachelor's by Inst.  1529  
Bachelor's by Dept.  11  
Master's by Dept.  14

## New Mexico

**New Mexico State University, Las Cruces 88003**

**DEPARTMENT OF COMPUTER SCIENCE**

J. Mack Adams, Head

| Fellowship (6) | 4000–4050 | 9 |
| DEPARTMENT OF MATHEMATICAL SCIENCES  
John D. DePree, Chairman  
Teaching Assistantship (23) | 4055–5255 | 9 |

Applications due: 3/15/79  
Faculty 8  
304/sem.  
Bachelor's by Inst.  1309  
Bachelor's by Dept.  15  
Master's by Dept.  5  
Ph.D. (1975–1978 incl.)  
A&NT 1, A&FA 2, AM 2, Total: 6

**University of New Mexico, Albuquerque 87131**

**DEPARTMENT OF COMPUTING AND INFORMATION SCIENCES**

Paul Young, Chairman

| Fellowship (5) | 3600 | 9 |
| Teaching Assistantship (2) | 4400 | 9 |

Applications due: 2/15/79  
Faculty 9; Published 6  
Bachelor's by Inst.  1309  
Bachelor's by Dept.  15  
Master's by Dept.  5  
Ph.D. (1975–1978 incl.)  
A&NT 1, A&FA 2, AM 2, Total: 6

## New York

**State University College at Brockport 14420**

**DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE**

Theron D. Rockhill, Chairman

| Teaching Fellowship (3) | 2650 | 9 |

Applications due: 4/15/79  
Faculty 21  
Bachelor's by Inst.  1738  
Bachelor's by Dept.  98  
Master's by Dept.  4

## Notes

- Bachelor's by Inst.: 1781  
- Bachelor's by Dept.: 2  
- Master's by Dept.: 3  
- Ph.D. (1975–1978 incl.): 2  
- AM 2, Total: 2  
- Bachelor's by Inst.: 4569  
- Bachelor's by Dept.: 27  
- Master's by Dept.: 19  
- Ph.D. (1975–1978 incl.): 4  
- S 6, Total: 6  
- Bachelor's by Inst.: 1529  
- Bachelor's by Dept.: 11  
- Master's by Dept.: 14  
- Bachelor's by Inst.: 1309  
- Bachelor's by Dept.: 15  
- Master's by Dept.: 5  
- Ph.D. (1975–1978 incl.): 6  
- A&NT 1, A&FA 2, AM 2, Total: 6  
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*Without a position, tuition (out-of-state) is $2736.
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136
**TYPE STIPEND TUITION SERVICE REQUIRED DEGREES AWARDED**

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**University of Windsor, Windsor, Ontario N9B 3P4**

**DEPARTMENT OF MATHEMATICS**

H.R. Atkinson, Chairman

Teaching Assistantship (20)

2000–3000 9 *

Scholarship (5)

1500–4000 12 *

*Canadian: $370 per term; non-Canadian: $777.50 per term.

Applications due: 5/15/79

Faculty 24; Published 19

Bachelor's by inst. 700

Bachelor's by dept. 30

Master's by dept. 2

Ph.D. (1975–1978 incl.)

A&FA 1, S 1, AM 8,

Total: 7

**ERRATA**

Corrections are necessary for some entries which appeared in the 1978 Special Issue on Assistantships and Fellowships. Listed below are the name of the university, the page on which the change is to be made, and the corrected information.

**WESLEYAN UNIVERSITY, Department of Mathematics (page 533).**

The total number of Ph.D.'s awarded for 1975–1978 should be 10, A&NT 5, G&T 5.

**FLORIDA STATE UNIVERSITY, Department of Statistics (page 533).**

The number of full-time members of the faculty who have published in the last three years is 16, not 3.

**CALIFORNIA INSTITUTE OF TECHNOLOGY (page 583) should not have been included in the list of Critical, Historical, or Expository Theses.**

**Critical, Historical, or Expository Theses**

*Supplementary List*

The list below supplements the list published on pp. 583–584 of the December 1978 NOTICES.

**CALIFORNIA**

University of California, Irvine

Mathematics

Ph.D.

**NEW YORK**

Union College, Schenectady

Institute of Administration and Management

Ph.D.

**COLORADO**

University of Denver, Denver

Mathematics

Ph.D.

**VIRGINIA**

Virginia Polytechnic Institute and

State University, Blacksburg

Computer Science

Ph.D.

**ILLINOIS**

University of Chicago, Chicago

Statistics

Ph.D.

**CANADA**

University of Toronto, Toronto, Ontario

Mathematics (History of Science)

Ph.D.

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This book is devoted to the theory of partial differential equations of mixed type. The author introduces the reader to the current state of mathematical problems closely connected with transonic gas dynamics.

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Publication date: July 15, 1978

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


**RECENT APPOINTMENTS**

President R. H. Bing has appointed James E. West to the Committee to Select Hour Speakers for Eastern Sectional Meetings. Continuing members of the Committee are Michael Artin (chairman), Raymond Ayoub (ex officio), James B. Ax, and James M. Greenberg.

George B. Pedrick has been appointed by President Peter D. Lax to the Committee on Teaching Loads and Class Size. Other members of the committee are Judy Green and Morris L. Marx.

President Peter D. Lax has appointed Everett Pitcher to be a representative of the Society with Paul T. Bateman on the Conference Board of the Mathematical Sciences. He replaces Richard S. Palais, whose term has expired.

George B. Seligman has been elected Chairman of the Committee to Monitor Problems in Communication, thereby also becoming a member of the Council. The other members of the committee are Robert M. Baer, Robert G. Bartle, Philip T. Church, Suzanne Fedunok (consultant), William J. LeVeque (ex officio), Carl M. Pearcy, and Hale F. Trotter.

Ivan Niven has been appointed chairman of the Committee on Prizes by President Peter D. Lax. Continuing members of the committee are Louis Auslander, James C. Cantrell, Walter Feit, Murray S. Klamkin, John W. Milnor, and Mary Ellen Rudin.

President Peter D. Lax has appointed C. Edmund Burgess to be Chairman of the Program Committee for National Meetings. Continuing members of the committee are James G. Glimm, Hugh L. Montgomery, George D. Mostow, Donald S. Ornstein, Barbara L. Osofsky, and Everett Pitcher (ex officio).

The members of the Joint AMS-MAA Committee on Arrangements for the Annual Meeting in San Antonio (January 3-8, 1980) have been appointed. They are Rita Bardano, Paul T. Bateman (ex officio), Kenneth E. Hummel, Constance Jones, William J. LeVeque (ex officio), Robert A. Northcutt, David P. Roselle (ex officio), and Bennir A. Zinn (chairman). Professor Hummel will serve as Publicity Director.


**REPORTS OF MEETINGS**

**The October Meeting in Claremont**

The seven hundred fifty-ninth meeting of the American Mathematical Society was held at the Claremont Colleges on the campus of Pomona College, Claremont, California, Thursday through Saturday, October 19-21, 1978. There were 227 registrants, including 177 members of the Society. The meeting was held jointly with the Southern California Sections of the Mathematical Association of America (MAA) and the Society for Industrial and Applied Mathematics (SIAM).

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings there were two invited one-hour addresses. RALPH S. PHILLIPS of Stanford University lectured on "Scattering theory for automorphic functions"; he was introduced by Henry A. Dye. The other speaker was DANIEL W. STROOCK of the University of Colorado, Boulder, who lectured on "Central limit phenomena for infinite interacting systems." He was introduced by Thomas M. Liggett.

By invitation of the same committee, there were three special sessions. KIRBY A. BAKER of the University of California, Los Angeles, and ALDEN F. PIXLEY of Harvey Mudd College organized a special session on Varieties of algebraic systems and related topics. Fifty-minute papers were presented by R. P. Dilworth, Ralph S. Freese, George A. Gruetzer, Bjarni Jónsson, Ralph N. McKenzie, E. T. Schmidt, and Walter F. Taylor. The special session also featured informal workshops devoted to particular aspects of varieties; these were chaired by Bernhard Banaschewski, Stanley N. Burris, Alan Day, Trevor Evans, and Robert Willis Quackenbush.

STAVROS N. BUSENBERG of Harvey Mudd College and RICHARD H. ELDERKIN of Pomona College organized a special session on Ordinary and functional differential equations and their applications. Part of this session was devoted to applications of differential equations to biological and ecological problems. Twenty-minute papers were presented by Donald S. Cohen, Courtney S. Coleman, Jim M. Cushing, Allan L. Edelson, Thomas C. Gard, Bean-San Goh, William A. Harris, Jr., Gary W. Harrison, Alan Hastings, Frederick A. Howes, Kurt Kreith, Roy B. Leipnik, Richard E. Plant, Simeon Reich, Robert J. Sacker, Klaus Schmitt, Victor L. Shapiro, Hal L. Smith, James D. Stafney, George W. Swan, and P. van den Driessche.

M. M. RAO and NEIL E. GRETSKY of the University of California, Riverside, organized a special session on Stochastic processes and functional analysis. The speakers included Donald G. Babbitt, J. R. Blum, Michael D. Brennan, Kai Lai Chung, John Theodore Cox, Jacob Feldman, Le Baron O. Ferguson, Ronald K. Getoor, Aggie Ho, Robert C. James, James D. Stafney, George W. Swan, and P. van den Driessche.

There were two sessions of contributed ten-minute papers, chaired by Laurence D. Hoffman and Paul B. Yale.

The MAA program included the following invited addresses: "Intuitionism, constructivism and recursivism" by ERRETT BISHOP; "Finitely generated reflection groups" by ROB GORDON; and "Buffon's legacy" by RICHARD A. VITALE. The speaker at the MAA luncheon was E. G. STRAUS who reminisced about his early days in Jerusalem and about Albert Einstein for whom he was an assistant.

The SIAM program included an invited address by JAIME MILSTEIN entitled "Numerical methods for inverse problems of large biochemical systems." In addition, ROBERT L. BORRELLI, ALAN HASTINGS, and RICHARD E. PLANT discussed project-centered programs in applied mathematics at their institutions. This was followed by four twenty-five-minute descriptions of projects undertaken by student teams.

The Association for Women in Mathematics met on Saturday.

The meeting was well planned by the local organizing committee consisting of Stavros N. Busenberg, Richard H. Elderkin and Alden F. Pixley.

Eugene, Oregon

Kenneth A. Ross
Associate Secretary

The October Meeting in Syracuse

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

There were 218 registrants, including 193 members of the Society.

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there were four invited one-hour addresses. MICHAEL BARRATT of Northwestern University spoke on "Thom spaces"; he was introduced by Philip T. Church of Syracuse University. SYLVAIN CAPPELL, Courant Institute of Mathematical Sciences, New York University, spoke on "Links and cobordism of links"; he was introduced by Jack Ucci of Syracuse University. DAVID DRASIN of Purdue University spoke on "More developments in value distribution theory"; he was introduced by Albert Edrei of Syracuse University. IRWIN KRA, State University of New York at Stony Brook, spoke on "Canonical mappings between Teichmuller spaces"; he was introduced by Clifford J. Earle, Jr., of Cornell University.

By invitation of the same committee, there were nine special sessions of selected twenty-minute papers. DOUGLAS R. ANDERSON of Syracuse University and JOHN HARPER of the University of Rochester, arranged a session on Geometric and algebraic topology; the speakers were Amir Assadi, Michael Davis, William G. Dwyer, Ronald Finashand, Philip B. Hirschhorn, Stanley O. Kochman, Fun- Che Liu, Richard Mandelbaum, Benjamin M. Mann, Jan Marik, Clint McCrory, J. A. Niesendorfer, Kenneth A. Perko, Jr., John G. Ratcliffe, and Alexander Zabrodsky. LEONARD ASIMOW of the University of Rochester, organized a special session on Rigidity; the speakers were Rachad Antonius, Ethan D. Bolker, Robert Connelly, Henry Crapo, Branko Grünbaum, Peter Kahn, I. G. Rosenberg, Ben G. Roth, and Walter J. Whiteley. LIPMAN Bers, of Columbia University, organized a special session on Kleinian groups; the speakers were Clifford J. Earle, Frederick P. Gardiner, Jane Gilman, W. J. Harvey, John H. Hubbard, S. P. Kerckhoff, A. Marden, Bernard Maskit, Robert J. Silber, and Scott Wolpert. THOMAS JECH, Pennsylvania State University, organized a special session on Set theory; the speakers were Tim Carlson, Carlos A. Di Prisco, William G. Fleissner, Kanji Namba, Robert J. Mignone, Arnold W. Miller, Alan D. Taylor, W. Hugh Woodin, and Wlodzimierz Zadrozny. LEOPOLDO NACHBIN, of Rochester University, organized a special session on Functional analysis; the speakers were L. A. Asimow, J. Barros-Neto, Carlos A. Berenstein, Joseph Diestel, Milos A. Dostal, Thomas A. W. Dwyer III, and Leopoldo Nachbin. ALAN C. NEWELL, Clarkson Institute of Technology, organized a special session on Nonlinear waves; the speakers were Mark J. Ablowitz, Boris Coopersmith, Hermann Flaschka, John Gibbons, R. Herrmann, and Craig A. Tracy. DANIEL WATERMAN, Syracuse University, organized a special session on Real analysis; the speakers were J. M. Ash, D. E. Bindeschidler, Richard B. Darst, M. J. Evans, James Foran, K. M. Garg, Ronald Gariepy, Paul D. Humke, Cheng-Ming Lee, C. J. Neugebauer, Togo Nishiura, D. W. Solomon, and Clifford E. Weil. CHARLES WATTS, Syracuse University, organized a special session on Homological algebra; the speakers were David A. Buchsbaum, Charles Ching-An Cheng, Carl Faith, Daniel R. Grayson, Saul Lubkin, and Yel-Chiang Wu. ALLEN WEITSMAN, Purdue University, organized a special session on Complex analysis; the speakers were Albert Baernstein II, Gerald T. Cargo, Sun-Yung A. Chang, J. Clunie, Albert Edrei, Simon Hellerstein, Boris Korenblum, T. MacGregor, Thomas A. Metzger, Daniel Shea, Arne Stray, John L. Troutman, and David L. Williams. The organizers presided at the sessions.

There were also sessions for contributed papers in Algebra, Analysis, Topology, and Abstract Algebra.

The meeting was held in conjunction with the Upstate New York Topology Seminar, which took place on Sunday, October 29. This seminar was organized by Phillip T. Church. The invited speakers included F. T. Farrell, Pennsylvania State University, who spoke on "The topological Euclidean space form problem"; V. P. Snaith, University of Western Ontario, who spoke on "On K_n(Z/4) and related K_n^0"; R. Oliver, Stanford University, who spoke on "Weight systems for S_0^3 actions"; and F. Cohen, Northern Illinois University, who spoke on "Configuration spaces and their universal covers".
University, who spoke on "Hopf invariants". Philip T. Church and Jack E. Graver, of Syracuse University, were in charge of the local arrangements.

University Park, Pennsylvania
Raymond G. Ayoub
Associate Secretary

The November Meeting in Charleston

The seven hundred sixty-first meeting of the American Mathematical Society was held at the College of Charleston in Charleston, South Carolina, November 3 and 4, 1978. There were 208 registrants in attendance, including 182 members of the Society.

By invitation of the Committee to Select Hour Speakers for Southeastern Sectional Meetings—William K. Allard, Frank T. Birtel, Thomas A. Chapman, Robert B. Gardner (chairman), and James D. Stasheff—hour addresses were given by ROGER W. BROCKETT of Harvard University, MICHAEL SCHLESSINGER of the University of North Carolina, Chapel Hill, and LAWRENCE ZALCMAN of the University of Maryland, College Park. Robert B. Gardner introduced Professor Brockett, who talked about "Mathematical aspects of control theory." James D. Stasheff introduced Professor Schlessinger, who talked about "The Lie algebras of deformation theory." W. E. Kirwan introduced Professor Zalcman, who talked about "Modern perspectives on classical function theory."

The meeting began Friday at 12:30 p.m. and concluded on Saturday at 3:25 p.m. There were four special sessions of selected twenty-minute papers. Three were split into two parts, and the fourth was split into three parts. CLYDE P. MARTIN of Case Western Reserve University organized a special session on Geometric and algebraic methods in control theory, which included as participants Christopher I. Byrnes, William D. Cain, Peter E. Caines, C. A. Desoer, Heinz W. Engl, Jan M. Gronski, Edward W. Kamen, P. S. Krishnaprasad, Clyde F. Martin, Sanjoy K. Mitter, and B. F. Wyman. HERB SILVERMAN of the College of Charleston organized a special session on Lie algebras of deformations and deformation of singularities, which included as participants Igor Dolgachev, Joseph Lipman, Henry C. Pinkham, Dock S. Rim, Jayant Shah, Philip Wagreich, and Sherwood Washburn.

There were also three sessions for contributed ten-minute papers. These sessions were chaired by Gloria A. Upson, Lynn H. Pearce, and R. W. Wilkerson.

The South Carolina State Chapter of the American Statistical Association (ASA) held a meeting in conjunction with this meeting of the Society. Fred C. Leone, Executive Director of ASA, spoke on "The role of the statistician in academia, government, and industry." The Association for Women in Mathematics held a luncheon meeting on Saturday.

The people who served on the Local Arrangements Committee were W. Hugh Haysworth (chairman), Herb Silverman, Brian Wesselinke, and William Golightly.

Frank T. Birtel
New Orleans, Louisiana
Associate Secretary

The November Meeting in Chicago

The seven hundred sixty-second meeting of the American Mathematical Society was held on Sunday, November 12, 1978 at the Center for Continuing Education of the University of Chicago, Chicago, Illinois. There were 77 registrants, including 70 members of the Society.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings there were two invited one-hour addresses. PETER P. ORLIK of the University of Wisconsin, Madison, spoke on the topic "Singularities and group actions"; he was introduced by Philip D. Wagreich, RONALD R. COFFMAN of Washington University, St. Louis, addressed the Society on the subject: "Fourier transforms and noncommutative harmonic analysis"; Robert A. Fefferman presided.

By invitation of the same committee there were two special sessions of selected twenty-minute papers. ROBERT J. STANTON of Rice University organized a special session on Harmonic analysis on real groups; the speakers were Michael G. Cowling, Jiri Dadok, Daryl N. Geller, R. Ranga Rao, Peter A. Tomas, and Robert J. Zimmer. JOHN W. WOOD of the University of Illinois at Chicago Circle organized a special session on Topology of varieties; the speakers were James B. Carrell, Igor V. Dolgachev, Louis H. Kaufman, Anatoly S. Libgober, Walter D. Neumann, Richard C. Randell, and Philip D. Wagreich.

There were three sessions of contributed ten-minute papers for which James L. Heitsch, Irving Kaplansky, and Abe Sklar served as presiding officers. Of the eighteen contributed papers listed in the program of the meeting, two were withdrawn, so that sixteen ten-minute papers were actually presented.

Urbana, Illinois
Paul T. Bateman
Associate Secretary
The Annual Meeting in Biloxi

The final report of the mathematical portion of the Society's annual meeting, held in Biloxi, Mississippi, in January 1979, will appear in a later issue of the NOTICES.

Council Meeting

The Council met on January 23, 1979 at 2:00 p.m. in the Vogue Room of the Broadwater Beach Hotel in Biloxi. President Lax was in the chair.

The results of the 1978 election were reported to the Council. These appear on p. 119.

The Council elected Ed Dubinsky, Richard J. Griego, and M. Susan Montgomery to the Editorial Committee of the NOTICES for a term of four years and elected Barbara L. Osofsky, who had just completed a term, to fill out the term vacated by the resignation of George Piranian because of the pressure of other added duties.

The Council abolished "blind refereeing" as a mandatory procedure for the Proceedings while preserving it as an option open to contributors. A more detailed account of the action and of the change in procedures may be found on p. 119.

The Council authorized the publication in an early issue of these NOTICES of a statement of facts, as they appear to the Council, concerning the dismissal by Yeshiva University of two tenured professors of mathematics.

The Council has been concerned with issues related to the support of research in mathematics, particularly with the proposed Mathematical Sciences Research Institute. (The text of the call for proposals will be found on pp. 120-121 of this issue.) The Council adopted a resolution concerning its priorities for support. The text is on p. 119. For background, see pp. 481-494 of the November 1978, and pp. 61-62 of the January 1979 NOTICES. A letter by James A. Krumhansl, Assistant Director of the National Science Foundation for Mathematical and Physical Sciences and Engineering, appears on p. 118. It is accompanied by an "Announcement to Members of the Mathematical Sciences Community."

During the meeting, the Council recessed for dinner at 6:30 p.m. and reconvened at 8:00 p.m. The Council adjourned at 11:10 p.m.

Business Meeting

The Business Meeting of January 25, 1979 was held at 5:00 p.m. in the Coliseum at the Convention Center in Biloxi. President Lax presided.

The Secretary reported on actions of the Council of interest to the membership and responded to questions.

There was no stated business and no new business introduced.

The meeting adjourned at 5:20 p.m.

Bethlehem, Pennsylvania

Everett Pitcher

Secretary

SIAM-AMS PROCEEDINGS

COMPUTATIONAL FLUID DYNAMICS
edited by Herbert B. Keller

This volume is based on lectures given at the Symposium on Computational Fluid Dynamics which was held April 14-15, 1977 in New York City. The symposium consisted of three sessions with the following topics. In the area of applications, an area of particular current activity, meteorological computations, were presented along with open numerical problems. Another section was devoted to computational methods for the Navier-Stokes equations. Finally, some special methods for nonlinear waves and transonic flows were included. Authors and their lectures included in the Table of Contents are:

Bengt Fornberg, Pseudospectral calculations on 2-D turbulence and nonlinear waves
Alexandre J. Chorin, Random vortices and random vortex sheets
Carl W. Kreitzberg, Progress and problems in regional numerical weather prediction

Harold D. Orville, The numerical simulation of severe convective storms
R. F. Warming and Richard M. Beam, On the construction and application of implicit factored schemes for conservation laws
Robert W. MacCormack, An efficient explicit-implicit-characteristic method for solving the compressible Navier-Stokes equations
S. C. R. Dennis, The computation of two-dimensional asymmetrical flows past cylinders.

Some knowledge of numerical analysis is required.

Volume 11
184 pages
List price $17.60; member price $13.20
ISBN 0-8218-1331-5; LC 78-9700
Publication date: July 31, 1978

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Send for the book(s) above to: AMS, P.O. Box 1571, Annex Station, Providence, RI 02901.
FRACTURE MECHANICS
Edited by Robert Burridge
SIAM-AMS Proceedings, Volume 12

This volume contains expanded versions of ten of the twelve invited papers given at a joint AMS/SIAM Symposium on Mathematical Problems in Fracture Mechanics, New York, March 28–29, 1978, the purpose of which was to interest applied mathematicians in this area of mechanics, which is currently of growing interest both in engineering and in the theory of earthquake mechanisms.

The Proceedings are divided into four sections which correspond to the four sessions at the Symposium: I. Dynamic Fracture Problems, II. Seismic Source Theory, III. Nonlinear Fields and Integral Conservation Laws, IV. Rate-Dependent and Non-Elastic Crack Growth.

The section on dynamic fracture problems deals with cracks running at speeds comparable with the wave speeds in the material. J. D. Achenbach opens with a broad introductory survey. L. B. Freund follows with a description of some one-dimensional problems which model fracture phenomena but have the virtues of being more transparent conceptually than the more usual two- and three-dimensional problems while retaining features essential to fracture mechanics. The paper by R. Burridge, G. Conn and L. B. Freund, which for reasons of copyright appears here only in abstract, solves a special problem but in the context of shearing rather than the more usual tensile fracture. Much interest in shear failure has been generated by recent advances in the study of earthquake mechanisms.

The section on seismic source theory opens with a survey by K. Aki who describes the evolution of modern theories of earthquake mechanisms and some of the relevant seismic observations. R. Madariaga follows with a more detailed study of a particular earthquake source model. He describes the pulse shapes and spectra, the features of seismic signals most easily observed in practice, which would be generated by his model. In the next paper at the Symposium, but unfortunately not included in this volume, D. J. Andrews described a numerical simulation of an earthquake source which showed an unexpected feature that the rupture ultimately ran faster than the shear wave speed. This is one example of a phenomenon which may occur in the context of frictional sliding but which does not occur in the more extensively studied realm of tensile fracture. This particular work also provided a motivation for the paper by Burridge et al. mentioned earlier.

Up to this point most of the analysis lies within linear elastodynamic theory. However, near crack tips large stresses and strains occur which make it desirable to introduce at least an "inner region" around the crack tip where nonlinear theory may be applied. J. K. Knowles describes a beautiful solution to a crack problem taking into account a fully nonlinear elastic constitutive law. J. R. Willis follows with an application of matched asymptotic expansions to the study of a crack with a plastic tip region. Although this technique has been used extensively in fluid dynamical problems for some time it is relatively new in fracture mechanics and shows great promise here. L. B. Freund follows with an extremely elegant demonstration of the use of one kind of path independent integral by which quantities of interest may be calculated directly from the boundary values of a problem without the need for a full, detailed solution.

In the last section growing cracks are again considered. However, the growth is slow enough not to require a fully dynamic treatment. Each problem has its own particular difficulty. J. C. Amazigo considers the growth of a crack in an elastic-plastic material. R. A. Schapery treats crack growth in a saturated porous medium as a mechanism for stabilizing crack growth.
LECTURES IN APPLIED MATHEMATICS

MODERN MODELING OF CONTINUUM PHENOMENA
Edited by Richard C. DiPrima

The articles contained in this volume follow the pattern of the lectures presented at the Ninth Summer Seminar on Applied Mathematics, sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics, held at Rensselaer Polytechnic Institute from July 7 to July 18, 1975. The articles are more detailed and include generalizations that could not be presented during the lectures.

The purposes of the seminar and therefore of this volume are (i) to introduce the participants to selected mathematical research areas of high current interest and relevance, (ii) to present the underlying fundamental laws of continuum model building, and (iii) to present selected mathematical topics particularly useful in solving modern mathematical problems of continuum phenomena.

The table of contents is: An introduction to continuum theory by Lee A. Segel; Perturbation theory by Donald S. Cohen; Introduction to the asymptotic analysis of stochastic equations by George C. Papanicolaou; Lectures in population dynamics by G. Oster; Anoehoid motions by Garrett M. Odell; and Earthquake sources by Leon Knopoff and John O. Mouton.

1977, 251 pages; list $30.80; institutional member $23.10; individual member $15.40. (ISBN 0-8218-1116-9; LC 77-9041); Code: LAM/16

MATHEMATICAL PROBLEMS IN THE

GEOPHYSICAL SCIENCES
Edited by W. H. Reid

Part 1. Geophysical fluid dynamics
Part 2. Inverse problems, dynamo theory, and tides

These volumes constitute the proceedings of the Sixth Summer Seminar in Applied Mathematics, sponsored jointly by the American Mathematical Society and Applied Mathematics, which was held in the summer of 1970. In the geophysical sciences there is an important interplay between the observational and experimental work on the one hand and the mathematical developments on the other. This aspect of the subject is clearly evident in many of the papers which appear in these proceedings. Part 1 (Volume 13) contains papers by D. J. Benney, F. P. Bretherton, G. F. Carrier, J. G. Charney, R. Hide, L. N. Howard, R. E. Meyer, J. Pedlosky, and J. T. Stuart. Part 2 (Volume 14) consists of papers by G. E. Backus, F. Gilbert, R. S. Lindzen, W. V. R. Malkus, G. W. Platzman, P. H. Roberts, and K. Stewartson.


MEMOIRS OF THE AMERICAN

MATHEMATICAL SOCIETY

A NEW FORMULATION OF PARTICLE MECHANICS
Reese T. Prosser

This paper presents an abstract formulation of particle mechanics and derives its most elementary properties. The formulation is based on a suitable generalization of the moment problem, and is designed to include both the classical and the quantum mechanics of systems of point particles as special cases. Questions of classification, representation and interpretation are taken up in turn. In particular, it is shown that under this formulation every system of mechanics is a suitable combination of the two special cases, so that no essentially different systems are possible.


TRANSLATIONS OF MATHEMATICAL

MONOGRAPHS

DYNAMICS OF NONHOLONOMIC SYSTEMS
Ju. I. Neimark and N. A. Fufaev
Translated by J. B. Barbour

This volume gives the first comprehensive and systematic exposition of the mechanics of nonholonomic systems, including the kinematics and dynamics of nonholonomic systems with classical nonholonomic constraints, the theory of the stability of nonholonomic systems, technical problems of the directional stability of rolling systems, and the general theory of electrical machines. The authors have brought together and united the abstract theory of analytic mechanics and the applied problems of stability of rolling systems and the theory of electrical machines. In order to present the concrete applications as fully as possible, a large number of examples are included. The book references are included in the bibliography.


PROCEEDINGS OF SYMPOSIA

IN APPLIED MATHEMATICS

MAGNETO-FLUID PLASMA DYNAMICS
Edited by H. Grad

This book contains the manuscripts of the invited addresses which were presented at a symposium on Magneto-fluid and Plasma Dynamics in New York City in 1965.

The subject matter concerns the physical interaction between electro-magnetic fields and fluids. Viewpoints expressed at the symposium range widely across mathematical physics and applied mathematics. While some contributions tend to emphasize the physical aspects of the problem, others, although physically motivated, are guided somewhat more by mathematical structure.

The contributors are:

K. M. Case J. M. Greene N. Rostoker
C. K. Chu G. S. S. Ludford R. Z. Sagdeev
E. A. Frieman W. V. R. Malkus M. Trocheris
H. Grad M. N. Rosenbluth H. Weitzner
P. Germain

Code: PSAPM/18

PROCEEDINGS OF THE STEKLOV INSTITUTE

ASYMPTOTIC METHODS AND STOCHASTIC MODELS
IN PROBLEMS OF WAVE PROPAGATION (1968)
Edited by G. I. Petrosyan and K. P. Latyshev

These proceedings contain results on wave propagation which have been obtained just prior to 1968 at the Lenin­grad Branch of the Steklov Institute of Mathematics of the Academy of Sciences of the USSR. In subject matter the book divides into two parts. The first part contains three papers on stochastic approaches to problems of the propagation of seismic waves. In respect of generality and the order
of realization, there appear to be no analogous papers in the literature. The remaining papers are concerned with problems of the propagation and diffraction of waves in determinate media. This collection of papers can prove valuable to specialists interested in problems of wave propagation and to mathematicians concerned with the practical application of probability theory and mathematical statistics.

1971, 256 pages; list $23.60; institutional member $17.70; individual member $11.80. (ISBN 0-8218-1895-3). Code: STEKLO/95

PROBLEMS IN THE THEORY OF POINT EXPLOSION IN GASES
V. P. Korobeinikov

The theory of point explosion arose from the necessity of describing processes of propagation of explosions from concentrated charges in continuous media.

The monograph is devoted to the development of the theory of point explosion in gases. It contains formulations of new problems; theoretical models of the motion of the medium are constructed which take account of various physical phenomena and properties of the medium; methods of solving the new problems which arise are developed; a detailed study of problems of the theory which have previously been formulated is presented. Certain applications to physical problems are considered.

This issue is intended for specialists in hydrodynamics and applied mathematics and especially those students in advanced courses who are studying these disciplines.

1976, 311 pages; list $37.20; institutional member $27.90; individual member $18.60. (LC 75-45104; ISBN 0-8218-3019-8). Code: STEKLO/119

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SPECIAL MEETINGS
Continued from p. 127

LATE ENTRIES

March 15-17. Thirteenth Annual Spring Topology Conference, Ohio University, Athens, Ohio.

Program: With the anticipated support of NSF, there will be invited lectures as well as presentations of contributed papers on topics of current research in topology. Areas represented include abstract spaces, continua theory, descriptive set theory, geometric topology, infinite dimensional topology, shape theory, and set-theoretic topology. Special problem sessions on infinite dimensional topology on March 16-18 will be organized by R. D. Anderson, T. A. Chapman, and J. E. West.


Information: George M. Reed, Associate Director, Institute for Mathematics and Medicine, Ohio University, Athens, Ohio 45701. Correspondence on the special problem sessions should be sent directly to the organizers.


Information: Ulrich Koschorke, Mathematik, Gesamthochschule Siegen, 59 Siegen, Federal Republic of Germany; Walter Neumann, Mathematics Department, University of Maryland, College Park, Maryland 20742.

July 22-August 12. Canadian Mathematical Society Annual Seminar, University of Toronto, Toronto, Canada.

Program: In each of the three weeks there will be a series of broad expositions of research in an area of ordinary differential equations, in addition there will be plenary lectures, special sessions, and an opportunity for contributed talks.

Principal Lecturers: W. N. Everitt (Dundee, spectral theory), H. T. Banks (Brown University, Functional Differential Equations), J.-P. Aubin (Paris) and A. Cellino (Padova) on Multi-valued differential equations, C. Lobry (Bordeaux, Optimal Control).


Special Sessions and Organizers: Spectral theory (P. J. Browne), Qualitative theory (L. Erbe, M. Muldoo), Non-linear boundary-value problems (J. Macki), Functional differential equations (A. Manitius), Geometric control (V. Jurdjevic).

Information: F. V. Atkinson, Department of Mathematics, University of Toronto, Toronto, Ontario, MSS 1A1, Canada.
ABSTRACTS

ABSTRACTS ARE GROUPED according to subjects chosen by the author from categories listed on the abstract form and are based on the AMS (MOS) Subject Classification Scheme (1970). Abstracts for which the author did not indicate a category are listed under miscellaneous.

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Abstracts of papers for

Presentation by title
Past meetings (late papers)
764th meeting in Honolulu, March 30–April 1, 1979

Appear on page
A-191
A-232
A-232

Subjects represented

<table>
<thead>
<tr>
<th>Subject Represented</th>
<th>By Title</th>
<th>764th</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Algebra and Theory of Numbers</td>
<td>A-191</td>
<td>A-232</td>
</tr>
<tr>
<td>B Analysis</td>
<td>A-205</td>
<td>A-241</td>
</tr>
<tr>
<td>C Applied Mathematics</td>
<td>A-218</td>
<td>A-246</td>
</tr>
<tr>
<td>D Geometry</td>
<td>A-223</td>
<td>A-246</td>
</tr>
<tr>
<td>E Logic and Foundations</td>
<td>A-224</td>
<td>A-247</td>
</tr>
<tr>
<td>F Statistics and Probability</td>
<td>A-227</td>
<td></td>
</tr>
<tr>
<td>G Topology</td>
<td>A-227</td>
<td>A-250</td>
</tr>
<tr>
<td>H Miscellaneous</td>
<td>A-227</td>
<td>A-253</td>
</tr>
</tbody>
</table>

Abstracts of Papers Presented to the Society

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

79T-A29 PAUL J. CAMPBELL, Beloit College, Beloit, Wisconsin 53511. The splitting method for Egyptian fractions is an algorithm.

The sequence \( n_1, n_2, \ldots, n_k \) of distinct positive integers is a (finite) Egyptian fraction expansion of the positive rational \( a/b \) if \( a/b = 1/n_1 + \ldots + 1/n_k \). The identity \( 1/n = 1/(n+1) + 1/n(n+1) \) forms the basis for the splitting method of generating an expansion: beginning with an input sequence of \( a \) copies of \( b \), the identity is applied in successive stages to remove duplicates of one unit fraction at a time, in the hope that after a finite number of stages all duplicates will have been removed. The method was discussed without proof by B. M. Stewart (Theory of Numbers, 2nd ed., 1964, pp. 198-207) and by M. N. Bleicher (A. Beck et al., Excursions into Mathematics, 1969, pp. 422-425), and is related to the "chain reaction process" of T. Botts (Math. Magazine 40 (1967) 55-65). The author provides two graph-theoretic proofs that the splitting method always terminates finitely. The first proof is valid for an arbitrary finite input sequence; the argument is similar to (but was devised without knowledge of) a combinatorial lemma of K. A. Post (Amer. Math. Monthly 77 (1970) 1085-1087). The second proof gives an estimate of how fast the number of terms grows with input sequence length. Another result shows that Botts' procedure, when generalized to arbitrary input strings, is equivalent to the splitting method. (Received October 23, 1978.)

79T-A30 KI HANG KIM and FRED W. ROUSH, Alabama State University, Montgomery, Al. 36101. A STATISTICAL PROOF OF THE VAN DER WAERDEN CONJECTURE.

We consider the measure on the set of doubly stochastic matrices which arises by representing them as convex combinations of permutation matrices. We derive a formula for the average value of the permanent, and shown this average permanent is always greater than \( n!/n^n \) for \( n > 1 \). Let \( n = \{1, 2, \ldots, n\} \).
THEOREM 1. The expected value of the permanent of an $n \times n$ doubly stochastic matrix, using the probability measure $\mu$ is
\[ \frac{n!}{(n+1)!} \sum_{\pi} \left( - \frac{n!}{k_1! \ldots k_n!} \right)_{\pi} \mu(\pi, \pi') \prod_{i=1}^{n} (n - i)! \left( \begin{array}{c} k_i \\ n - i \end{array} \right). \]

In this expression the first summation is over all partitions $\pi$ of $n$ in which every cell is an interval and the cells are arranged in order of nonincreasing size. This set is in 1-1 correspondence with partitions of the integer $n$. The second summation is over all partitions $\pi'$ of $n$ whose cells are unions of cells of $\pi$. The numbers $k_i$ and $k_i'$ respectively, are the numbers of cells of size $i$ in $\pi$ and $\pi'$, respectively. And $\mu(\pi, \pi')$ denotes the Mobius functions.

THEOREM 2. The expected value of the permanent of an $n \times n$ doubly stochastic matrix is at least $n!/n^n$ for each value of $n$. In general it is at least
\[ \frac{n!}{n^n} \left( 1 + \frac{1}{2(n - 1)!} + O\left( \frac{n^2}{(n - 1)!^2} \right) \right). \]

(Received October 23, 1978.)

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**#79T-A31** ALLAN B. CRUSE, University of San Francisco, San Francisco, California 94117. **On removing a vertex from the assignment polytope.**

A nonnegative $n \times n$ matrix is doubly stochastic if all its row-sums and column-sums are 1. It is well known that the set of all such matrices is the convex hull of the $n!$ permutation matrices of order $n$. Because of its connection with the famous "optimal assignment problem," this convex set is called the **assignment polytope**. An $n \times n$ matrix $T = (t_{ij})$ is a generalized tournament if it satisfies: $i) t_{ij} \geq 0$, $ii) t_{ii} = 0$, $iii) t_{ij} + t_{ji} = 1$, for all distinct $i, j$; in case $T$ also satisfies: $iv) t_{ij} + t_{jk} + t_{ki} \geq 1$, for all distinct indices $i, j, k$, then $T$ is called transitive. The following theorem answers a question posed by L. Mirsky. **Theorem.** An $n \times n$ matrix $X = (x_{ij})$ belongs to the convex hull of the non-identity permutation matrices of order $n$ if, and only if, $X$ is doubly stochastic and satisfies $\sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij} x_{ij} \geq 1$, for every generalized transitive $n \times n$ tournament $T = (t_{ij})$. Our proof employs the fundamental "duality" and "complementary slackness" principles of linear programming. We remark that, for $n \geq 6$, there exist generalized transitive $n \times n$ tournaments which cannot be expressed as convex combinations of integral matrices satisfying (i)-(iv). (Received October 28, 1978.)

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**#79T-A32** Clôvis P. da Silva and Florinda K. Miyaoka, Federal University of Paraná, Caixa Postal 1963, Curitiba (80.000), Brazil. **Relations among quasigroups.** Preliminary report.

In this paper we show relations among some classes of unipotent quasigroups, i.e., quasigroups $(G, \cdot)$ which contain an element $x$ such that $a \cdot x = x$, $\forall a \in G$. A quasigroup is called subtractive iff $b \cdot (a \cdot x) = a$ and $a \cdot (b \cdot c) = c \cdot (b \cdot a) \forall a, b, c \in G$. A quasigroup $(G, \cdot)$ is called medial iff $(a \cdot b) \cdot (c \cdot d) = (a \cdot c) \cdot (b \cdot d)$, $\forall a, b, c, d \in G$. We define Ward quasigroup as any quasigroup $(G, \cdot)$ which satisfies the axioms: there is an element $i \in G$ such that $a \cdot i = a$ and $(a \cdot b) \cdot c = a \cdot (c \cdot (i \cdot b))$, $\forall a, b, c \in G$. A quasigroup $(G, \cdot)$ which contains an element $i$ which satisfies the axioms $a \cdot x = b \leftrightarrow x = (i \cdot b) \cdot (i \cdot a)$ and $y \cdot a = b \leftrightarrow y = b \cdot (i \cdot a)$, $\forall a, b \in G$, was called Cardoso quasigroup by A. Sade (An. Sti. Univ. "Al. I. Cuza" 13(1967), 5-15). If the class of the quasigroup is denoted by the initial letter of the respective name, then: 1) $S \subset W \subset C : U$; 2) $M \subset C = S$. Furthermore, we establish necessary and sufficient conditions for a Cardoso quasigroup to be a loop. (Received October 26, 1978.) (Authors introduced by Professor Jayme M. Cardoso).

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**#79T-A33** TEMPLE H. FAY, New Mexico State University, Las Cruces, New Mexico 88003. **A Characterization of Topological Functors.**

If $T: A \rightarrow X$ is a semi-topological functor with $T$-generating morphisms in $X$ which are sections being necessarily isomorphisms, then $T$ is topological if and only if $T$ has a full and faithful right adjoint. Thus $(E, M)$-topological functors are topological if and only if they admit a full and faithful right adjoint. (Received October 26, 1978.)
On products of lattice varieties. II.

Theorem. Let \( A \) and \( B \) be lattice varieties. Then every lattice \( L \) in \( A \circ B \) can be embedded in a subdirectly irreducible lattice \( S \) in \( A \circ B \). If \( L \) is finite, \( S \) can be chosen to be finite. Combining the Theorem with results from Part I we obtain: Corollary 1. The lattice of equational classes of lattices has \( 2^{0} \) join-irreducible members. A. Day (Idempotents in the groupoid of all \( \sim \) classes of lattices) proved that \( X = 1 \) and \( X = T \) are the only solutions of \( X \circ X = X \). We generalize his result by considering the equation \( X \circ Y = X \vee Y \) for lattice varieties \( X \) and \( Y \). Call a solution \( X \circ Y \) of \( X \circ Y = X \vee Y \) trivial iff \( \{ X, T \} \cap \{ Y, T \} \neq \emptyset \).

Corollary 2. \( X \circ Y = X \vee Y \) has only trivial solutions. (Received October 30, 1978.)

A slight adaptation and simplification of an argument of Bergman (most accessible reference: P.M. Cohn, Skew field constructions, 165-171) is used to prove the following: Theorem. Let \( D \) be a fixed division ring and let \( E \supset D \) be a division ring with involution \( * \) and with infinite center \( C \), such that \( (E:C) = \infty \). Let \( X = \{ x_1, x_2, \ldots, x_m, y_1, y_2, \ldots, y_m \} \), let \( R \) be the set of all formal rational expressions in \( X \) and the elements of \( D \) (in the sense of Bergman), and set \( S = \{ \text{p} e \mathbb{E}^{2m} \mid p = (a_1, a_2, \ldots, a_m, a_1^*, a_2^*, \ldots, a_m^*) \} \). Then any element of \( f \in R \) vanishing on \( S \) (wherever defined) must vanish on \( E \) (wherever defined). (Received October 30, 1978.)

More than sixty years ago, Professor Pólya proved that a real interval of length less than four can contain only a finite number of sets of conjugate algebraic integers. In the present paper, we prove the complementary result that any real interval of length greater than four contains an infinite number of sets of conjugate algebraic integers. The problem remained unsolved for intervals of length exactly four, except when the end-points are rational integers, in which case there are infinitely many sets. The first contribution to the problem was made by Kronecker [1] and later by R. Robinson[2]. The purpose of the present paper is to give a complete solution of the above problem.

REFERENCES:

Theorem: Every \( G \)-image of \( D \) has some ordinary or color-interchange symmetry.

**EXAMPLE:**

\[
\begin{array}{cccc}
\bullet & \circ & \bullet & \circ \\
\circ & \bullet & \circ & \bullet \\
\bullet & \circ & \bullet & \circ \\
\circ & \bullet & \circ & \bullet \\
\end{array}
\]

\( = \)

\[
\begin{array}{cccc}
\bullet & \circ & \bullet & \circ \\
\bullet & \circ & \bullet & \circ \\
\bullet & \circ & \bullet & \circ \\
\bullet & \circ & \bullet & \circ \\
\end{array}
\]

\( = Dg \) (where \( g \in G \) is a product of two disjoint 7-cycles).

Note that \( Dg \) has rotational color-interchange symmetry like that of the famous \textit{yin-yang} symbol.

**REMARKS:** \( G \) is isomorphic to the affine group on \( V_4 \) (GF(2)). The 35 structures of the 840=35·24 \( G \)-images of \( D \) are isomorphic to the 35 lines in the 3-dimensional projective space over GF(2);
orthogonality of structures corresponds to skewness of lines. We can define sums and products so that the G-images of D generate an ideal (1,024 patterns characterized by all horizontal or vertical "cuts" being uninterrupted) of a ring of 4,096 symmetric patterns. There is an infinite family of such "diamond" rings, isomorphic to rings of matrices over GF(4). (Received October 31, 1978.)

79T-A38 LOUIS H. ROWEN, Bar Ilan University, Ramat Gan, Israel. Additive subgroups of prime rings with involution.

Let (R,*) be a ring with involution which is prime, in the sense that the product of any two nonzero (*)-invariant ideals is nonzero. Also assume 2R ≠ 0. Let S = {antisymmetric elements of R} and K = {antisymmetric elements of R}, let Z = Cent(R), and let C be the extended centroid of (in the sense of Martindale-Amitsur). For any Lie ideal U of K and any additive subgroup A of R such that A, U ⊆ A, one of the following conclusions holds: (i) The standard polynomial S is an identity of R; (ii) U ⊆ Z or A ⊆ Z; (iii) For some (*)-invariant ideal I of R with [IK,K] (resp. [IK,S]) not commutative, and for some μ ∈ C, [IK,K] ⊆ A or μ[IK,S] ⊆ A. If A = A or if (*) is of the first kind on the central closure of R, we may take μ = 1. We may take μ invertible unless ANP* = 0 for some prime ideal P of R with FN = 0 (in this case R is not prime). The starting point for these results is theorem 2 of Lanski, Comm. Alg. 6 (1), 1978, pp. 75-96. (Received November 2, 1978.)

79T-A39 S.A. AMITSUR, Hebrew University, Jerusalem, Israel, L.H. ROWEN, Bar Ilan University, Ramat Gan, Israel, and J.P. TIGNOL, Université Catholique de Louvain, Louvain-la-Neuve, Belgium. Division algebras with involution.

Examples of division algebras with involution of the first kind are given, having the respective properties: (i) D has degree 8, and is not the tensor product of quaternion subalgebras; (ii) D has degree 4, and is not the tensor product of quaternion subalgebras invariant under the given involution. The first example answers negatively a long-standing question of Albert. (Received November 2, 1978.)

79T-A40 HARRIET J. FELL, Northeastern University, Boston, Massachusetts 02115. Convex Combinations of Polynomials.

Theorem: Let P₀ and P₁ be monic polynomials of degree n with all of their zeros contained in the disk |z| ≤ 1, then for 0 ≤ A ≤ 1 all of the zeros of P₀ = (1-A)P₀ + AP₁ are contained in the disk |z| ≤ 1/sin(π/2n).

Theorem: Let P₀ and P₁ be real monic polynomials of degree n with all of their zeros contained in the disk |z| ≤ 1, then for 0 ≤ A ≤ 1 all of the zeros of P₀ = (1-A)P₀ + AP₁ are contained in the disk |z| ≤ cot(π/2n). (Received November 2, 1978.)

79T-A41 B. C. Kestenband, New York Institute of Technology, Dept. of Mathematics, Old Westbury, N.Y. 11568. Geometries that are disjoint unions of caps.

We show that any Desarguesian PG(2n,q²) is a disjoint union of (q²ⁿ+1 - 1)/(q-1) (q²ⁿ+1 + 1)/(q + 1)-caps. Further, these caps constitute the "large points" of a PG(2n,q), with the incidence relation defined in a natural way.

A square matrix H = (h_ij) over GF(2,q²) is Hermitian if h_ij = h_ij for all i,j. A = (a_ij) being any matrix, let A = (a_ij).

A square matrix H = (h_ij) over GF(2,q²) is Hermitian if h_ij = h_ij for all i,j. A = (a_ij) being any matrix, let A = (a_ij).

In PG(2n,q²), the set of points x satisfying xHx = 0, H being Hermitian, is a Hermitian variety and we denote it by \{H\}.

Let H be a 2n+1 by 2n+1 Hermitian matrix with irreducible characteristic polynomial over GF(q). Let then H be a primitive root of the GF(q²ⁿ+1) consisting of the polynomials p(H') over GF(q). Consider the family \( \chi = \{H^k : i=0,1,...,(q²ⁿ+1-q)/(q-1)\} \). Let \( \{\chi\} = \{H^k : H^k \in \chi\} \).
Theorem. Any $2n$ independent Hermitian varieties from $\{x\}$ intersect on a $(q^{2n+1}+1)/(q+1)$-cap and any two such caps are disjoint.

Corollary. The point set of any Desarguesian $PG(2n,q^2)$ is a disjoint union of $(q^{2n+1}+1)/(q+1)$-caps. If we call these caps "large points", they form a $PG(2n,q)$, the "large lines" of which are the intersections of $2n-1$ independent Hermitian varieties from $\{x\}$. (Received November 7, 1978.)

79T-A42 M. S. BURGIN, Gilvarovskogo 56-78, Moscow-110, USSR. Some properties of the set of Schreier varieties of linear $\Omega$-algebras. Preliminary report.

Let $M$ be the variety of all (all commutative) linear over a field $K$ $\Omega$-algebras. If $|K| \leq \max (\aleph_0, |\Omega|)$ then it is supposed that the Generalized Continuum Hypothesis is valid. Theorem 1. The cardinality of the set of all Schreier subvarieties of $M$ is equal to the cardinality of the set $V$ of all subvarieties of $M$. As it is shown in [1] the set $V$ has uncountable cardinality. The proof of Theorem 1 uses the criterion from [2] and the following result. Theorem 2. There is an infinite irreducible system of identities that define a Schreier variety of commutative linear $\Omega$-algebras. Corollary. There is a set of Schreier varieties of commutative linear $\Omega$-algebras ordered by the inclusion relation and isomorphic to the interval $[0,1]$.


Let $R$ be an alternative ring with idempotent $e$ and let $R = R_{ii} \oplus R_{i0} \oplus R_{0i} \oplus R_{00}$ be the Peirce decomposition of $R$ with respect to $e$. Then if $P$ denotes the prime radical we have $P(R_{ii}) = R_{ii} \cap P(R)$. In the course of the proof we show that if $R$ is simple then $R_{ii}$ is simple for $i = 0,1$.

(Received November 13, 1978.)

#79T-A44 ALBERT A. MULLIN, USA BMD Advanced Technology Center, Data Processing, P. O. Box 1500, Huntsville, Al. 35807. More on special rational approximations.

Definition. An Egyptian prime is the reciprocal of a positive rational prime.

Lemma. Each positive real number can be rationally approximated as a finite sum of distinct Egyptian primes. As in the earlier sequel [ these Notices 25 (1978), A-422; 78T-A106 ], this note addresses the problem of economical rational approximations; e.g., determination of the minimum number of distinct Egyptian-prime summands necessary to approximate rationally any given (real) algebraic or transcendental number to within a prescribed tolerance. Problems. Determine the minimum number of distinct Egyptian-prime summands necessary to approximate rationally (1) $\pi^2$ to within $10^{-6}$, (2) $e^e$ to within $10^{-6}$, and (3) $2^{1/3}$ to within $10^{-6}$. Note: the solution to the first problem exceeds 13,109 summands. (Received November 13, 1978.)

#79T-A45 Robert Gilmer, Florida State University, Tallahassee, Florida 32306 and William Heinzer, Purdue University, W. Lafayette, Indiana, 47907. The Laskerian property for power series rings. Preliminary report.

A commutative ring $R$ with identity is a $ZD$-ring if the set of zero divisors on the $R$-module $R/A$ is a finite union of prime ideals for each ideal $A$ of $R$. The second author and J. Ohm [Proc. Amer. Math. Soc. 34(1972), 73-74] have shown that the conditions Noetherian, Laskerian, and $ZD$ are equivalent in the polynomial ring $K[X]$ in one indeterminate over $R$. In contrast to this result, we show that the power series ring $R[[X]]$ is Laskerian if and only if $R$ is Noetherian, whereas $R[[X]]$ a $ZD$-ring implies $R$ has Noetherian spectrum, but $R$ need not be Noetherian. Related to these considerations it is shown that, in general, a Laskerian ring has Noetherian spectrum. (Received November 16, 1978.)

A-195
Let $R$ be a commutative ring with identity, let $S$ be an additive abelian semigroup with identity, and let $f = r_1X^{s_1} + r_2X^{s_2} + \ldots + r_nX^{s_n}$ be an element of the semigroup ring $R[X;S]$ of $S$ over $R$. We seek a characterization, in terms of the coefficients and support of $f$, in order that it be a unit of $R[X;S]$, such a characterization requires some restrictions on $S$. Theorem 1. Assume that $S$ is torsion-free and cancellative. Then $f$ is a unit of $R[X;S]$ if and only if there exists a positive integer $k$ such that $r_i$ is not nilpotent for each $i$ such that $r_i$ is invertible in $S$ for each $i$ such that $r_i$ is not nilpotent. Theorem 2. Assume that $S$ is torsion-free and that 0 is the only idempotent of $S$; let $G$ be the set of invertible elements of $S$. Write $f = f_1 + f_2$, where $f_1 \in R[X;G]$ and $f_2 \in R[X;S-G]$. Then $f$ is a unit of $R[X;S]$ if and only if $f_1$ is a unit of $R[X;G]$ and each coefficient of $f_2$ is nilpotent. (Received November 16, 1978.)

On lattices, rings with polynomial identities.

By a ring $R$ we mean a noncommutative ring (not necessarily having 1). The purpose of this paper is to show that certain types of polynomial identities on $R$ induce a lattice structure on $R$. Theorem 1. Let $< R, +, \cdot >$ be a ring satisfying a polynomial identity $P(X, Y) = XYX - YX$ and with left annihilator of $R$ equal to zero. Then (i) $R$ is a generalized boolean lattice under the operations defined by $a \wedge b = a \cdot b$ and $a \vee b = a + b + ab$, (ii) $x$ a bijection map between the subrings of $< R, +, \cdot >$ and the sublattices of $< R, \wedge, \vee >$. Theorem 2. Let $< R, +, \cdot >$ be a ring satisfying a polynomial identity $P(X, Y) = YX - XY^2$. Then also the results (i), (ii) of Theorem 1 hold. Theorem 3. Let $< R, +, \cdot >$ be a ring of characteristic 2, satisfying the identity $x^2 = x$. Then, $< R, \wedge, \vee >$ is a generalized boolean lattice. (Received November 3, 1978.) (Author introduced by Dr. D. Sundararaman).

On the equation $|Ax^q - By^q| = 1$. Preliminary report.

Let $A$ and $B$ be fixed positive integers. It is proved here that the equation $|Ax^q - By^q| = 1$, where $q$ is prime $\geq 5$, has at most one solution in positive integers $x, y$ if at least one of the following condition is satisfied: (a) $|A-B| > 1$, (b) $A = B+1 \geq \max(8, (q+1)/2)$, (c) $q > 3.25 \times 10^{11}$, (d) $q = 5$. (Received November 20, 1978.) (Author introduced by Professor Raymond G. Ayoub).

Linear transformations on matrices: the invariance of rank $k$ matrices, II.

Let $M_{m,n}(F)$ denote the set of all $m \times n$ matrices over the algebraically closed field $F$ and let $T$ be a linear transformation on $M_{m,n}(F)$. $T$ is said to preserve rank $k$ matrices if the image under $T$ of every rank $k$ matrix is a rank $k$ matrix. Theorem: If $T$ preserves rank $k$ matrices and if the kernel of $T$ is not a nonzero subspace of rank 1 matrices then there exist nonsingular $m \times m$ and $n \times n$ matrices $U$ and $V$ respectively such that either i) $T:A \rightarrow UAV$ for all $A \in M_{m,n}(F)$; or ii) $m = n$ and $T:A \rightarrow U^TAV$ for all $A \in M_{m,n}(F)$, where $A^T$ denotes the transpose of $A$. (Received November 21, 1978.)

On a Conjecture Concerning Broadcasting in Grid Graphs. Preliminary report.

Broadcasting in $m$-dimensional grid graph originates at one vertex of the graph, and proceeds along its edges, so that each unit of time an informed vertex may call one new vertex. Let $g(m,n)$ denote the maximum number of vertices of the $m$-dimensional grid graph which may be informed by the end of $n$
We have shown that
\[ g(2,n) = 2n^2 - 6n + 8, \quad n \geq 5 \]
and
\[ g(3,n) = \frac{4}{3} n^3 - 11 n^2 + \frac{101}{3} n - 28, \quad n \geq 9. \]
The first result verifies the conjecture of Cockayne and Hedetniemi (and of Farley and Hedetniemi), the second result implies that the best known broadcasting schemes in higher dimensions are not, as was expected, optimal. (Received November 21, 1978.)


Given a graph G(V,E), |V| = n, and a subset S c V the Theta Operator Θ(S) is the number of edges between S and V. The Theta Operator Problem is the following: Given a real constant P, \( 1 \leq P \leq \infty \), and a graph G, find a sequence \( S_0 \subset S_1 \subset S_2 \subset \ldots \subset S_n = V \), where \( |S_i| = i \) which minimizes \( \sum_{i=0}^{n} P|Θ(S_i)| \).

In this paper, it is shown that there exist polynomial algorithms for the special cases where G is a rooted or unrooted tree. (Received November 27, 1978.) (Author introduced by Professor L. Harper).

Let A, B, C, ... denote objects in a subcategory T of the category of sets. Assume further that T contains finite direct products and that each coordinate projection is a homomorphism. An n-ary relation \( R \subseteq A^n \) is generic in A provided there is some \( B \in T \) and \( b \in B^n \) with \( R = \{ (ab_1, \ldots, ab_n) | a \in \text{Hom}(B,A) \} \). Thus a generic relation is obtained by "surveying morphisms" on a fixed n-tuple. R is indigenous in A if R is finitely generic, i.e. for each finite \( D \subseteq R \) there is a generic relation G with \( D \subseteq G \subseteq R \). R is substitutive over A provided R is a subalgebra of \( (A^*)^n \) with \( A^* = \langle A, f \rangle_{f \in \text{Hom}(A^k, A)} \). If A itself is an algebra then subalgebras, endomorphisms and congruences are examples of substitutive relations. We prove Theorem 1: R \( \subseteq A^n \) is substitutive over A iff R is indigenous in A. Various concrete characterization Theorems for subalgebras, endomorphisms, substitutive relations, and congruences due to J. Schmidt, the authors, L. Szabó, H. Werner and others follow as corollaries, by appropriate manipulation of the category T. (Received November 27, 1978.)

D. J. HARTFIEL and ARTHUR M. HOBBS, Texas A&M University, College Station, Texas 77843. A k-connected graph can be partitioned into k connected subgraphs of prespecified sizes.

We prove: Let G be a k-connected graph. Let \( p_1, p_2, \ldots, p_m, \ m \leq k \), be positive integers whose sum is \( |V(G)| \). Then there exist disjoint connected subgraphs \( H_1, H_2, \ldots, H_m \) of G such that \( |V(H_i)| = p_i \) for each i. In addition, we provide an algorithm for finding these subgraphs. This result is best-possible, in the sense that m cannot exceed k, as is shown by the graph \( K_k, r \), with \( r \geq k \), which is k-connected but cannot be decomposed into more than k connected subgraphs with 2 or more vertices in each. Finally we discuss how this result can be applied to routing problems in computer networks. (Received November 29, 1978.)

S.S. SANB, Department of Mathematics, Indian Institute of Technology, Bombay 400 076, India. New invariant pairs for projective Hjelmslev planes.

Some general constructions of projective Hjelmslev planes are given which imply the existence of a projective Hjelmslev plane with an invariant pair (t,2), where

(1) \( t = 20 \ q^n, \quad 11 \leq q \leq 59, \)
(11) \( t = 32 \ q^n, \quad 17 \leq q \leq 95, \)
(11i) \( t = 36 \ q^n, \quad 13 \leq q \leq 107, \)
(iv) \( t = 44 \ q^n, \quad 11 \leq q \leq 131, \)
q being a prime power and \( n = 0, 1, 2, \ldots \). These give 21 new values (in addition to the 51 values known so far) of the invariant pair \((t, 2)\) with \( t \leq 1,000 \), for which a projective Hjelmslev plane exists. (Received November 30, 1978.) (Author introduced by Dr. B. V. Limaye).

#79T-A55 Raymond Balbes, University of Missouri, St. Louis, Missouri, 63121. **Catalytic Distributive Lattices.** Preliminary report.

A distributive lattice \( L \) is **catalytic** provided that the set \( \text{Hom}(L, M) \), of homomorphism from \( L \) to \( M \) point-wise partially ordered, is a lattice for every distributive lattice \( M \). T. G. Kucera and B. Sands have shown that for finite distributive lattices the property is equivalent to projectivity.

For the general case we have the following: **Theorem** A distributive lattice is catalytic if and only if i) every element is a finite sum of join-irreducible elements and ii) the product of join-irreducible elements is join irreducible and iii) the duals of i) and ii) hold. In particular, catalytic and projective distributive lattices are the same in the countable case but not in the uncountable case. (Received December 4, 1978.)

#79T-A56 R. Birkenhead, N. Sauer and M.G. Stone, University of Calgary, Calgary, Canada, T2N 1N4. **Algebraic extensions of transformation monoids.**

A transformation monoid \( M_A \subseteq A^A \) is **algebraic** provided \( M_A = \text{End} \mathcal{L} \) for some algebra \( \mathcal{L} = \langle A; \mathcal{P} \rangle \).

We say a unary algebra \( \mathcal{A} = \langle A; f_A \rangle \) is a **faithful representation** of an abstract monoid \( M \) iff \( (f_A) \cdot (a) = f_A (g_A) \) and \( \text{id}_A (a) = a \) for all \( f, g \in M \), \( a \in A \), and for \( f \neq g \) there is an element \( a \in A \) with \( f(a) \neq g(a) \). A faithful representation of \( M \), \( \langle A; f_A \rangle \) is algebraic provided \( \{ f_A \mid f \in M \} \) is algebraic.

Given a monoid \( M \) we consider the category of all faithful representations of \( M \). Our main result is: Every faithful representation \( \mathcal{A} \) of \( M \) is a retract of a faithful algebraic representation, \( \mathcal{L} \) of \( M \), i.e. there is an invertible homomorphism \( \delta : \mathcal{A} \to \mathcal{L} \).

Hence for each faithful representation \( M_A \) there is a faithful representation \( M_B \) on a set \( B \supseteq A \) so that \( M_B \) is algebraic and for each \( f \in M \), \( f_B | A = f_A \); such a representation is called an algebraic extension of \( M_A \). Every finite faithful representation has a finite algebraic extension. (Received December 5, 1978.)

#79T-A57 KENNETH S. WILLIAMS, Carleton University, Ottawa, Ontario, Canada, K1S 5B6. **On the divisibility of the class number of \( \mathbb{Q} (\sqrt{-p}) \), \( p = 1 \mod 8 \) a prime, by 16.**

Let \( p \) be a prime congruent to 1 modulo 8, and let \( h(-p) \) denote the class number of the imaginary quadratic field \( \mathbb{Q} (\sqrt{-p}) \). It is well-known that

\[
h(-p) \equiv 0 \pmod{4}.
\]

If \( \zeta_p = T + U/p \) is the fundamental unit of \( \mathbb{Q} (\sqrt{p}) \) then \( T \) and \( U \) are positive integers with

\[
T \equiv 0 \pmod{4}, \quad U \equiv 1 \pmod{4}.
\]

It is known that

\[
h(-p) \equiv 0 \pmod{8} \iff T \equiv 0 \pmod{8}.
\]

In this work it is shown that, if \( h(-p) \equiv 0 \pmod{8} \), then

\[
h(-p) \equiv 0 \pmod{16} \iff T \equiv p-1 \pmod{16}.
\]

(Received December 8, 1978.)

#79T-A58 C. J. MOZZOCHI, Massachusetts Institute of Technology Information Processing Center, 39-213 Vassar Street, Cambridge, Massachusetts 02139. **A remark on Goldbach's conjecture IX.**

Let \( p \) denote a prime, and let \( n \geq 2 \) denote an integer. Let \( C(x) = \sum_{p \leq n} \cos px \), \( S(x) = \sum_{p \leq n} \sin px \), \( C^*(x) = \cos nx \) and \( S^*(x) = \sin nx \). Let \( A(x, n) = C^2(x)C^*(x) + 2C(x)S(x)S^*(x) - S^2(x)C^*(x) \), and let \( B(x, n) = S^2(x)S^*(x) + A-198
C(x)S(x)C*(x) - C^2(x)S*(x). Let A(n) = \int_0^\pi A(x, n) \, dx and B(n) = \int_0^\pi B(x, n) \, dx. **Theorem.** (I) For all n and for all \( \theta \), \( A(0, n) = (\pi(n))^2 \), \( A(\pi, n) = (\pi(n) - 2)^2 \), \( A(\pi + \theta, n) = A(\pi - \theta, n) \), \( B(0, n) = B(\pi, n) = 0 \), and \( B(\pi + \theta, n) = -B(\pi - \theta, n) \). (II) \( A(n) = 0 \) for infinitely many odd n. (III) \( A(n) > 0 \) for n even if and only if n can be expressed as the sum of two primes. (IV) \( B(n) = 0 \) for every n. **Remark.** A preliminary (small) computer investigation of the pointwise behavior of \( A(x, n) \) and \( B(x, n) \) for \( x \) in \([0, \pi]\) and for n even seemed to reveal the existence of a (uniform in n) clustering effect, which would be relevant in the Hardy-Littlewood circle method of attack on the problem. A more careful and a deeper investigation of this effect will be made with an I.B.M. 370/168 computer. (Received December 11, 1978.)

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**Theorem.** Given a finite partially ordered set \( P \), each partition lattice \( P(n) \) with \( 10 < n < \omega \) is generated by an isotone image of \( P \) if and only if \( P \) contains a copy of \( \{+1, +1\} \) as a subset. This has been proved by H. STRIEITZ under the additional assumption that \( P \) is a cardinal sum of chains (cf. also AMS Notices 22 (1975), #75T-A190). The main tool in the proof of the "only if" direction is the following extension of R. WILLE'S \( D_2 \) - Lemma (cf. Coll. Math. Soc. J. Bolyai, vol. 14 (1976), 455-462), where \( D_2 \) denotes the two-element lattice: **Lemma.** Let \( L \neq D_2 \) be a simple (or subdirectly irreducible and modular) complemented lattice generated by the union of two finite subsets \( E_0 \) and \( E_1 \). Then sup \( E_0 = 1 \) or inf \( E_1 = 0 \). (Received December 14, 1978.)

**Theorem.** A near-ring \( R \) is called \( \pi \)-regular (semi \( \pi \)-regular, right \( \pi \)-regular, left \( \pi \)-regular) if for each element \( a \) in \( R \), there exists \( x \) in \( R \) and a positive integer \( n \) such that \( a^n = a^n x a^n \) (\( a^n = a^n x a^n \)). Several properties and characterizations of these near-rings have been obtained. Conditions are given under which these near-rings become regular. Radicals of these near-rings and chain conditions have also been discussed. Examples and counter examples are given to illustrate most of the results. (Received December 14, 1978.) (Authors introduced by Dr. R. V. Andree).

**Theorem.** Though the parity problem for the unrestricted partition function \( p(n) \) is still unsettled, it is known that \( p(n) \) takes both odd and even values, each of them infinitely often. As a wide generalization of this result; M. Newmann (Trans. Amer. Math. Soc; 97(1960) 225-236) conjectured that for all integers \( m \geq 2 \), each of the congruences \( p(n) \equiv r \pmod{m} \), \( 0 \leq r \leq m-1 \), has infinitely many solutions in positive integers \( n \). He proved this conjecture for \( m = 2,5,13,65 \) (see the above cited paper and Illinois J. Math. 6(1962), 59-63), while T. Klove (Math. Scand. 23(1968) 133-159) proved for \( m = 7,17,19,29,31 \). In this paper, the author makes a conjecture in a different direction, namely that for any given integer \( r > 1 \), each of the congruences \( p(nr + s) \equiv 0 \pmod{2} \), \( p(nr + s) \equiv 1 \pmod{2} \) has, for each \( s \) satisfying \( 0 \leq s \leq r-1 \), infinitely many solutions in \( n \). In (Amer. Math. Monthly 1966, 851-854) the author proved this partially for the case \( r = 2 \) and 4. We prove here that the conjecture holds for \( r = 16 \). (Received December 19, 1978.)

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\[ \text{A-199} \]
λ, κ are cardinals. A λ-normal κ-tree is a normal κ-tree such that each of its elements has exactly λ immediate successors. A rigid tree is a tree which has just one automorphism, the identity. Let \( T = \langle T, \prec \rangle \) be a normal κ-tree. Then there is a unique (up to isomorphism) Boolean algebra \( B(T) \) such that \( T \) is a base of \( B(T) \) and \( \prec \) is the canonical ordering of \( B(T) \).

**Theorem.** Let \( \kappa > \lambda \) and regular, \( 2^{\lambda} < \kappa \). Let \( \nu = \max (\lambda, \kappa) \). Let \( T = \langle T, \prec \rangle \) be a \( \nu \)-normal κ-tree. Then there is a sequence \( \langle T^\nu : \kappa < 2^\kappa \rangle \) such that for every \( \kappa < 2^\kappa \):

1. \( T^\kappa \) is a base of \( B(T) \).
2. \( T^\kappa = \langle T^\kappa, \prec^\kappa \rangle \) is a rigid \( \lambda \)-normal κ-tree which has exactly as many branches of length κ as \( T \) does,
3. if \( \lambda \neq \kappa \) then \( T^\lambda \) and \( T^\kappa \) are not isomorphic. (Received December 20, 1978.) (Author introduced by Professor Thomas Jech).

Non-splitting unitary perfect polynomials having precisely linear and quadratic prime factors over \( \mathbb{GF}(p) \) are known to exist whenever \( p \) satisfies a condition [Notices 26 (1979), January] we now generalize. Let \( p = 2^e + 1 \) be an odd prime, \( (2, e) = 1 \), and let \( s \) be a positive divisor of \( t \). We say the prime \( p \) is \( s \)-square-separable (s.s.s.) if each integer interval \([\theta^s, \theta^t]\) contains a quadratic residue modulo \( p \), where \( \theta \) is a primitive root modulo \( p \), \( \theta^s \), \( \theta^t \) are odd powers of \( \theta \), and \( \theta^s < \theta^t \) under the “ordering” \( 1 < 2 < \ldots < p - 1 \). The prime \( p \) is called square-separable if it is s.s.s. for some integer \( s \). Thus \( p = 3 \) is the only prime which is 1-s.s.s., no prime \( p = 2^e + 1 > 3 \) is s.s.s., and \( p = t_2 > s \) whenever \( t_1 | t_2 \) and \( p \) is \( t_1 \)-s.s.s. A computer study of 338 cases shows that is \( 2^e + 1 \) t-s.s. for the following \( e \) and admissible \( t \geq 3 \) excepting the 21 given values of \( t > e \) and exceptional \( t \): \( t \leq 1251 \) none
\[
\begin{array}{cccc}
\text{Admissible } t & 3 & 4 & 5 \\
\text{Exceptional } t & t \\ 3 & 1251 & 603 & 365 \\
4 & 603 & 365 & 337 \\
5 & 365 & 365 & 423 \\
6 & 365 & 365 & 429 \\
7 & 365 & 365 & 429 \\
\end{array}
\]

(Received December 22, 1978.)

A hamiltonian walk of a graph is a shortest closed walk that passes through every vertex at least once, and the length of a hamiltonian walk is the total number of edges traversed by the walk. The main theorem is:

**Theorem.** The length, \( h(G) \), of a hamiltonian walk of any maximal planar graph \( G \) with \( p \) vertices satisfies
\[
h(G) \begin{cases} 
\leq 3(p-3)/2 & \text{if } p \geq 11, \\
= p & \text{otherwise.} 
\end{cases}
\]

(The detail will appear in the Proceeding of International Symposium on Circuits and Systems, 1979.) (Received December 26, 1978.)

Z-groups as automorphism groups. Preliminary report.

**THEOREM:** Let \( G \) be a finite group all of whose sylow subgroups are cyclic, i.e., a Z-group, and \( X \) a finite group such that \( \text{Aut}(X) \) is isomorphic to \( G \). Then one of the following holds.

(a) \( X \) is isomorphic to \( C_1, C_2, C_3, C_4, C_2 \times C_2, C_{p^a} \) or \( C_2 \times C_{p^a} \), \( p \) an odd prime.

(b) \( t \) is an automorphism of \( C_p \) of order greater than 1 and \( X \) is the semi-direct product of \( C_p \) by \( t \) induced by the natural action. Moreover \( G \) is the holomorph of \( C_p \).
(c) t is an automorphism of $C_p$ of odd order greater than 1 and $X = Y \times C_2$ where $Y$ is the semi-direct product of $C_p$ by $t$ induced by the natural action. Moreover $G$ is the holomorph of $C_p$.

The converse is also true. (Received December 26, 1978.)

79T-A66

CONSTANTINE TSINAKIS, University of California, Berkeley, California 94720. Characterizations of projectable and strongly projectable lattice-ordered groups. I. Preliminary report.

Let $G$ be an arbitrary lattice-ordered group.

Theorem 1. The following conditions are equivalent.

(i) $G$ is projectable.

(ii) For each positive element $g$ of $G$, the interval $[0, g]$ is a pseudo-complemented lattice.

Theorem 2. The following conditions are equivalent.

(i) $G$ is strongly projectable.

(ii) For each positive element $g$ of $G$, the interval $[0, g]$ is a pseudo-complemented lattice and, in addition, the Boolean lattice of its regular (skeletal) elements is complete. (Received December 27, 1978.)

79T-A67


Let $1 \leq k_1 \leq k_2 \leq \cdots \leq k_n$ be integers and let $S$ denote the set of all vectors $x = (x_1, \ldots, x_n)$ with integral coordinates satisfying $0 \leq x_i \leq k_i$, $i = 1, 2, \ldots, n$. A subset $X$ of $S$ is an antichain if and only if for any two vectors $x$ and $y$ in $X$ the inequalities $x_i < y_i$, $i = 1, 2, \ldots, n$ do not all hold. For an arbitrary subset $H$ of $S$, (i) $H$ denotes the subset of $H$ consisting of vectors with component sum $i$, $i = 0, 1, 2, \cdots, K$, where $K = k_1 + k_2 + \cdots + k_n$, and $|H|$ denotes the number of vectors in $H$.

Theorem: If $X$ is an antichain in $S$, then

$$\sum_{i=0}^{K} \frac{|(i)X|}{(i)S} \leq 1.$$  

Moreover, if $K$ is even and $|(K/2)X|$ does not exceed the number of vectors $\sum_{i=0}^{(K/2)-1} \frac{|(i)X|}{(i)S} + \frac{|(K/2)X|}{(K/2)S}$ with first coordinate different from $k_1$, then

$$\sum_{i=0}^{K} \frac{|(i)X|}{(i)S} + \frac{|(K/2)X|}{(K/2)S} \leq 1.$$  

(Received January 2, 1978.)

79T-A68

OLGA TAUSKY, California Institute of Technology, Pasadena, California 91125. Representation of ideals in orders of algebraic number fields by one sided ideals in the ring of integral matrices.

The representation discussed replaces non principal ideals by one sided principal ideals in $\mathbb{Z}^{n \times n}$, since this matrix ring is a principal ideal domain. It can further be shown that a generator of a principal ideal can be obtained as an eigenvalue of a suitable ideal matrix (for definition cf. O. Taussky, Archiv Math. 13 (1962) 275-282). A theorem of MacDuffee relating an ideal matrix of an ideal to the greatest common right divisor of the matrices in the regular representations plays a role in these questions (Math. Ann. 105 (1931) 663-669). (Received January 8, 1979.)

79T-A69

YEHIEL ILAMED, Soreq Nuclear Research Centre, Yavne, Israel. On central polynomials and algebraic algebras. Preliminary report.

Let $C_n(x_1, \ldots, x_n; y_1, \ldots, y_{n-1}) = \sum_{\pi \in P_n} \text{sign} \pi x_{\pi(1)} y_{\pi(2)} \cdots x_{\pi(n)} y_{\pi(n-1)} x_n$ where the summation is taken over $\pi \in P_n$, the group of permutations on $(1,2,\ldots, n)$. Let $R$ be a ring with 1 the identity of $R$ and let $Z(R)$ denote the center of $R$. Theorem 1. Let us assume that: i) in $R$ there are $2n-1$ elements $a_1, a_n, b_1, \ldots, b_{n-1}$ that satisfy $C_n(a_1, \ldots, a_n, b_1, \ldots, b_{n-1}) = 1$ and ii) $C_n(x_1, \ldots, x_n; b_1, \ldots, b_{n-1})$ is a central polynomial for $R$. Then the elements of $R$ are roots of
monic polynomials of degree \(n\) with coefficients in \(Z(R)\).

**Theorem 2.** Let us assume that: 
1) in \(R\) there are \(2nk\) elements \(a^h_1, \ldots, a^h_n, b^h_1, \ldots, b^h_{n-1}\), that satisfy
\[
\varepsilon^h_n C_n(a^h_1, \ldots, a^h_n, b^h_1, \ldots, b^h_{n-1}) v^h = 1
\]
and ii) for any \(h \in \{1, \ldots, k\}\), \(j \in \{1, \ldots, n\}\), \(x \in P_n\), and \(r\) an element of \(R\), \(C_n(r a^h_1, \ldots, r a^h_j, a^h_{j+1}, \ldots, a^h_{n-1}, b^h_1, \ldots, b^h_{n-1}) v^h \in Z(R)\). Then \(r\) satisfies a polynomial of degree \(n\) with the coefficient of the \(n\)-th power \(1\) and the other coefficients in \(Z(R)\).

**Remark.** Theorem 1 is a corollary of theorem 2. (Received January 12, 1979.)

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**IVAN CHAJDA, třída LM 290, 750 00 Přerov, Czechoslovakia. Regularity and permutability of congruences. Preliminary report.**

A variety \(V\) of algebras is regular if it contains only regular algebras, i.e., if any two congruences on an algebra \(A\) of \(V\) coincide whenever they have a congruence class in common.

**Theorem.** Let \(V\) be a variety of algebras. The following conditions are equivalent:

1. \(V\) is regular and congruence permutable
2. There exist \((n+3)\)-ary polynomials \(p\), \(t\), \(u\) with
   \[
   t_i(x, x, z) = z = u_i(x, x, z)
   \]
   for \(i = 1, \ldots, n\), such that
   \[
   x = p(x, y, z, t_1(x, y, z), \ldots, t_n(x, y, z)),
   y = p(x, y, z, u_1(x, y, z), \ldots, u_n(x, y, z)),
   \]
   where for each \(i = 1, \ldots, n\) either \(t_i = z\) or \(u_i = z\) identically.

(Received January 12, 1979.)

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**J.L. BRENNER, Palo Alto, California 94303 and EDWARD T.H. WANG, Wilfrid Laurier University, Waterloo, Canada, N2L 3CS, Permanental Pairs of Doubly Stochastic Matrices II.**

The \(n \times n\) doubly stochastic matrices \(A, B\) form a permanental pair if the permanent of every convex linear combination \(\alpha A + (1 - \alpha)B\) \((0 \leq \alpha \leq 1)\) is independent of \(\alpha\); \(A, B\) are called mates. In this article we show that the direct sum of any number, \(k\), of matrices \(J_i\) (of varying individual dimension) cannot have a mate. Here, \(J_i\) is the \(n_i \times n_i\) matrix with every entry equal to \(1/n_i\); \(\sum_i n_i = n\).

This article will appear in Linear Algebra and its Applications. (Received January 15, 1979.)

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**DAVID ZSITLIN, 1650 Vincent Ave, North Minneapolis, MN, 55411, Parametric solutions for a sum of \(n+2\) squares equal to a sum of \(2n+1\) squares.**

Let \(3 = P_1^2 + P_2^2 + \ldots + P_n^2\), \(n = 1, 2, \ldots\), where \(P_i\) are distinct integers. Let \(W_0\) and \(W_1\) be integers, and set \(W_{k+2} = W_{k+1} + (3-1)W_k\), \(k = 0, 1, \ldots\). Then, for \(k = 0, 1, \ldots\), the two equal sums of \(n+2\) and \(2n+1\) squares are given by

\[
(*) \quad \sum_{i=1}^n (P_i W_{k+2}^2 + (3W_{k+1})^2 + (W_k - 1)^2 W_k^2) = \sum_{i=1}^n (P_i W_{k+1}^2 + W_k^2) + \sum_{i=1}^n (P_i W_k^2 + W_{k+1}^2) + W_{k+3}^2.
\]

Moreover, the two sums of the base variables are equal for all values of \(n\) and \(k\). Example 1.

For \(n = 1, 3, 2\), and \(k = 0\), \((*)\) gives the identity

\[
(1) \quad (P_1 W_1^2 + (3-1)W_1^2 + (P_2 - 1)W_2^2)^2 + (P_1 W_1^2 + (P_2 - 1)W_2^2)^2 = ((P_1 W_1^2 + (3-1)W_1^2 + (P_2 - 1)W_2^2)^2 + (P_2 W_2^2 + (P_2 - 1)W_2^2)^2),
\]

which is a result noted by A. Cunningham in 1903 (see p. 706 in L. E. Dickson, History of the Theory of Numbers, Vol. 2, Chelsea, 1952). (Received January 15, 1979.)

**PETER KÜHLER and DON PIGOZZI, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2, Varieties with equationally definable principal congruences.**

A variety \(V\) of algebras has strongly equationally definable principal congruences (SEDPC) if there exist 4-ary polynomials \(p_1, \ldots, p_m, q_1, \ldots, q_m\) with the following property: For every algebra \(A \in V\) and all elements, \(a, b, c, d\) of \(A\), \(c\) is congruent to \(d\) modulo the congruence relation on \(A\).
generated by the pair \((a, b)\) if and only if the equations \(p_i(a, b, c, d) = q_i(a, b, c, d)\) hold in \(A\) for \(1 \leq i \leq m\). This notion is introduced by Fried, Grätzer, and Quackenbush, Uniform Congruence Schemes (Preprint). Theorem. \(\forall\) has (SEDPC) if and only if, for every \(A \in \mathcal{V}\), the join-semilattice of compact elements of the congruence lattice of \(A\) is dually Brouwerian. As a consequence, every variety which has (SEDPC) is congruence distributive. In particular every filtral variety is congruence distributive. This answers a question raised by Fried, Grätzer and Quackenbush. (Received January 15, 1979.)

Richard A. Mollin, Mathematics Department, McMaster University, Hamilton, Ontario L8S 4K1, Canada. Cyclotomic Division Algebras.

Let \(K\) be a field abelian over the rationals \(Q\). The Shur subgroup \(S(K)\) of the Brauer group \(B(K)\) consists of those equivalence classes \([A]\) which contain an algebra which is isomorphic to a simple summand of the group algebra \(KG\) for some finite group \(G\). It is known that the classes in \(S(K)\) are represented by cyclotomic crossed product algebras. However it is not necessarily the case that the division algebra representatives of these classes are themselves cyclotomic. Our main result is to provide necessary and sufficient conditions for the latter to occur.

Next we provide for the first time necessary and sufficient conditions for the Schur group of a local field to be induced from the Schur group of an arbitrary subfield. We obtain a corollary from this result which links it to the main result.

For the 2-primary point \(S(K)_2\) of \(S(K)\) we generalize our main result and link the concept of the stuff of a number field to the existence of the ordinary quaternions in \(S(K)\). The latter result is used in the last section to determine \(S^{(2c)}(K)\) which we define to be the subgroup of \(S(K)\) consisting of those classes containing a simple component of \(KG\) for some finite group \(G\) of exponent \(2^c\). Finally we show how to determine all elements of \(S(K)\) as elements of \(S^{(n)}(K)\) for composite \(n\). (Received January 19, 1979.)

J. T. B. Beard, Jr., J. K. Doyle, and K. I. Mandelberg, Emory University, Atlanta, Georgia 30322. Square-separable primes II. Preliminary report.

An odd prime \(p = 2^t + 1, t \text{ odd, is } s\)-square-separable, \(s|t\), if there exist quadratic residues between every pair of distinct odd powers of \(2^t\), where \(\Theta\) is a primitive root modulo \(p\) [Notices 26(1979), February]. A constructive argument for the non-vacuous cases has yielded this THEOREM. Let \(p = 2^t + 1\) be prime, \(t \text{ odd. Then } p \text{ is } t\)-square-separable whenever \(e = 1, e = 2\) and \(t > 3\), or \(e = 3\). A computer study for \(4 \leq e \leq 7\) and \(1 < t < 10^6\) has found the following numbers \(SS\) of \(t\)-square-separable primes and the largest prime \(LNSS\) not \(s\)-square-separable for any \(s|t\) among the \(N\) primes in each case:

<table>
<thead>
<tr>
<th>(e)</th>
<th>(N)</th>
<th>(SS)</th>
<th>(LNSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>64,335</td>
<td>64,335</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>61,657</td>
<td>61,653</td>
<td>127,649</td>
</tr>
<tr>
<td>6</td>
<td>58,981</td>
<td>58,966</td>
<td>56,867,009</td>
</tr>
<tr>
<td>7</td>
<td>56,769</td>
<td>56,742</td>
<td>65,456,257</td>
</tr>
</tbody>
</table>

Finally, \(p = 2521 = 8 \cdot 315 + 1\) is \(s\)-square-separable for \(s = 35, 45, 105, 315\) but not for \(s = 3, 5, 7, 9, 15, 21, 63\) so that the index of square-separability (i.e., the smallest \(s\) for which \(p\) is \(s\)-square-separable) lacks several desirable properties. (Received January 19, 1979.)


Here I briefly indicate three more applications of the results I described in the last issue of these Notices:

1) The following result of E. Becker is an immediate consequence of my structure theory: A field \(K\) is Superpythagorean and satisfies \(K^{13} + K^{13} = K^{13}\) if and only if it carries a 2-Henselian valuation with Euclidian residue class field.

2) Let \(K\) be a Pythagorean field with space of orders \((X_1, K/K^2) = (X_1, G_1) \oplus \cdots \oplus (X_n, G_n)\), where each \((X_i, G_i)\) is an E-I subspace (as defined by M. Marshall). If \(K\) is the 2-closure
of $K$, and if $K_{1} \subset \hat{K}$ is the 2-Henselization of $K$ for which $(X_{K_{1}}/X_{K_{1}}^{2}) \cong (X_{1}/G_{1})$, then 
$Gal(\hat{K}/K) \cong Gal(\hat{K}/K_{1}) \ast \cdots \ast Gal(\hat{K}/K_{m})$, where "$\ast"$ denotes the free product in the category of pro 2-Groups.

3) Let $K$ be a Pythagorean field whose space of orders has finite chain length. Then Milnor's maps $s_{n}: k_{n}(K) \rightarrow H^{2}(K/Z^{2})$ and $h_{n}: k_{n}(K) \rightarrow H^{2}(K/Z^{2})$ are isomorphisms for all $n$.

(Received January 19, 1979.)

79T-A77 EARL S. KRAMER, SPIYROS S. MAGLIVERAS and DALE M. MESNER, University of Nebraska, Lincoln, Nebraska 68588. t-Designs from the large Mathieu groups.

A t-design $(X, \mathcal{B})$ is a $v$-set $X$ together with a family $\mathcal{B}$ of $k$-subsets from $X$, called blocks, such that each subset of $X$ of size $t$ is contained in exactly $\lambda$ members of $\mathcal{B}$. A t-design with the above parameters is also called a $(v,k,\lambda)$ design. Here, we allow repeated $k$-sets in $\mathcal{B}$, i.e. $\mathcal{B}$ is a multiset. We describe the action of the Mathieu groups $M_{n}$, $n = 24, 23, 22$, on the power sets of the respective $X$ (Chang Choi and John H. Conway have done this for $M_{24}$) and then determine all of the quadruples of parameters $t,n,k,\lambda$ with $2 \leq t < k \leq n/2$ for which there is a $t-(n,k,\lambda)$ design with $M_{n}$ as automorphism group. Among the many new t-designs found there, for example, an $11-(24,12,6)$ design which is the union of three orbits of 12-sets under $M_{24}$, two of which are repeated six times. (Received January 19, 1979.)

79T-A78 F. RUDOLF BEYL, Math. Institut, Im Neuenheimer Feld 288, 6900 Heidelberg 1, W. Germany

Isoclinisms of group extensions and the Schur multiplicator.

Interesting properties of the (finite or infinite) group $G$ in the central group extension $e = (K,\pi): 0 \rightarrow A \rightarrow G \rightarrow Q \rightarrow 0$ are determined just by certain subgroups of the Schur multiplicator $M(Q)$. We use an elementary group-theoretic approach to the transgression $\theta_{*}(e): M(Q) \rightarrow A$. Sample results:

(1) If $Q_{1} = Q_{2} = Q$ and $\text{Ker } \theta_{*}(e_{1}) = \text{Ker } \theta_{*}(e_{2}) \subseteq M(Q)$, then $e_{1}$ and $e_{2}$ are isoclinic as extensions and $\pi_{1}Z(G_{1}) = \pi_{2}Z(G_{2})$ for the centers. An explicit formula for $\pi Z(G)$ is given.

(2) The lifting property for complex projective representations holds (if $e$ is a generalized representing group of $Q$) precisely when $\text{Ker } \theta_{*}(e) = 0$.

(3) If $Q$ lies in a variety $V$ of exponent 0, then there is a subgroup $K_{V}(Q)$ of $M(Q)$ with $V(G) = \theta_{*}(e)K_{V}(Q)$ for all $e$. Thus $G \in V$ precisely when $K_{V}(Q) \subseteq \text{Ker } \theta_{*}(e)$. If $W$ is any variety and $V$ is the variety of center-by-$W$ groups, then $K_{V}(Q) = \text{Ker } (M(Q) - M/Q/W))$. If $V$ is the variety of abelian-by-$W$ groups then $K_{V}(Q) = \text{Im } (M/Q/W - M(Q))$. This yields a handy description of the induced-central extensions of I.B.S. Passi. (Received January 22, 1979.)

79T-A79 HAI-PING KO, Oakland University, Rochester, Michigan 48063 and DILJEN K. RAY-CHAUDHURI, Ohio State University, Columbus, Ohio 43210. A result on the multiplier group of cyclic relative difference sets.

Let $v, m, n, k$ be positive integers and $v = mn$. Let $D$ be a $k$-element subset of $Z_{v}$ such that for every nonzero element $j$ of $Z_{v}$, $\{(d_{1},d_{2}) \mid d_{1},d_{2} \in D, d_{1} - d_{2} = j \text{ in } Z_{v}\}$ is equal to $0$ if $j$ is divisible by $m$ and equal to 1 otherwise. Define $M_{\text{fix}}(D)$ to be the set of all integers $t$ for which $(t,v) = 1$ and $(td \in Z_{v} | d \in D) = D$. We generalize a result of M. Hall, H.B. Mann, J.E.H. Elliott and A.T. Butson for such cyclic relative difference sets $D$ of a certain type: if $k \geq 22$ and, $v$ is odd or $v = k^{2} - 1$, then for any $t_{1}$, $t_{2}$, $t_{3}$, $t_{4} \in M_{\text{fix}}(D)$, if $t_{1} - t_{2} = t_{3} - t_{4} (\text{mod } v)$ then either $t_{1} \equiv t_{2}$ or $t_{1} \equiv t_{3} (\text{mod } v)$. By this property, A.J. Hoffman's multiplier theorem implies that for $22 \leq k \leq 5000$, a cyclic affine plane of order $k$ exists only if $k$ is a prime power, and M. Hall's multiplier theorem implies that for $21 \leq q \leq 717$, a cyclic projective plane of order $q$ exists only if $q$ is a prime power. (Received January 22, 1979.)
We consider weak solutions on the real line of nonhomogeneous differential equations in a Banach space:
\[ u'(t) = Au(t) + f(t), \]
where \( A \) is the infinitesimal generator of a semigroup of class \( c_0 \). An optimal solution is a function \( u(t) \) such that:
\[ \sup_{t \in \mathbb{R}} \| u(t) \| = \inf_{u \in \Omega_f} \sup_{t \in \mathbb{R}} \| u(t) \| \]
where \( \Omega_f \) is the class of bounded weak solutions on the real line \( \mathbb{R} \). We prove existence of optimal solutions when \( \Omega_f \neq \emptyset \) in reflexive Banach spaces and their uniqueness in uniformly convex spaces provided that nontrivial bounded solutions of:
\[ x'(t) = Ax(t), \ t \in \mathbb{R}, \]
verify the condition: \( \inf_{t \in \mathbb{R}} \| x(t) \| > 0 \).

(Received August 15, 1978.)

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**79T-B15**

T.R. Prabhakar and R.C. Tomar, University of Delhi, Delhi (India). Biorthogonal polynomials suggested by the Legendre polynomials.

In 1965 J.D.E. Konhauser studied general properties of biorthogonal polynomials and also introduced a pair of polynomials which is, in a certain sense, suggested by the orthogonal set of the generalized Laguerre polynomials. The polynomials in this pair were subsequently studied by Konhauser himself, L. Carlitz, T.R. Prabhakar, H.M. Srivastava and others. In this paper we solve the analogous problem suggested by the Legendre polynomials \( P_n(x) \). We prove that the polynomials
\[ U_n(x;k) = \sum_{j=0}^{n}(-1)^{j} \binom{n}{j} \binom{n}{k} \binom{n}{k}^{-1} \left( 1-x \right)^j, \ V_n(x;k) = \sum_{j=0}^{n}(-1)^{j} \binom{n}{j} \binom{j}{j} \binom{j}{k}^{-1} \left( 1-x \right)^j \]
of degree \( n \) in the basic polynomials \( \left( 1-x^2 \right)^j \) and \( \left( 1-x^j \right) \) respectively form a biorthogonal pair with respect to the interval and weight function of \( P_n(x) \). For \( k = 1 \), both \( V_n(x;k) \) and \( U_n(x;k) \) reduce to \( P_n(x) \). Several generating functions, recurrence relations, integrals etc. are obtained for both \( U_n \) and \( V_n \). (Received October 19, 1978.) (Authors introduced by Dr. Shashi Prabha Arya.)

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**79T-B16**

Howard A. Levine, Iowa State University, Ames, Iowa 50011. A numerical estimate for the best constant in a two dimensional Sobolev inequality with three integral norms.

Let \( H^1(\mathbb{R}^2) \) denote the Sobolev space of all real valued functions, which, together with their gradients, are square integrable in the plane. For \( \phi \in H^1(\mathbb{R}^2) \) we show, \( \pi < J_2(\phi) \equiv \iint_{\mathbb{R}^2} \| \nabla \phi \|^2 \, dx \, dy \cdot \left( \iint_{\mathbb{R}^2} \phi^2 \, dx \, dy \right)^{1/2} < \pi^{4/3} + 5 \times 10^{-4} \). We show that there is a minimizing sequence \( \phi_n \) with a weakly (in \( H^1(\mathbb{R}^2) \)) convergent subsequence and show that if some weak limit is nonzero, then it minimizes \( J_2(\phi) \). If this weak limit is \( \phi_0 (\neq 0) \), then \( J_2(\phi_0) > \pi \).

The variational equation for this inequality is \( \phi''(r) + \phi'(r)/r + \phi''(r) - \phi(r) = 0, \ \phi'(0) = 0, \ \phi'(\infty) = 0, \ \phi > 0 \). We have the asymptotic expansion \( \phi(r) \sim 3^{1/4}(\text{sech}\left(-2\sqrt{K_0}(r)\right))^{1/2} e^{-2\sqrt{K_0}(r)}/r \rightarrow +\infty \) where \( K_0 \) is the modified Bessel function of the second kind and zero order. A numerical integration of the O.D.E. shows that \( J_2(\phi_0) \sim 4.5981... \) which supports the conjecture that \( \inf_j J_2(\phi) = \pi^{4/3} \). (Received October 23, 1978.)

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**79T-B17**


We give estimates such as
\[ \int_0^T \int_{\mathbb{R}^n} |v(x,t)| \, dx \, dt \leq C_p(T) \int_0^T \int_{\mathbb{R}^n} |L v(x,t)| \, dx \, dt \]
and \( L \) is a hyperbolic operator, and
\[ \left| \frac{1}{p} - \frac{1}{2} \right| \leq \frac{1}{n-1} . \]

A-205
Also as other application we get a theorem of global existence for the non-linear Cauchy problem

\[ Lu = F(x,t,u) \]

\[ u(x,0) = g(x) \]

\[ u_t(x,0) = f(x) \]

proving also uniqueness and regularity in the contest of the \( L^p \) spaces with \( p \) as before. (Received October 24, 1978.)

**79T-Bl8** JAMES GUYKER, SUNY College at Buffalo. At present Purdue University, West Lafayette, Indiana, 47907. On the Structure of Reducing Subspaces. Preliminary report.

Let \( T \) be an operator on a Hilbert space \( H \), and let \( W^*(T) \) denote the weakly closed algebra generated by \( T, T^* \) and \( I \). Let \( F \) be a subfamily of \( W^*(T) \), and let \( K(f) \) denote the orthogonal complement of the kernel of \( f = f(T) \) for each \( f \) in \( F \). A subspace \( M \) of \( H \) reduces \( T \) if and only if

\[ M = \bigoplus \{ \text{ker}(f) : f \in F \} \]

where \( \text{ker}(f) \) is the kernel of \( f \) for each \( f \) in \( F \) and \( \bigoplus \) denotes the direct sum. This result extends (these Notices 17, #70T-B180). (Received October 30, 1978.)

**79T-B19** Hans Heinig, McMaster University, Hamilton, Ontario, Canada L8S 4K1. Raymond Johnson, University of Maryland, College Park, Maryland 20742. A weighted norm inequality for a maximal function.

Generalizing the result of Kokilashvili (Doklady 239(1)) we give strong type \((p,q)\) estimates for a fractional maximal operator. For a function \( f \), defined on \( \mathbb{R}^n \times Y \), where \((Y,v)\) is a measure space, we form the fractional maximal function using only the spatial variables,

\[ f^\gamma(x,y) = \frac{1}{|Q|} \int_Q |f(t,y)|^{1-\gamma} \, dt, \quad 0 \leq \gamma < n. \]

Then we set

\[ f^\gamma_p(x,y) = \left( \int_Y |f^\gamma(x,y)|^p \, dv(y) \right)^{1/p}, \]

\[ f^\gamma_p(x) = \left( \int_{\mathbb{R}^n} |f^\gamma(x,y)|^p \, dv(y) \right)^{1/p}. \]

Our main result is: Theorem 1. If \( 0 \leq \gamma < n, 1 < p < n/\gamma, \]

\[ 1/q = 1/p - \gamma/n \]

and \( \omega \in A_{pq} \) (Muckenhoupt class), then

\[ \left( \int_{\mathbb{R}^n} [\omega(x)f^\gamma_p(x)]^q \, dx \right)^{1/q} \leq C \left( \int_{\mathbb{R}^n} [\omega(x)f^\gamma_p(x)]^p \, dx \right)^{1/p}. \]

The result of Kokilashvili is the case \( \gamma = 0 \). Applications include vector-valued \((p,q)\) estimates as in Fefferman-Stein \((Y=\mathbb{N})\), the ordinary fractional maximal operator \((Y=\mathbb{R},v=\delta_0)\) and \((p,q)\) estimates for a Marcinkiewics function. (Received October 27, 1978.)

**79T-B20** H. W. PU, Texas A&M University, College Station, Texas 77843. Conditions for the uniform continuity of a real function.

An function \( f: \mathbb{R} \to \mathbb{R} \) is said to be regular with respect to a subset \( R_1 \) of \( \mathbb{R} \) if for any \( \varepsilon > 0 \) there exists \( \eta > 0 \) such that \( |f(x) - f(y)| < \varepsilon \) when \( x - y \in R_1 \) and \( |x - y| < \eta \). Let \( P \) denote the sentence that regularity with respect to \( R_1 \) is equivalent to uniform continuity on the whole real line. The following theorems are obtained: Theorem 1. If \( P \) holds, then \( \hat{R}_1 \subseteq 2\hat{R}_1 \subseteq \ldots = \mathbb{R} \), where \( \hat{R}_1 = R_1 \cup (-R_1) \cup \{0\} \) and \( k\hat{R}_1 = \left\{ \sum_{j=1}^k x_j \mid x_j \in \hat{R}_1 \text{ for } j = 1, 2, \ldots k \right\} \) for \( k \in \mathbb{N} \).

Theorem 2. If there is a positive integer \( n \) such that for any given \( \mu > 0 \) there is \( \alpha(\mu) > 0 \) with \( |\alpha(\mu) - \eta(\hat{R}_1(\mu))| = 0 \) (Lebesgue measure 0), then \( P \) holds, where \( \hat{R}_1(\mu) = \hat{R}_1 \cap (-\mu,\mu) \).

Theorem 3. If \( \hat{R}_1 \) has right density 1 at the origin, then \( P \) holds. (Received October 30, 1978.)
Baylor, Hodgkin, and Lamb (J. Physiol., 1974, 242, 759-791) developed a nonlinear model to explain data concerning turtle cones. This model suggests that cones are built up from mechanisms that are hard to interpret from the viewpoint of optimal design. A model for the optimal design of a miniaturized chemical transducer explains their data in a unified fashion. Its equations are \[ \dot{x} = -Ax + (B - x)Sz, \quad \dot{y} = C(D - y) - E(Fy - z), \quad \dot{z} = F(Fy - z) - Sz, \]
where enzymatic activation of C, D, and/or E yields equations such as \( \dot{C} = -(G + HS)(C - C_0) + IS \).

(Received November 1, 1978.)

John F. Ahner and Charles S. Kahane, Department of Mathematics, Vanderbilt University, Nashville, Tennessee 37235. On an integral equation for the electrified disk.

The authors consider the integral equation

\[ \int_{|x-y|<1} \frac{F(y)}{|x-y|} dy = G(x) \]

are points in \( E^2 \). For given integrable \( G \) it is shown that this equation has at most one integrable solution \( F \). Assuming \( G \) to be a \( C^2 \) function, the existence of an integrable solution is established by constructing an explicit inversion formula which expresses the solution \( F \) in terms of integral operators acting on \( G \) and its derivatives. (Received November 6, 1978.)

MARK M. BAITMAN, Dzirciema 5-65, Riga 7, USSR, and HAIM I. KILOV, Karl Marx Str. 75-13, Riga 11, USSR. Structure changing points of Van der Pol equation controllability areas. Preliminary report.

Controllability areas of Van der Pol equation \( \ddot{x} + (\alpha x^2 - 1)\dot{x} + x = u, \quad u = y(t), \quad |u| < k \) were investigated by E. James [1]. She noted that for each \( \alpha > 0 \) such a \( k = k(\alpha) \) exists that if \( k > k(\alpha) \), then the controllability area (to the origin) coincides with the whole \( (x, \dot{x}) \) plane; if \( k < k(\alpha) \) then this area is bounded. However, numerical values of \( k(\alpha) \) were unknown and, at best, only roughly estimated. Using the ideas described in [2] we tabulated the function \( k(\alpha) \). (The corresponding PL/1-program ran on ES-1020 computer.) If \( k < k(\alpha) \) then the controllability area is separated from infinity by two so called \( \alpha \)-cycles (closed trajectories like shown on fig. 1) for \( \alpha > 0 \) and \( k = k(\alpha) \), but \( \alpha \)-cycles merge and disappear. As \( \alpha \) increases, computation time increases rather sharply.

References.

(Received November 7, 1978.) (Author introduced by E. Ja. Gabovich).

JU. A. ABRAMOVICH, 197341 Leningrad, Serebristy bul'var 24, korp. 4, kv. 197 and M. G. ZAIDENBERG, Department of Mathematics, The Pedagogical Institut, Orel, 302000, USSR. Rearrangement invariant spaces.

Theorem. Let \( E \) be a rearrangement invariant Banach function space on \([0, 1]\). (1) If \( E \) is isomorphic to \( L_p[0, 1] \) for some \( p \in [1, \infty) \), then \( E \) coincides (as set) with \( L_p[0, 1] \) and consequently the norms \( \| \cdot \|_E \) and \( \| \cdot \|_p \) are equivalent. (2) If \( E \) is isometric to \( L_1[0, 1] \), then \( E = L_1[0, 1] \) and \( \| \cdot \|_E = \lambda \| \cdot \|_1 \) (where \( \lambda = \| \cdot \|_1 \) is equivalent). For \( p = 2 \) the theorem is known. Case (1) is due to L. Potepun (Isv. Vuzov, 1974, No. 1) and case (2) is due to E. Semenov (Dokl. Akad. Nauk SSR 185 (1969), No. 6). For \( p \neq 2 \in (1, \infty) \) the theorem follows easily from the results of Bretagnolle-Dacunha Castell, Lindenstrauss-Tzafriri and L. Potepun. For \( p = 1, \infty \) the theorem follows from some results of Abramovich-Wojtaszczik (Mat. Zametki 18 (1975), No. 3). (Received November 8, 1978.)
The procedure of Duistermaat (Fourier Integral Operators, Courant Lecture Notes) for determining partial asymptotic series expansions of functions of the form $F(\lambda) = \int e^{i2\lambda(x)} f(x)dx$ with $x \in \mathbb{R}^n$ is somewhat modified and applied to functions of the form $G(\lambda) = \int e^{i2\lambda(x)} f(x)dx$ with $x \in \mathbb{R}^n$. The convolution theorem and the fractional integration theorem are extended to the $L(p, q)$ space is $\mathbb{L}(p, q)$ and have applications to the study of Lipschitz operators. (Received November 13, 1978.)
An uncountable family $F$ of Lebesgue measure preserving transformations on the unit interval is constructed such that

1.) The elements of $F$ are pairwise non-isomorphic.

2.) Each element of $F$ is weakly mixing but not mixing, one of them being the well-known example of Chacon of this type.

3.) For each $T \in F$, $F$ contains a transformation isomorphic to $T^{-1}$.

In addition, using methods of del Junco, it is shown that all the elements of $F$ are prime (i.e. have no proper factors) and commute only with their powers. (Received November 22, 1978.)

The problem considered is how to reduce the integral equation $f(x) - \epsilon \int K(x-y)f(y)dy = g(x)$ $(0 < \epsilon \ll \infty)$ with $K(x) = \epsilon \sin x$ (where $\epsilon$ being a parameter) to a Fredholm equation. This can be achieved by using an approximate kernel of the form $K(x;\alpha) = K(x)e^{-\alpha x}$ $(\alpha > 0)$ and applying the Projection Method described in Theorem 3.1 of the book "Convolution Equations and Projection Methods for their Solution" by Gohberg and Feldman (Transl. of Math. Monogr. AMS 1974). (Received November 27, 1978.)

A Banach lattice $E$ is said to be order dentable if for every closed bounded convex subset $C \neq \{0\}$ of any sublattice of $E$ containing a quasi-interior point $u$, we have

$$A_0(C,u) = \frac{1}{n} \text{conv}(y \in C; ||y - nu|| \leq \frac{1}{n}) \not\subseteq C.$$  

Theorem (1): A dual Banach lattice is order dentable if and only if it does not contain $L^1$ as a sublattice.

Theorem (2): Every Banach lattice with norm compact order intervals is order dentable.

Theorem (3): A Banach lattice has the Radon-Nikodym property if and only if it is order dentable and it does not contain $c_0$ as a sublattice.

Corollary: A Banach lattice with the Shur property has the Radon-Nikodym property.

(Received November 27, 1978.) (Authors introduced by R. V. Chacon).

A permutation $p$ of the natural numbers is said to be sum-preserving if for any convergent series $\sum u_k$ the rearranged series $\sum u_{p_k}$ converges to the same sum.

Each of the following is a necessary and sufficient condition for a permutation $p$ to be sum-preserving for series in any Banach space. (The first condition is due to R. P. Agnew [Proc. Amer. Math. Soc. 6 (1955), 563-564] for complex series.)

CONDITION A: There is a positive integer $N$ so that for each $j$, the set $\{p_1, \ldots, p_j\}$ is representable as the union of $N$ or fewer blocks of consecutive integers.

CONDITION B: For each $k$, let $I_k = \{j \mid j \leq \text{an integer and } m \leq j < \hat{m}_k\}$, where $m_k$ is the smaller of $p^{-1}(k)$ and $p^{-1}(k+1)$ and $\hat{m}_k$ is the larger of these numbers. There is a positive integer $N$ so that every collection of $N$ such intervals $I_k$ has an empty intersection.

Several simpler sufficient but not necessary conditions for sum-preserving permutations are given, such as (1) there is a $B > 0$ so that $p_j < j+B$ for all $j$, or (2) there is a $C > 0$ such that for all $k$, the lengths of $I_k$ do not exceed $C$. (Received November 27, 1978.)
We consider uniform approximations to analytic functions with positive coefficients by polynomials and rational functions with positive coefficients. Let \( \mathbb{P}_n \) denote the set of polynomials of degree at most \( n \) with real coefficients. Let \( \mathbb{P}'_n \) denote the subset of \( \mathbb{P}_n \) whose elements have non-negative coefficients.

**Theorem 1.** Let \( f(x) = \sum_{n=0}^{\infty} a_n x^n \) where \( a_n \geq a_{n+1} \geq 0 \) for all \( n \). Then
\[
\text{minimum}_{p \in \mathbb{P}_n} ||f-p||_{[0,1]} = \text{minimum}_{p \in \mathbb{P}_n', q \in \mathbb{Q}^+} ||f-p/q||_{[0,1]}.
\]

**Theorem 2.** Let \( f(x) = \sum_{n=0}^{\infty} a_n x^n \) where \( a_n \geq (n+1) a_{n+1} \geq 0 \) for all \( n \). Then
\[
\text{minimum}_{p \in \mathbb{P}_n} ||f-p||_{[0,1]} = \text{minimum}_{p \in \mathbb{P}_n'} ||f-p/q||_{[0,1]} = \text{minimum}_{p \in \mathbb{P}_n', q \in \mathbb{Q}^+} ||f-p/q||_{[0,1]}.
\]

(Received November 27, 1978.)

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A. Mate, Brooklyn College, Brooklyn, NY 11210 and P. Nevai, The Ohio State University, Columbus, OH 43210. Bernstein's inequality in \( L_1 \) and \( (C,1) \) bounds for orthogonal polynomials.

Using related ideas, contributions are made toward the solutions of two long open problems. The first concerns the determining of the best constant \( C(p) \) in Bernstein's inequality
\[
\int_0^{2\pi} |H_n(t)|^p dt \leq C(p) \pi n^p \int_0^{2\pi} |H_n(t)| dt, \quad 0 < p < 1
\]
where \( H_n \) is any trigonometric polynomial of degree \( n \). We prove \( C(p) \leq 1 \) while previously \( C(p) \leq 8/p \) was known.

The second concerns orthogonal polynomials \( p_n(d\chi) \) corresponding to positive measures \( d\chi \) defined on \([-1,1]\). We prove that
\[
\limsup_{n \to \infty} \frac{1}{n} E \left[ \left| p_n(x) \right| \right] < \infty \quad \text{a.e. in } [-1,1]
\]
provided that \( d\chi \) belongs to the Szegö class, i.e.,
\[
\int_{-1}^{1} \frac{\log |\chi'(t)|}{\sqrt{1-t^2}} \, dt < \infty.
\]
These results have interesting applications in approximation theory, probability and statistics. E.g., the second one is known to imply that if \( d\chi \) belongs to the Szegö class and \( f \in L_1(d\chi) \) then the orthogonal series of \( f \) in \( p_n(d\chi) \) is a.e. \((C,\varepsilon)\) summable to \( f \) for every \( \varepsilon > 0 \).

(Received November 30, 1978.)

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Lawrence Fialkow, Western Michigan University, Kalamazoo, Michigan 49008. Weighted shifts quasisimilar to quasinilpotent operators.

**Proposition.** An injective unilateral weighted shift is quasisimilar to a quasinilpotent operator if and only if it is quasinilpotent.

This result is used to give an example of a weighted shift \( T \) such that \( T \) and \( T^* \) are quasiaffine transforms of quasinilpotent operators, but \( T \) is not quasisimilar to any quasinilpotent operator. This example answers several questions of the author (see section 3 and Example 3.2 of [Pacific J. Math., 70(1977), 151-162]). (Received December 4, 1978.)

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Taussky proved: Let \( A, B \) be two integral \( n \times n \) matrices with irreducible characteristic polynomial which are similar via a matrix with integral elements. Then there exists an algebraic extension \( F \) of \( Q \) such that \( A, B \) are similar via a matrix with integers in \( F \) as elements and determinant a unit in \( F \). Dade generalized the above to integral matrices, with separable characteristic polynomial, over an algebraic extension of \( Q \), via ideal classes, yielding new results concerning invertible ideals in an order. (Received December 4, 1978.)
Let \( w'(t) \leq w(t) \) for \( 1 \leq j \leq n+1, n \geq 2 \). Given \( y \in C^n[a,\infty) \), let \( L_y \) be defined by \( (L_y)(t) = (L_ny)(t) \) where \( (L_ny)(t) = r_1(t)y(t) + (L_1y)(t) = r_{k+1}(t)y_k(t) \) for \( k = 1, \ldots, n \).

Let \( i_1, \ldots, i_k, j_1, \ldots, j_{n-k} \) be integers such that \( 1 \leq k \leq n-1 \) and \( 0 \leq i_1 < i_2 < \cdots < i_k \leq n-1 \) and \( 0 \leq j_1 < j_2 < \cdots < j_{n-k} \leq n-1 \). We assume \( A \) given \( b > a \) there exists no nontrivial solution of

\[
-\Delta y + b(t)y = 0, \quad y(a) = 0, \quad y = 1, \ldots, n-k - this \ will \ be \ true \ if, \ for \ example, \ i_p = p, p = 1, \ldots, k, j_q = q, q = 1, \ldots, n-k. \]

Necessary and sufficient conditions for \( A \) to hold have been given by Ellias (J. Differential Equations 29(1978), 28-57). Let \( p \in C[a,\infty) \) and satisfy (2) \( (-1)^{n-k}p(t) < 0 \) if \( t > a \). We say that \( b > a \) is conjugate to \( a \) relative to the differential equation (3) \( L_y + p(t)y = 0 \) if there exists a nontrivial solution of (3) satisfying the boundary conditions (1). Theorem: Let \( p_1(t) \) and \( p_2(t) \) satisfy (2). Suppose \( b_2 < a \) is the first point conjugate to \( a \) relative to \( L_y + p_2(t)y = 0 \). If \( (-1)^{n-k}p_1(t) < (-1)^{n-k}p_2(t) \) on \( [a, b_2] \) and \( p_1 \neq p_2 \), then \( a < b_1 < b_2 \) where \( b_1 \) is the first point conjugate to \( a \) relative to \( L_y + p_1(t)y = 0 \). (Received December 5, 1978.)

**79T-B37**

**CLAYTON W. KELLER**, Brown University, Providence, Rhode Island 02912.

Existence of infinitely many solutions of a nonlinear eigenvalue problem on \( \mathbb{R}^n \).

Theorem. Let \( L \) be the elliptic operator \( I - \Delta \) and \( F: \mathbb{R} \to \mathbb{R} \) satisfy the following hypotheses: 1) \( F(s) \) is Hölder continuous; 2) \( F(s) = o(|s|) \) as \( |s| \to 0 \); 3) \( F(s) > 0 \) for \( 0 < s < \delta \); 4) there exists an \( s_0 \) such that \( F(s_0) < 0 \); 5) \( F(-s) = -F(s) \). Then, for each \( \gamma > 0 \), there exists an infinite sequence of distinct solution pairs \((u_k, \lambda_k)\) of \( L\mu = \lambda F(u) \) on \( \mathbb{R}^n \), where each \( u_k \in H^1(\mathbb{R}^n) \) is radial and \( (Lu_k, u_k) = \gamma \).

Remarks. The usual growth condition on \( F(s) \) at infinity is absent. Moreover, this extends a result previously obtained for bounded domains to the unbounded case. (Received December 12, 1978.)

**79T-B39**

**RONALD E. BRUCK**, University of Southern California, Los Angeles, Ca. 90007.

Weak asymptotic almost-periodicity of bounded solutions of \( w' \in \mathbb{R} + t \).

The results of abstract \( \# 763-472 \) can be considerably strengthened; in particular, every weak solution is a strong solution. Let \( A \) be maximal monotone on a real Hilbert space \( H \), let

\[
f \in L^2_{1oc}(R;H), \text{ and suppose } u \in L^2_{1oc}(R^+;H) \cap L^\infty(R^+;H) \text{ satisfies (DE): } u''(t) \in Au(t) + f(t)
\]

for almost every \( t \in R^+ \).

**THEOREM.** If \( f \) is periodic (resp., a.p.) then (DE) has a bounded periodic (resp., a.p.) solution \( u \) on \( R \) such that \( u(t) - u(R) \to 0 \) weakly as \( t \to +\infty \). Moreover, \( u(t) - u(t') = o(t^{-1/4}) \) and \( u''(t) - u''(t') \to 0 \) weakly in \( L^2(0,1;H) \) as \( t \to +\infty \) (where \( u'(-t) = u(t+t) \)).

Note that almost-periodicity is, in one sense, a stronger assumption than periodicity since in the latter we only require \( f \) to be 2. This theorem extends results of Birolı (Boll. U.M.I. 6(1972), 229-241; 9(1974), 767-774) and is strongly reminiscent of results of Baillon and Haraux (Arch. Rational Mech. Anal. 67 (1977), 101-109), although the techniques of proof are different. We also obtain existence results when \( f \in L^\infty(R;H) \) without using the existence of a compact injection (Birolı loc. cit.) and prove a regularizing effect for the two-point boundary value problem for (DE). Extensions of the Baillon-Haraux theorem to the a.p. case, and of the present result to the \( S^2 \)-a.p. case, would be of great interest. (Received December 15, 1978.)

**79T-B40**

**J.J.M. CHADWICK**, Cuttington University College, P.O. Box 277, Monrovia, Liberia. Schauder decompositions in the duals of \( L_\infty \) spaces.

Using straightforward methods it is deduced from results of Hagler and Stegall that the conjugate space of any \( L_\infty \) space has a boundedly complete Schauder decomposition. (Received December 19, 1978.)
Let $X$ and $Y$ be complete metric spaces with $Y$ metrically convex, and let $T$ be a closed mapping of $X$ into $Y$. It is shown that if $D$ is an open subset of $X$ such that $T$ is locally expansive on $D$ and $T$ maps open subsets of $D$ onto open subsets of $Y$, then an element $y$ of $Y$ belongs to $T(D)$ if and only if there exists $x_0 \in D$ such that $\text{dist}(T(x_0), y) \leq \text{dist}(T(x), y)$ for all $x \in X - D$. Several implications of this result are considered, specifically for equations in Banach spaces involving locally condensing, locally strongly accretive and locally strongly monotone mappings. (Received December 19, 1978.)

Let $A$ be the generator of a contraction semigroup on a Banach space $X$ and let $k$ and $n$ be real numbers with $0 < k < n$. Then, if $x \in D(A^n)$, we have the inequality $\|A^k x\| \leq C_{nk} \|x\|^{1 - k/n} \|A^n x\|^{k/n}$. Here the constants $C_{nk}$ are the same constants that obtain for $A = d/dx$, $X = C[0, \infty)$. The case $k = 1$, $n = 2$, $C_{21} = 2$ is an inequality of Kallman and Rota. The case of integer $k$, $n$ has been treated by Ditizian and, independently, Certain and Kurtz. If $X$ is a Hilbert space then the constants $C_{nk}$ can be decreased to those valid for $d/dx$ on $L^2(0, \infty)$. Here the case $k = 1$, $n = 2$, $C_{21} = \sqrt{2}$ is due to Kato. (Received December 19, 1978.)

Let $S$ be a separately continuous locally compact semigroup, $M(S)$ the measure algebra and $M_0(S)$ the probability measures. We obtain the following results:

**Theorem 1** $M(S)^*$ has a subspace $X$ such that (i) $\mu \otimes F \notin X$ for all $F \in M(S)^*$, $\mu \in M_0(S)$, (ii) $F \in M(S)^*$ and $\inf\{F(\mu) : \mu \in M_0(S)\} > 0$ implies $F \notin X$ if and only if $M(S)^*$ has a topological left invariant mean (where $\mu \otimes F$ is an element of $M(S)^*$ defined by $(\mu \otimes F)(\nu) = F(\mu \otimes \nu)$ for all $\nu \in M(S)$).

**Theorem 2** The following are equivalent (a) $M(S)^*$ has a topological left invariant mean, (b) $N(S)$ is closed under addition, (c) $d(\mu_1 \otimes M_0(S), \mu_2 \otimes M_0(S)) = \inf\{|\mu_1 \otimes \nu - \mu_2 \otimes \nu| : \nu \in M_0(S)\} = 0$ for any $\mu_1$, $\mu_2 \in M_0(S)$ where $N(S)$ is the set of all $F$ in $M(S)^*$ such that $\inf\{|\mu \otimes F| : \mu \in M_0(S)\} = 0$. These are topological analogues of Propositions 1.1 and 1.7 in W.R. Emerson [Characterizations of amenable groups, Trans. Amer. Math. Soc. Volume 241, July 1978, pp. 183-194]. Other results in this direction are also obtained. (Received December 19, 1978.)

In this paper we prove two theorems:

**Theorem 1.** If $E$ is a Banach space. Then the dual $E^*$ has the Radon-Nikodym property if and only if the natural projection from $E^{***}$ with its $w^*$-topology to $E^*$ with its weak topology is universally Lusin measurable.

**Theorem 2.** If $E$ is a Banach space which is complemented in its second dual $E^{**}$ by a projection $P : E^{**} \rightarrow E$. (a) If for every $x \in E^*$ the map is $x P$ is Baire-1 when $E^{**}$ is equipped with its $w^*$-topology then $E$ has the weak Radon-Nikodym property. (b) If $P$ is Baire-1 from $E^{**}$ with its $w^*$-topology to $E$ with its weak topology then $E$ has the Radon-Nikodym property.

It is very easy to see that the projection $P$ from $\ell^n$ to $\ell^1$ satisfies the condition (b) of Theorem 2. (Received December 19, 1978.)
Let $D$ be an equilateral triangle of side $l$. We consider solutions of $\Delta u + \lambda u = 0$ in $D$ with either the boundary condition $u = 0$ or $\frac{\partial u}{\partial n} = 0$. Let $n(\lambda)$ be the number of distinct eigenvalues $\lambda$, including multiplicities. **Theorem 1:** For either boundary condition, $A_w n = -\pi - (m + n - mn)$, where $m + n \equiv 0 \pmod{3}$. In the first case it is further required that $m \neq 2n, n \neq 2m$. **Theorem 2:** $A_w n = \infty$. The proof uses the representation of $A_w n$ as the norm of an integer in the quadratic number field $k(\omega)$, where $\omega$ is a primitive cube root of unity. These results contrast with the generic results for domains with $Z_3$ symmetry, obtained by V. Arnold, Modes and Quasi-Modes, Functional Analysis and Applications 6(1972), 12-20. (Received December 26, 1978.)

Let $S(c,d) = \sum_{k=0}^{\infty} \frac{(-1)^k}{c-kd}$, for $c \neq 0$, $d > 0$. **Theorem.** If $d/c = p/q$, where $p$ and $q$ are integers and $1 \leq q \leq p$, then $S(c,d) = (q/c) S(q,p)$. If $q$ is not in this range, $S(c,d)$ differs from such a series by a finite number of terms $(-1)^k/(c+kd)$. Let $a(n,k) = 1$ if $1 \leq k \leq n \pmod{2n}$ and $-1$ if $n+1 < k < 2n \pmod{2n}$. Let $T_n$ be the sum of the block-alternating harmonic series $\sum_{j=1}^{\infty} \frac{a(n,k)}{k} = \sum_{j=1}^{n} \frac{S(k,n)}{2}$. This sum simplifies as follows. **Theorem.** $T_n = (\pi/n^2) \left[ \frac{\log n}{2} \right] + (\log 2)/n$. (Received December 26, 1978.)

J.M. Marstrand in A counter-example in strong differentiation Bull. London Math., 9(1977)209-211, defines $f \in L^1$ on $\mathbb{R} \times [0,1]$ such that for every orientation of the axes the strong upper derivative of $f$ is $\ll$ almost everywhere. With slight changes we prove that the same can be made if any pair $\Psi < \Phi$ of Orlicz functions are considered in the place of $u < u(\log u)$, in the following sense: Let $\mathcal{B}$ a Busemann-Peller differentiation basis in $\mathbb{R}^m$ that is translation invariant, and let, for every $0 < r < 1$ $\phi(r) = |\{r \mathcal{B} : r \in B_1, |B| \geq r\}$, $B_1$ being the ball $B(0,1)$. If $\Psi : (1,\infty) \to \mathbb{R}$ with $\lim \Psi(u)/u^\phi(\frac{u}{u}) = 0$, then there exists $f \in \Psi(L)$ such that for every rotation $\gamma$ of $\mathbb{R}^m$ the upper derivative of $f \gamma$ relative to the basis $\mathcal{B}$ obtained by rotating $\mathcal{B}$ through $\gamma$ is $\ll$ almost everywhere, and every $f \in \Psi(L)$ but a set of the first category in $\Psi(L)$ shares this property. In Marstrand's case $u^\phi(\frac{1}{u}) = u(\log u)$ is just the halo function of the interval basis, but we don't know if this is always true. (Received January 3, 1979.) (Author introduced by M. de Guzman).

The object of this paper is to present a systematic introduction to and several interesting applications of a general method of obtaining bilinear, bilateral or mixed multilateral generating functions for a fairly wide variety of special functions in one, two and more variables. The main results, which are stated and proved as Theorems 2 and 3 of the present paper, are shown to apply not only to the Bessel polynomials, the classical orthogonal polynomials including, for example, Hermite, Jacobi (and, of course, Gegenbauer or ultraspherical, Legendre, and Tchebycheff), and Laguerre polynomials, and to their various generalizations studied in recent years, but indeed also to such other special functions as the Bessel functions, a class of generalized hypergeometric
functions, the Lauricella polynomials in several variables, and the familiar Lagrange polynomials which arise in certain problems in statistics. It is also indicated how these general results are related to a large number of known results scattered in the literature. (See, for example, the recent papers by H. M. Srivastava and J.-L. Lavoie [Indag. Math. 37(1975), 304–320], R. Panda [Glasnict Mat. Ser. III 11(31) (1976), 27–30], and S.K. Chatterjea[Bull. Inst. Math. Acad. Sinica 5(1977)].)

(Rceived January 5, 1979.)


Let $P(D)$ and $Q(D)$ be suitable selfadjoint differential operators (here of second order) in naturally rigged Hilbert spaces $E_0$ and $E_0$ (with $\sigma(P) = \sigma(Q)$ here), determining generalized translations $T$ and $S$ so that in standard notation $T^* = H(x,P)$ and $S^* = \Theta(y,Q)$ where the generalized eigenfunctions $H$ and $\Theta$ satisfy $P\phi = \lambda\phi$, $Q\Theta = \nu\Theta$, $H(0,\mu) = \Theta(0,\nu) = 0$, and $H^*(0,\mu) = \Theta^*(0,\nu) = 0$. Set $\tilde{T}(\mu) = \langle H(x,\mu),f(x) \rangle$ and $\tilde{T}(\nu) = \langle \Theta(y,\nu),f(y) \rangle$ with inversions $f(x) = \int \tilde{T}(\mu)H(x,\mu)d\sigma(\mu)$ and $f(y) = \int \tilde{T}(\nu)\Theta(y,\nu)d\rho(\nu)$. Assume the transmutation problem $P(D_x)f = Q(D_y)\phi$ where $f(x) = \int \tilde{T}(\mu)H(x,\mu)d\sigma(\mu)$ and $\phi(x,0) = 0$ (resp. $\phi(0,y) = g(y)$, $\phi(0,y) = 0$) is uniquely solvable with $\phi(0,y) = B\phi(y)$ (resp. $\phi(x,0) = \tilde{\phi}(x)$) so that $\tilde{\phi} = B\tilde{\phi}$. Then $\phi(x,y) = \int \tilde{\phi}(\mu)H(x,\mu)d\sigma(\mu) = \int \tilde{\phi}(\nu)\Theta(y,\nu)d\rho(\nu)$ while formally $B\phi(y) = \langle \int \tilde{T}(\nu)\Theta(y,\nu)d\rho(\nu),\phi(y) \rangle$. The formulas can be based on the tensor product spectral constructions of Berezanskij for $\mathfrak{P}\mathfrak{I} + \mathfrak{Q}(\mathfrak{Q})$ in $E_{\mathfrak{P}}\tilde{\phi}E_{\mathfrak{Q}}$ or obtained directly. Details will appear in the author's book "Linear differential equations with operator coefficients and operational calculus", North-Holland, to appear 1979. (Received January 8, 1979.)

Alexander ABIAN, Department of Mathematics, Iowa State University, Ames, Iowa 50011.

Two Theorems on Symmetric Truncations of the Laurent Expansion.

In what follows by "almost every" we mean "every with the exception of at most a finite number". Without loss of generality, let $0$ be an essential singularity of an analytic function $f$ whose Laurent expansion around $0$ is given by:

$$
... + b_3 z^{-3} + b_2 z^{-2} + b_1 z^{-1} + a_0 + a_1 z + a_2 z^2 + a_3 z^3 + ...
$$

It is shown that in every neighborhood of $0$ any complex number $c$ is attained more than (counting the multiplicities) any given number of times by almost every symmetric truncation (i.e., truncation of the form $b_3 z^{-3} + b_2 z^{-2} + b_1 z^{-1} + a_0 + a_1 z + ... + a_n z^n$) of the above Laurent expansion of $f$.

Also, it is shown that in every neighborhood of any point of analyticity $a$ of $f$ the value $f(a)$ is attained by almost every symmetric truncation of the Laurent expansion (which may coincide with the Taylor expansion) of $f$. (Received January 8, 1979.)

79T-B51 HAROLD EXTON, 27 Hollinlhurst Avenue, Penwortham, Preston, Lancashire PR1 0AE, United Kingdom. Basic Fourier series.

The following lemma is established and used as the basis for deducing $q$-orthogonal expansions of generalised Fourier type in which no polynomials are involved: Lemma. Suppose that the real functions $r(x)$, $t(x)$ and $w(x)$ possess the appropriate number of $q$-derivatives and that $q$ is real and $0 < q \leq 1$. Let $y_m(qx)$ and $y_n(qx)$ be eigenfunctions corresponding to distinct eigenvalues $\lambda_m\lambda_n$ of the boundary-value system $B_t(x)By(x) + l(t(x)+\lambda n(x))y(x) = 0$, $h_y + h_0 By = 0$ at $x = g$, $k_y + k_0 By = 0$ at $x = h$, $h_1$, $h_2$, $k_1$ and $k_2$ being real constants. Then $y_m(qx)$ and $y_n(qx)$ are $q$-orthogonal on the closed interval $g \leq x \leq h$ with respect to the weight function $w(x)$. That is $\int g w(x)y_m(qx)y_n(qx)d(qx) = 0$, $m \neq n$. The operators $B$ and $S$ denote respectively basic differentiation and basic integration. The above boundary-value system is a basic analogue of the simple Sturm–Liouville system of the second order. The $q$-difference equation $a^{q+1}Bqy + [a+1]By + q(y) = 0$ to which the lemma is applicable is shown to have the solutions $X_\pm(qx)$ and $X_{-a}(q^{-a}x)$, where $X_\pm(qx) = \sum q^{r-1}x^{\lceil r-1 \rceil}/[r!]q^{a+1}r$, where $[r!]$ is a basic analogue of $r!$ and $\Gamma_q$ is the basic gamma function.
Eigenvalue expansions of an arbitrary function are given in terms of \( X_n(q;q_0) \) and \((q_0)^{-a} X_{-n}(q;q_1^{-a})\) in which the eigenvalue is multiplicatively associated with the independent variable as in the case of the Fourier and Fourier-Bessel expansions. An approximate formula for basic integrals is given and the possibility of applying the above analysis in the field of time-series and stochastic processes is indicated. (Received January 9, 1979.)


In an earlier paper we proved that if \( X \) is a compact metric space, \( E \) is a Banach space and \( A \) is a linear subspace of \( C(X,E) \), then each element of \((A \otimes E)^*\) can be represented by a boundary vector measure on \( X \) with the same norm. Using the same techniques we developed in (C. R. Acad. Sci., Paris Serie A 286, 1978), we can prove the same result without assuming that the compact \( X \) is metrizable. Also the same techniques allow us to prove that if \( X \) is a Choquet Simplex and \( E \) a Banach space then \( A(X,E) \), then the space of all affine continuous \( E \)-valued functions defined on \( X \) has the Dunford-Pettis property whenever \( C(X,E) \) does. In particular if \( E \) has the Schur property then \( A(X,E) \) has the Dunford-Pettis property. (Received January 10, 1979.)


We prove a theorem on the sum of unbounded linear operators in Hilbert space \( H \). The space \( H \) will be fixed, all operators are assumed linear, and the algebra of all bounded operators is denoted by \( B(H) \). The theorem applies to the sum of a closed and densely defined \( (\text{called regular in the sequel}) S_1 \) and a closed linear relation \( G_2 \) in \( H \). We show that \( G(S_1) \) and \( G_2 \) are orthogonal iff \((S_1 \otimes S_2)G_2 = 0\), and \( G(S_1) \otimes G_2 \) is the graph of a regular operator \( T \) iff \( R(G_2^* \cap B(S_1^*)^*) = 0 \). \( T \) is said to be a graph perturbation of \( S_1 \). If \( T \) is a regular operator and \( B \in B(H) \) we say that \( B \) and \( T \) commute, \( B \circ T = T \circ B \), if \( BT = TB \), i.e. \( Bx \in D(T) \) and \( T(Bx) = B(Tx) \) for all \( x \in D(T) \). The implication \( B \circ T = B \circ T \) for normal \( B \) and regular \( T \) was listed as an open problem in [B. Fuglede, A commutativity theorem for normal operators, Proc. Natl. Acad. Sci. USA 36 (1950), 35-50]. The problem was stated originally by von Neumann. As an application we show that the implication is false for \( B = \text{the bilateral shift} \ U \) of infinite multiplicity. (If the multiplicity is finite the implication is also false, \( B \sim U \).) As a corollary we characterize all the regular operators that commute with \( U \). The operator \( T \), used in the counter example, has \( \sigma_p(T) = \mathbb{C} \), even though it is the graph perturbation of a selfadjoint operator by a "partially symmetric" operator. (Received January 11, 1979.)


There exists a separable liminal C*-algebra which does not admit any finite composition sequence \((I_p)^p\) such that the spectra of the quotients \( I_{p+1}/I_p \) are Hausdorff. This solves a problem of J. Dixmier published in "Les C*-algèbres et leurs représentations", Gauthier-Villars, Paris 1964. (Received January 12, 1979.)


Let \( \Omega \) be a proper subregion of the complex plane \( \mathbb{C} \) and let \( X_0(\Omega) \) be the pre-Hilbert space that is obtained when \( \mathcal{C}_0^\infty(\Omega) \) is normed by

\[ ||u||^2 = \int_\Omega |\Delta u|^2 \, dx \, dy. \]

A-215
When \( X_0(\Omega) \) has a proper functional completion \( X(\Omega) \) let the reproducing kernel of that space be denoted by \( \Gamma_0 \). When \( \Gamma_0 \) can be so defined then the distribution solution of
\[
\Delta^2 u = f \quad \text{in} \quad \Omega, \quad u = \frac{\partial u}{\partial n} = 0 \quad \text{on} \quad \partial \Omega,
\]
\( f \in C^0_0(\Omega) \), is given by
\[
u(z) = \int_{\Omega} \Gamma_0(z, \zeta) f(\zeta) d\zeta d\eta,
\]
\( z = x + iy, \quad \zeta = \xi + im \); in particular \( \Gamma_0 \) coincides with the classical biharmonic Green's function when the later is defined. Thus the biharmonic Green's function will be said to exist whenever \( X(\Omega) \) exists and will be defined as the reproducing kernel. We find that \( X_0(\Omega) \) has a proper functional completion provided: (i) \( C \setminus \Omega \) contains a connected component which is not a singleton (in particular if \( \Omega \) is simply connected) or (ii) \( C \setminus \Omega \) does not lie on a line; \( X_0(\Omega) \) fails to have a proper functional completion when \( C \setminus \Omega \) is finite and lies on a line. (Received January 15, 1979.)

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**A-216**  
DAVID HOFF, Indiana University, Bloomington, Indiana 47405. *Construction of solutions of a degenerate parabolic equation with nonsmooth initial data.*

We construct by finite differences solutions of the initial value problem for \( u_t = u_{xx} \) subject to zero Dirichlet boundary conditions. The initial value \( u_0(x) \) is assumed only to be essentially bounded and nonnegative and to satisfy a certain boundary -compatibility condition. Our method is to obtain the solution \( u(x,t) \) as a limit point of approximate solutions \( u_h(x,t) \) constructed by finite differences. The compactness of the net \( \{u_h\} \) follows by showing that \( \frac{\partial u_h}{\partial x} \) and \( \frac{\partial u_h}{\partial t} \) are bounded like \( c/t \) in \( L^1([0,1]) \) and \( L^0([0,1]) \) respectively. These estimates in turn are easy consequences of a one-sided pointwise bound for \( \frac{\partial u_h}{\partial t} \), analogous to the well-known "entropy" condition for a single hyperbolic conservation law. (Received January 15, 1979.)

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**A-217**  
JOSE L. RUBIO DE FRANCIA, Facultad de Ciencias, Universidad de Zaragoza (Spain). *Vector valued inequalities for Fourier and Walsh series.*

Let \( \mathcal{S}^* f(x) = \sup n \mathcal{S} f(x) \) where \( \mathcal{S} f \) denotes the nth partial sum of the Fourier series of \( f \). If \( 1 < p, r < \infty \) the following inequality holds
\[
\left\| \left( \sum \mathcal{S}^{*} f_j \right)^{1/r} \right\|_p \leq C_{p,r} \left( \sum \left\| f_j \right\|^r \right)^{1/r}.
\]
As an application, if \( f(x,y) \) belongs to the Benedek-Panzone space \( L^{p,r}(T^2) \) with \( p, r \) as above, and \( (S_{nm} f) \) are the rectangular sums of the Fourier series of \( f \), we obtain
\[
\lim_{n,m \to \infty} \left\| S_{nm} f(x,y) - f(x,y) \right\|_p = 0 \quad \text{for almost every} \quad x \in T
\]
It is well known that \( S_{nm} f(x,y) \) tends to \( f(x,y) \) as \( n, m \to \infty \) in the norm of \( L^{p,r} \), but the pointwise convergence for almost every \( (x,y) \) fails in general. The preceding results are also true for Walsh series. (Received January 15, 1979.)

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**A-218**  

Equations of the type \( Tx + Cx = f \) are studied, where \( T: D(T) \subset X \rightarrow X, C: D(T) \rightarrow X, f \in X \) with \( X \) a Banach space. \( T \) is (in general) nonlinear and satisfies some accretiveness property, while \( C \) (also nonlinear) is compact. The methods involved employ mainly degree theory arguments. Since \( T \) is never assumed continuous, these results complement and extend various known results of Browder, Petryshyn, Ward and other authors. Indications are given on how these results can be applied to boundary value problems for evolution equations with nonlinear boundary conditions. It is also shown that several of the above results can be extended to the case where the compactness assumption on \( C \) is replaced by the compactness of one resolvent of the nonlinear operator \(-T\). It should be noted here that if \( T \) is not continuous, then the generalized degree function, as developed by Browder [Proc. Symp. Pure Math., 18 (2) (1976)], is not defined on \( T + C \), although \( T \) satisfies all the other suitable assumptions. (Received January 16, 1979.) (Author introduced by M. N. Manougian.)
Let $\mathfrak{A}$ be a complex $C^*$-algebra with unit. A $J^*$-subalgebra of $\mathfrak{A}$ is a closed * subalgebra which is also closed under the Jordan product $T \circ S = (TS + ST)/2$. Let $P_1, P_2, \ldots$ be positive linear maps on $\mathfrak{A}$ such that $P(I) \leq I$ and $P_n(I) \leq I$ for $n = 1, 2, \ldots$. Let

$$C = \{ T \in \mathfrak{A} : P_n(T) \to P(T), P_n(T^* o T) \to P(T^* o T) = P(T^*) o P(T) \}.$$ 

If the convergence → is taken in the strong, or weak, operator topology on $\mathfrak{A}$, let the corresponding sets be denoted by $C_{st}$, or $C_{wk}$.

**Theorem.** $C$, $C_{st}$ and $C_{wk}$ are $J^*$-subalgebras of $\mathfrak{A}$. In fact, $C_{st} = C_{wk}$. If $P_1, P_2, \ldots$ are Schwarz maps, then $C$ and $C_{st} = C_{wk}$ are $C^*$-subalgebras of $\mathfrak{A}$.

**Corollary.** Let $\mathfrak{A} = (H)$ for some Hilbert space $H$, $P = I$ and $P_1, P_2, \ldots$ completely positive. If $C_{wk}$ contains a nonzero compact operator, then $C_{wk}$ is a $J^*$-subalgebra.

The above results extend earlier results of Priestly and Robertson. (Received January 17, 1979.)

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Let $X$ be a compact Hausdorff space, $\mathcal{T}$ an involutoric homeomorphism on $X$ and $C(\lambda, \mathcal{T}) = \{ f : f$ a complex-valued continuous function on $X$ such that $f(\mathcal{T}(x)) = \bar{f}(x)$ for all $x \in X \}$. A real function algebra $A$ on $(X, \mathcal{T})$ is defined to be a uniformly closed (real) subalgebra of $C(X, \mathcal{T})$ containing 1 and separating points of $X$ (weakly). It is proved that the carrier space $\tilde{X}_A = \{ \phi : \phi$ a nonzero real linear homomorphism of $A$ into the complex numbers $\}$ of a real function algebra $A$ on $(X, \mathcal{T})$ is partitioned into equivalence classes, called Gleason parts of $A$, by the relation $||\phi - \psi||(\mathcal{T} - \Psi) || < 4$. Various characterizations of Gleason parts are given.

The relationship between the Gleason parts of $A$ and those of its complexification is used to compute the Gleason parts of some concrete real function algebras. Sufficient conditions are obtained for embedding finite open Riemann surfaces in $\tilde{X}_A$ and finite open Riemann surfaces in the maximal ideal space of $A$. (Received January 17, 1979.)

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Let $X$ be a (reduced) complex space of pure dimension $m > 0$. Assume $\pi : X \to Y$ defines an analytic cover of a subvariety $Y$ in an open ball $C^0(a)$, where $0 < a < \infty$. Let $\tau(x) = ||\pi(x)||^2$, $(x \in X)$, and $u = (1/4n)dd^c\tau$. On $X - \tau^{-1}(0)$, define $\omega = (1/4n)dd^c\log\tau$, $\sigma_0(p) = (1/4n)dd^c\log\tau \wedge \omega^{m-1}$. 

**Thm. 1.** Assume $h : X \to C$ is of class $C^2$ with $\nabla^m + dd^c\nu = 0$ on $X_{reg}$. Then

$$\int \sigma_m(p) \wedge dh = 0,$$

where $x(r) = \{ x \in X | \tau(x) < r \}$, $0 < r < a$. **Thm. 2.** Assume either $X$ and $Y$ or $X(r)$ are normal or $\pi = id_X$ (with $X = Y$). Let $G$ be a Stokes domain in $X$ with $G \cap \tau^{-1}(0) = G \cap \tau^{-1}(0) = \{ z \}$. Then for every $C^1$ function $h : X \to G$,

$$\nu_\psi(x)\omega_\nu(0)h(z) = \int_G h \sigma_m(p) - \int_G \nu_\psi^{m-1} \wedge dh.$$ 

Here $\nu_\psi(z)$ is the branching order of $\pi$ at $z$; $\omega_\nu(0)$ is the Lelong number of $Y$ at $0$.

(Received January 22, 1979.)
89T-C10  O. M. KOSHELEVA, USSR 196140 Leningrad Pulkovo Special Astrophysical Observatory. Proof that rest mass of graviton is 0. Preliminary report.

In quantum language gravity is a spin-2 field $h_{ij}$ in flat space, whose source is energy-momentum tensor. Therefore, if we know Lagrangian $L(L_{h_{ij}} = h_{ij}, k = 0)$ of gravitation we can obtain its equations in two different ways: (1) by simply varying $L$ with respect to $h_{ij}$: $\delta L / \delta h_{ij} = 0$. (2) by applying general form of spin-2 equations in flat space: $(Dh)_{kl} + m_0^2 h_{kl} = T_{kl}(L)$, where $T_{kl}$ is obtained from $L$ by a standard Hilbert's procedure and $D$ denotes the correspondent Lorentz-covariant differential operator of II order. Of course, equations obtained in two different manners, must be equivalent and this natural demand restricts possible $L$. For $m_0 = 0$ this restriction is consistent, (example of such $L$ is general relativity). For $m_0 \neq 0$ they are not: Theorem. There exists no $L$ such that for some $m_0 \neq 0$, (1) is equivalent to (2). So rest mass of graviton is 0. The author is greatly thankful to K. S. Thorne and V. Kreinovic for valuable discussions. (Received September 25, 1978.) (Author introduced by Mr. V. Kreinovic).


In [1] properties of spherical stars of cold catalysed matter are analysed. In theorems of ch. 4 [1] it is proved that (1) for any density $\rho_0$ in the center one and only one stable configuration exists and (2) for equations of state $p = n\rho$, $0 \leq n \leq 1$ values of mass $M$ and radius $R$ of such configurations remain finite, when $\rho_0 \rightarrow \infty$. This means that for $M > M_{\text{max}}$ no stable configuration is possible, so a cold star will inevitably collapse. Whether it is so for arbitrary equation of state was an open problem. Theorem. For arbitrary equation of state mass-energy $M$ and radius $R$ of stable configurations remain finite, when $\rho_0 \rightarrow \infty$. The authors are thankful to K. S. Thorne for valuable discussions. [1] B. K. Harrison, K. S. Thorne et al., Gravitation theory and gravitational collapse, Univ. of Chicago Press, Chicago and London, 1965. (Received September 18, 1978.)

#89T-C12  C. E. Blair, University of Illinois, Urbana, Illinois 61801; J. Borwein, Dalhousie University, Halifax, Nova Scotia B3H 3J8; and R. Jeroslow, Georgia Institute of Technology, Atlanta, Georgia 30342. Constraint Qualifications for the Limiting Lagrangean.

For $h \in \{0\} \cup K$, with $K$ a set of arbitrary cardinality, let $f_h : D_h \rightarrow \mathbb{R}$ be convex, where $D_h$ for $h \in \{0\} \cup K$ is a convex set. We assume that the following convex program (CP) is consistent with finite value $v(P)$: $\inf f_0(x)$, subject to $f_h(x) \leq 0$ for $h \in K$ and also $x \in C$. The closure (CP)$^\epsilon$ of (CP) is defined as: $\inf \{v \in (f_h)\} \leq 0$ for $h \in K$ and also $x \in C$. Here, $\epsilon$ denotes the closure of the object 0. Let $v(P)$ denote the value of (CP)$^\epsilon$. Let $K^\epsilon$ denote those indices $h \in \{0\} \cup K$ such that $f_h$ is not closed. $C$ is assumed to be convex.

Theorem: Any of these three conditions is sufficient to insure that $v(P) = v(P')$: (1) There exists $x_0 \in \text{relint}(C) \cap \bigcap_{h \in K^\epsilon} \text{relint}(D_h)$ with $f(x_0) \leq 0$ for $h \in K$; (2) $C$ is closed and there exists $x_0 \in C \cap \bigcap_{h \in K^\epsilon} \text{relint}(D_h)$ with $f(x_0) \leq 0$ for $h \in K$; (3) The program (CP) has at least two feasible points, and none of the sets $C$ resp. $D_h$ (for $h \in K^\epsilon$) contains any line segment in $C \text{relint}(C)$ resp. $D_h \text{relint}(D_h)$. (In the above, relint(S) denotes the relative interior of the convex set S. Also, the intersection over an empty set is taken to be $\mathbb{R}^n$.) (Received October 23, 1978.)

#89T-C13  Paul F. Dubois, University of California, Livermore, Manuel Keeler; South Carolina State College, Orangeburg, South Carolina 29117 and Stephen I. Warshaw, University of California, Livermore, California 94550. On the decomposition of crossed polygon into simple ones.

In simulation calculations containing finite polygonal mesh elements which deform as the simulation progresses, the mesh may become so entangled that crossed polygons may occur. We give an algorithm for decomposing any crossed polygon into a collection of simple ones which allows a consistent interpretation of its area, so that available overlap techniques for simple polygons may then be employed. This technique is efficient and unique in a certain sense. (Received November 13, 1978.)
Let $P$ be the Banach space of continuous, $\sigma$-periodic functions $f : \mathbb{R} \to \mathbb{R}$ ($\sigma > 0$ fixed), with norm $\|f\| = \max \{|f(x)| : x \in \mathbb{R}\}$, and let $X = \{f \in \mathbb{R} : f, F, X$ fixed. For any $f \in X$, let $\Omega(f) = \{p = (x, y) \in \mathbb{R}^2 : F(x, y) \leq L\}$ and let $U(f, p)$ be the $\sigma$-periodic (in $x$) solution of the boundary value problem $V_0 = 0$ in $\Omega(f)$, $U_0$ on $f$ (considered as a graph), $U_1$ on $p$. \exists one function $f^* \in X$ such that for all $p \in f^*$, $|U(f^*, p) - U(f^*, q)| = 1$ (where $q \in \Omega(f^*)$). To approximate $f^*$, we define the transformations $T \in x \to x, 0 \leq < 1$, by $T(f) = \frac{f(x)}{E(x)}$. Here $f_0(f) = \{p \in \Omega(f) : U(f, p) = e\}$ and $f_0(f) = \{p(x, y) \in \mathbb{R}^2 : U_0(f, p) + d(p, f) = e\}$, where $d(p, f) = \min \{|p - q| : q \in f\}$. One can choose a set $X = \{f \in X : f \leq U, f \leq F + v\}, 0 < v < \infty$ fixed, such that $f^* \in X$ and $T_{f^*} = \tilde{x} \to \tilde{x}$ for each $0 < c < 1$. Theorem. If $P(x)$ is Lipschitz continuously differentiable over $R$, then $T_{f^*}$ is a contraction in $\tilde{x}$ for each $0 < c < 1$, i.e., $\|T_{f^*}(f) - T_{f^*}(g)\| \leq \lambda(f - g)$ in $\tilde{x}$, where $\lambda = \alpha(e) < 1$. Thus $T_{f^*}$ has a unique "fixed point" $f^* \in X$ which can be obtained by successive approximations, i.e., $\|f_{n+1} - f_n\| \leq \alpha(n)^n(1 - \alpha)$ $\|f_n - f\|, f \in X, n \in \mathbb{N}$. Moreover, $\|f_{n+1} - f\| = o(\varepsilon)$ as $\varepsilon \to 0$. Thus, to approximate $f^*$ by $f_n(f)$, first choose $\varepsilon > 0$ sufficiently small, then $n \in \mathbb{N}$ sufficiently large. One can approximate $U(f^*, p)$, and hence $T_{f^*}(f)$, by discrete methods. (Received November 13, 1978.)

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Aldo De Luca, Laboratorio di Cibernetica del C.N.R., Arco Felice, Napoli, Italy. On some properties of the syntactic semigroup of very pure semigroups.

Let $A^+$ be the free semigroup (false monoid) generated by a set $A$ and $P$ a subsemigroup of $A^+$. A pair $(u, v) \in P \times P$ is called synchronizing if for all $s, t \in A^+, su, tv \in A^+$. $P$ is said to have a bounded synchronization delay if a positive integer $k$ exists such that all the pairs of $P^k \times P^k$ are synchronizing. $P$ is called very pure if for all $u, v \in A^+$, $uv, vu \in P \cup u, v \in P$. For any $M \subseteq A^+ (S(M)$ is the syntactic semigroup of $M$ and $\sigma: A^+ \to S(M)$ the syntactic morphism. The main results of the paper are the following: Proposition 1. A recognizable very pure subsemigroup of $A^+$ has synchronizing pairs. Proposition 2. Let $P$ be a free subsemigroup of $A^+$ such that $P \cap (S(P)) = S(P)$, where $S(P)$ is the set of idempotents of $S(P)$ is a finite set. The following propositions are equivalent: 1. $P$ has a bounded synchronization delay. 2. $P$ is very pure and its base $X \times P \times \mathbb{Z}$ satisfies the condition $A^+ (X \times P \cap X = 0$ for a suitable integer $p$. 3. $P$ has a unique 0-minimal ideal $J$ which is completely $p$-simple. Moreover $P \cap (E(S(P)) \leq J$ and the $\mathbb{H}$-classes of $J$ are trivial. 4. For all $e \in P \cap (E(S(P))$, $e \in P, e \subseteq \{e, 0\}$. (Received November 13, 1978.)

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The L-V nonlinear differential equations for two competing biological species when migration at constant rate is present are \( \frac{d x}{d t} = x ( r - a x - b y ) + p \), and \( \frac{d y}{d t} = y ( s - c y - d x ) + q \), where $a, b, c, d, r$ and $s$ are positive parameters, and $p, q \in \mathbb{R}$ may be positive (immigration), or negative (emigration). F. Brauer and D. A. Sanchez (Theor. Pop. Biol., 8 (1975), 12-30) gave a qualitative analysis in the $(x, y)$ phase plane for $q = 0$ and $p$ negative. When $p = q = 0$, the author gave exact solutions for six cases (Math. Biosci., 20 (1974), 293-297), and six more cases in a submitted paper. For more than fifty cases of $(E)$, in each of which two or more of the parameters are interrelated, we obtain the exact solutions in the phase plane. E.g., for $p = 0, b s = 2 c r$, and $s = r (1 + n)$, where $a n = d$, the general $(x, y)$ solution is

\[
\frac{d x}{d y} = \frac{b n y^2 + d x y - n r y - n q}{(1 + n)} = C x^{1+n},
\]

where $C$ is a constant of integration. The sign and magnitude of $q$ are seen to strongly affect the mode of behavior of the two species. Other solutions involve exponential integrals, and Bessel, Legendre, hypergeometric and Weber functions. (Received November 27, 1978.)

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A new cutting plane algorithm is proposed for minimizing a convex function of \( n \) variables. This algorithm combines the best features of previous cutting plane methods. Each cut is "deep," i.e. each cut is a supporting hyperplane. Furthermore, the computation of the supporting hyperplane is straightforward and does not require an "interior" point (as do the standard supporting hyperplane methods). Another possible feature is that everytime a new cut is generated an old cut may be dropped. This would mean that the size of the linear programming subproblems remains constant. In addition, the amount of work needed to solve these subproblems is equivalent to performing a single pivot in the simplex method. Restricted to one dimension, this algorithm produces a new form of line search.

(Received November 27, 1978.)

DONALD M. LESKIW and KENNETH S. MILLER, Riverside Research Institute, New York, NY 10023. A comparison of some Kalman estimators.

The Kalman method represents a particular approach to the problem of estimating a dynamical state vector \( \mathbf{x} \). A system model is used to propagate an estimate of \( \mathbf{x} \), and a measurement model is used to update the estimate. Based on some a priori unbiased estimates of \( \mathbf{x} \), new estimates are constructed by smoothing and updating. The performance of these new estimators is evaluated by comparing the traces of their covariance matrices. In particular, it is shown that in many cases it is immaterial in what order the operations of smoothing and updating are performed. For other cases, inequalities on the traces of the covariance matrices are obtained. (Received December 4, 1978.)

E. JA. GABOVIĆ, VNIRO, Moscow 107140 USSR and I. I. MELAMED, MIIT, Moscow 103055 USSR. On constant problems in discrete programming.

Let \( S_n \) be the set of all substitutions \( s = s(i) \), \( C = \| c_{ij} \| \) and \( L(s) = c_1 s(1) + \cdots + c_n s(n) \), where \( i, j = 1, \ldots, n \), \( c_{ij} \in R \). For \( H \subseteq S_n \) the H-problem means: to find \( s_0 \in H \) with \( L(s_0) = \min L(s) \), \( s \in H \). Let \( H_1 = \{ s \in S_n \text{ of the form } s = (v_1) \cdots (v_m)(t_1w_1) \cdots (t_kw_k) \text{ (a cyclic class)} \} \). \( H_2 = \{ (s \in S_n : s = (t_1w_1) \cdots (t_kw_k)) \text{ (a cyclic class)} \} \). An H-problem is called constant if \( s, t \in H \implies L(s) = L(t) \). An H-problem and the set \( H \) itself is called specific if from its constancy implies \( s_{i1}, b_1, \ldots, s_{in}, b_n \forall s \in H \implies c_{ij} = c_{i1} s_{j1} = a_i + b_j \); \( a_k = b_k \) for symmetric \( C \). For \( s \in H \) let \( D(s) = \| d_{s(i)j} \| \) where \( d_{k\ell} \) is the symbol of Kronecker. We call substitutions \( s_1, \ldots, s_r \) independent, if the matrices \( D(s_1), \ldots, D(s_r) \) are linearly independent. Theorem 1. Every Z-problem with \( ul = 0 \) and \( n > 2(u_1 + \cdots + u_n) \) is specific. Every \( H_2 \)-problem for \( n > 3 \) is specific. Symmetrized \( H_3 \)-problem with the matrix \( g_{ij} \), where \( g_{ij} = (c_{ij} + c_{ji})/2 \), is specific. Theorem 2. A subset \( U \) of a specific set \( H \) is a minimal specific set in \( H \) if and only if \( U \) is a maximal independent subset of \( H \). (Received December 11, 1978.)

Verma, H.K., P.A.U., Ludhiana Simultaneous diffusion and mass flow to plant-roots-II

We present here a theoretical solution of the mathematical model for simultaneous diffusion and mass flow to plant roots given by P.H.Nye and J.A.Papiers (1964) (8th Inter cong.Soil Sci.Bucharest,Romania, III,p.535) under non-homogeneous boundary conditions and zero initial condition. This paper is continuation of the earlier work (Notices AMS, Feb.1976) by the author. (Received December 11, 1978.)
The solvent extraction of metals from an aqueous to an organic medium is described by the chemical equations:

\[ M^{+2} + 2HL \rightleftharpoons ML_2 + 2H^+; \quad M(OH)^{+1} + HL \rightleftharpoons M(OH)L + H^+; \]

and the distribution coefficient

\[ D = \frac{[ML_2] + [M(OH)L]}{[M(OH)^{+1}][HL]}; \]

where \( M \) represents the metal, \( L \) is the ligand, and \( [\cdot] \) denotes the concentration in moles.

It is known from experiment that \( \log D/\partial pH \bigg|_{PH=0} > 1 \) while \( \log D/\partial pH \bigg|_{PH=0} = 1 \). Assuming the concentrations appearing in the definition of \( D \) are normally distributed random variables, relations between their respective means and standard deviations are derived. (Received December 19, 1978.)


Let \( X \) be a complete locally convex Hausdorff space over \( k (k = \mathbb{R} \text{ or } \mathbb{C}) \) equipped with a strongly continuous semigroup \( \{\Phi(t)\}_{t \geq 0} \). Let \( M_c(\mathbb{R}) \) denote the set of \( k \)-valued Radon measures with compact support contained in \((-\infty, 0]\); each compact subset of \( C(-\infty, 0] \) (note that \( M_c(\mathbb{R}) = C(-\infty, 0)^* \)). Let \( A_c(\mathbb{R}^-) := \{ \sum \delta_{t_j}; \alpha_j \in k, \text{finite sum} \} \). It is known that \( A_c(\mathbb{R}^-) \) is a dense linear subspace of \( M_c(\mathbb{R}^-) \) with respect to the above defined topology.

**Theorem 1.** Define \( (\sum \alpha_j \delta_{t_j})x := \sum \alpha_j \delta_{(-t_j)}x \) for all \( x \in X \). This defines a module action of \( A_c(\mathbb{R}^-) \) on \( X \), and the induced correspondence: \( A_c(\mathbb{R}^-) \times X \rightarrow X \) is separately continuous.

**Theorem 2.** Suppose further that \( \{\Phi(t)\}_{t \geq 0} \) is locally equicontinuous (T. Komura [Semigroups of Operators in Locally Convex Spaces, J. Funct. Anal., 258-296]). Then the above defined module action can be extended to \( M_0(\mathbb{R}^-) \), and the induced correspondence: \( M_0(\mathbb{R}^-) \times X \rightarrow X \) remains separately continuous.

If \( \Sigma \) is a constant linear system with the reachability map \( g \) and the observability map \( h \), then this module action satisfies \( \mu \cdot g(\omega) = g(\mu \cdot \omega) \) and \( \mu \cdot h(x) = h(\mu \cdot x) \). (Received December 27, 1978.)


**Definition.** A semantics \( \mathcal{M}(M, \mathcal{P}, \mathcal{C}) \) is \( \epsilon \)-unrestricted if \( \pi : \Phi \rightarrow \mathcal{P} \), \( \mathcal{C}: \{\text{programs}\} \rightarrow 2^{\mathbb{R}^\omega} \), and \( \Pi \) is extended to all formulas as follows:

\[
\begin{align*}
\Pi(p \lor q) &= \Pi(p) \lor \Pi(q) \\
\Pi(\ell(s)) &= \left\{ x \mid \exists y \forall v \in (\ell(s)) \right\} \\
\Pi(\neg \epsilon) &= \Pi(\epsilon) \\
\Pi(\epsilon^f) &= \Pi(\epsilon)
\end{align*}
\]

**Definition.** Let \( \mathcal{M} \) be a \( \epsilon \)-unrestricted semantics in which the set of schema \( D \) is valid. Let \( \mathcal{M}' \) be a semantics in which \( \mathcal{C} \) is restricted by requiring \( \epsilon \) of a program operator \( f \) to be a relation \( \mathcal{R}(f) \). Then \( \mathcal{M}'(\mathcal{R}(f)) \) is \( D \)-axiomatizable iff \( \forall \phi \mathcal{M} \phi ' \) and \( \forall \phi ' \mathcal{M} \phi ' \) (\( \mathcal{R}(\sigma) = \mathcal{R}(\sigma) \)).
Definition A semantics $\mathcal{G} = (\mathcal{W}, \mathcal{T}, \mathcal{C})$ is $\Sigma$-axiomatizable if $\mathcal{G} = (\mathcal{W}, \mathcal{T}, \mathcal{C})$ where each restriction on the relations $\mathcal{R}(f)$ is $\Sigma$-axiomatizable.

Let $\Gamma$ be a set of formulas and $A$ be a formula.

Definition $\Gamma \vdash A$ iff $\exists \omega_1, \omega_2 \in \mathcal{W}$ such that $\Gamma = (\omega_1, \omega_2)$ is a theorem of $\Sigma$-axiomatizable in the deductive system comprised of the axiom schema $\mathcal{D}$ and rules of inference $\mathcal{MP}$ and $\mathcal{N}$.

Denote by $\mathcal{D}_0$ the schema $\mathcal{D}(\lambda A \supset \mathcal{B})$ where $\mathcal{D}(\lambda A \supset \mathcal{B})$ and $\mathcal{B}$ is a sub-instance of $\mathcal{D}(\lambda A \supset \mathcal{B})$.

Theorem 1 Let $\mathcal{D}_0$ be the class of $\Sigma$-unrestricted semantics such that $\mathcal{D}_0 \subseteq \mathcal{D}$ for all $\mathcal{D}_0 \subseteq \mathcal{D}$.

Then for all wffs $A$, $\Gamma \vdash A$ iff $\Gamma \vdash A$.

Theorem 2 Let $\mathcal{A}$ be a $\Sigma$-axiomatizable class of semantics with $\mathcal{D}_0 \subseteq \mathcal{D}$. Then $\mathcal{D} \vdash A$ iff $\mathcal{D}_0 \vdash A$.

For the appropriate sets of schema, these theorems show the nonstandard semantics of $\mathcal{D}$ and $\mathcal{D}_0$ to be complete with respect to natural axiom systems. They also give an alternate proof of Parikh's completeness result for nonstandard semantics. (Received January 8, 1979.)

79T-C25 ALOIS GLANC, California State University, Northridge, California 91330.

Programs as Evaluators of Logic Formulas in Generative Models.

Quantifiers are interpreted in a context of a procedural model $M$ (recursively enumerable sets with recursive functions and relations). The function new $(e, M)$ - when called - gives a new element of $M$. The quantifiers are defined by the following procedures:

$$(\forall x) R \ x \ in \ M = \ do \ new(M, e); \ evaluate \ Re \ in \ M \ until \ not \ Re \ od$$

$$(\exists x) R \ x \ in \ M = \ do \ new(M, e); \ evaluate \ Re \ in \ M \ until \ Re \ od$$

Other Control Constructs - do while, for to, subroutines, demons, coroutines - can be defined using the quantifiers and models. The main point is that we can write programs which are identical to the quantifiers and models. The main point is that we can write programs which are identical to

For example, the following program computes the square root of positive integer $a$:

$$(\exists n) \ (n^n < a < (n+1)^{(n+1)}) \ in \ M \ where \ M = \ (N, +, *, <) \ (Received \ January \ 8, 1979.)$$


Let $B$ be a ring of sets; $\Omega_n = \{x(1), \ldots, x_n) | x_i x_j = \emptyset \ for \ i \neq j; x_i \in B, i, j = 1, 2, \ldots, n\}$,

$\Gamma_n = \{p = (p_1, \ldots, p_n) | p_i \geq 0, \ L \leq 1; i = 1, 2, \ldots, n\}$. Inset divergence: A divergence of randomized system of events, an inset divergence for short, is a sequence $K_n: \Omega_n \times \Gamma_n \times \Gamma_n \rightarrow R \ (n = 2, 3, \ldots, R$ the set of reals). A inset is measurable in each variable $p, q, r$ on $J = \{0, 1\} \cup \{0, 1, \ldots, 0, 1\} \cup \{1, 0, 1\} \cup \{0, 0, 1\} \cup \{0, 0, 0\} \cup \{0, 0, 0\}$,

$y, z \in \{0, 1\}$, $v, w \in \{0, 1\}$. For fixed $x = (x_1, x_2) \in \Omega_2$, $p = (p_1, p_2)$, $q = (q_1, q_2)$, $r = (r_1, r_2)$. Then the following result holds: Theorem: The sequence $K_n: \Omega_n \times \Gamma_n \times \Gamma_n \rightarrow R \ (n \geq 2)$ is recursive, 3-symmetric and measurable if, and only if, there exists a function $g: B \rightarrow R$ such that,

$$K_n(X; P || Q; R) = g(U_{1,1}) \cdot \log p_{1,1} log p_{1,1} log q_{1,1} log q_{1,1} log r_{1,1} \ where \ a, b, c \ are \ arbitrary \ constants.$$  

Results covering generalizations of the above are also treated. (Received January 11, 1979.)

79T-C27 HENRY C. TUCKWELL, University of British Columbia, Vancouver, B.C., Canada V6T 1W5.

Solitons in reaction-diffusion systems. Preliminary report.

Let $u_t = Du_{xx} + f(u, v)$ and $v_t = v_{xx} + g(u, v)$ be a certain reaction-diffusion system which supports stable travelling solitary pulse solutions. When such solitary pulses collide, annihilation occurs in the system under consideration as $u$ and $v$ return to stable resting values. During the collision $u$ and $v$ take on values that have not occurred at pre-collision times. Introducing modified reaction terms, wherever $u_t = Du_{xx} + f(u, v)$ and $v_t = v_{xx} + g(u, v)$ in such a way that for collision and post-collision time values of $u$ and $v$, $f^*$ and $g^*$ tend to approximately restore the initial data that gives rise to solitary waves, solitary pulses emerge from the collision. The modified system thus has solutions with soliton behavior. (Received January 12, 1979.)

A-222
We construct a model $G(QM)$ for $G(ST)$ for $G(ST)$ a set-theoretic representation of the chronogeometric continuum and each lattice $\mathcal{F}_n$ defined for $G(ST)$ a set of coordinates of Riemann-Minkowski spacetime. Let $f_n$ be a function representing a momentary cross-section ($l$-dimensional point) of the chronogeometric continuum and $g$ a function on $f_n$ defining the surface of a lattice chain $\mathcal{F}_n$ defined by $\#$.

$\mathcal{F}_n$ on $C$ defines the position of $\{x\}$ an element of the set $P$ of quantum particles (photons) in the continuum; and the summation $\int_{\mathcal{F}_n}$ on the lattice chain $\mathcal{F}_n$ defines the momentum and position of any $f_n$ with a Heisenberg variance of $\Delta x\cdot \Delta p \approx h$.

Thus, a quantum-mechanical calculus $G(QM)$ is a model of a classical calculus $G(ST)$ embedded in the second-order functional chronogeometric calculus $G(ST)$, the $\{x\}$-particles of $P$ providing the quantum-mechanical interpretation set-theoretically of the hyperbolic solids of topological interpretation of the set-theoretic semantic of $G(ST)$. (Received January 18, 1979.)

G. S. Tsirelson [On the complexity of derivations in the propositional calculus, Structures in constructive mathematics and Math. Logic, II, A.O. Slisenko ed. I] proved that there are arbitrarily large inconsistent sets $\mathcal{S}$ of formulae of propositional calculus $M$ whose shortest proof of inconsistency, using regular resolution only, exceeds $2^{2^{rd}}$ for $C = 1/\sqrt{2}$. Z. Galil [On the complexity of regular resolution and the Davis-Putnam procedure, Theoretical Comp. Sc. 4 (1977)] improved this to $2^{1/32}$ for some real constant $d$ whose order of magnitude remained open. The constant was derived from a theorem of G. A. Margulis [Explicit construction of concentrators, Probl. Inf. Transm. 9 (1973)] on graphs which is based on very deep results in group presentation theory. Using probabilistic methods we improve Galil's result to $2^{1/60}$ where $\mathcal{S}$ consists of disjunctions of length 3. only. The graphs of Margulis are replaced by sets of three random permutations (involutions) on a set $V$. The same technique applies also, as in Galil's paper, to the Davis-Putnam procedure. (Received January 19, 1979.)

**Geometry (50, 52, 53)**

If on a Riemannian manifold $M$ there is a convex function $\tau : M \to \mathbb{R}$ which is not constant on any open subset of $M$ then: 1. $M$ has at most two ends. 2. If some level set $\tau^{-1}([a])$, $a \in \mathbb{R}$, is compact and nonempty, every level set is compact. 3. Each level set has at most two components; if one has two then $\tau$ attains its minimum and the level set of the minimum is a connected totally geodesic submanifold without boundary with trivial normal bundle. 4. If $M$ has two ends, then the level sets are compact and $M$ is homeomorphic to $\mathbb{R} \times$ some level set. 5. If $\tau$ attains its minimum on a compact set which is a topological manifold without boundary, then $M$ is diffeomorphic to the normal bundle of the minimum set. 6. If $\tau$ is strictly convex with compact level sets, then $M$ is diffeomorphic to $S^2$ or to a product $\mathbb{R} \times$ compact. 7. If $dim \ M = 2$, then $M$ is diffeomorphic to $S^1 \times \mathbb{R}$, $\mathbb{R}^2$, or the Möbius strip. (Received December 14, 1978.)

Suppose a connected Lie group $G$ acts simply-transitively by isometries on a Riemannian manifold $M$. Let $I_{o}(M)$ denote the connected component of the identity in the group of all isometries of $M$.

**Theorem 1.** If $G$ is simple, then $G$ is a normal subgroup of $I_{o}(M)$.
Theorem 2. Suppose $G$ is semisimple. Let $g$ be the Lie algebra of $G$ and let $a$ be the direct sum of all non-compact rank one ideals of $g$. Assume the connected subgroup $A$ of $G$ with Lie algebra $a$ has finite center. Then

(i) $I_o(M)$ is reductive and $G$ is locally isomorphic as a Lie group to a connected closed normal subgroup $G'$ of $I_o(M)$ which acts transitively on $M$.

(ii) If $G$ is simply-connected (and hence $a = (0)$), $G'$ in (i) can be chosen so that $G$ is isomorphic to $G'$ and $G'$ acts simply transitively on $M$.

(iii) Let $g_{nc}$ be the direct sum of all non-compact simple ideals of $g$. The corresponding connected subgroup $G_{nc}$ of $G$ is normal in $I_o(M)$. (Received January 16, 1979.)

Logic and Foundations (02, 04)


Th. 1: $2^0 \times 2^1$ imply there are Aronszajn trees $T_\alpha (\alpha < 2^1)$ such that: If $C$ is a closed unbounded subset of $\omega_1$, $f$ an embedding of $T_\alpha | C$ into $T_\beta | C$ then $\alpha = \beta$ and $f$ is trivial.

Th. 2: It is consistent with $\text{ZFC} + \text{GCH}$ that: (A) There is a universal Aronszajn tree and (B) Any two Aronszajn trees have uncountable isomorphic subtrees. Th. 3: It is consistent with $\text{ZFC} + \text{GCH}$ that: There is a Souslin tree $T_\alpha$ such that for any non-special Aronszajn tree $T$ there is $x \in T_\alpha$ such that $T_\alpha | (y \in T_\alpha : y \geq x)$ can be embedded into $T$ on a closed unbounded set of levels.

Th. 4: It is consistent with $\text{ZFC} + \text{MA} + 2^{\aleph_0} = \aleph_2$ that any regular cardinal that $(\ast)$ any two Aronszajn trees are isomorphic on a closed unbounded set of levels. Th. 5: $\text{MA} + 2^{\aleph_0} > \aleph_1$ does not imply $(\ast)$. Th. 6: The parallels of Th. 1, 2, 4, 5 hold for Specker orders whose square is the union of $\aleph_0$ chains. Th. 7: The Malitz-Magidor logic is not necessarily compact for the $\aleph_1$-interpretation. (Received November 7, 1978.)

79T-E8 S. Shelah, The Hebrew University, Jerusalem, Israel. Isomorphism of $\aleph_1$-dense subsets of reals.

Let $K$ be the family of all subsets of the reals with no first or last element containing $\aleph_1$ elements within any of their intervals. Baumgartner proved the consistency of $\text{MA} + 2^{\aleph_0} = 2^{\aleph_1} = \aleph_2 + \text{BA}$: Any two members of $K$ are isomorphic.

Call orders $I, J$ far if they have no uncountable isomorphic subsets. Th. 1. $\aleph_1 \times \aleph_1$ does not imply $\text{BA}$. Even (U. Avraham) it is consistent that there is an uncountable $S \subseteq R$ such that any $1 \rightarrow 1$ $F \circ S \circ S$ is monotonic on some uncountable set.

Th. 2. $\text{ZFC} \rightarrow \text{MA} + 2^{\aleph_0} = \aleph_2$ is any regular cardinal is consistent with $\text{BA}$. If we wave $\text{MA}$ we need only $\text{cf} 2^{\aleph_0} > \aleph_1$.

Th. 3. If $\text{cf} 2^{\aleph_0} = \aleph_1$ then there are far $I, J \in K$. Th. 4. It is consistent with $\aleph_1 < 2^{\aleph_0} < 2^{\aleph_1}$ that no $I, J$ are far. Th. 5. It is consistent with $\text{ZFC}$ that e.g. there are far $I_0, I_1 \in K$ so that for every $J \in K$ $I_0$ or $I_1$ can be embedded into $J$, moreover there are up to isomorphism just three $1$-homogeneous $I \in K$. (Received November 7, 1978.)


The lattices $A_n, B, B^d$ are defined in Kelly and Rival (Planar lattices, Can. J. Math. Vol. 27 (1975), pp.636-665). We define the height of a lattice $L$ as $\sup(\kappa : \kappa$ is the cardinality of a chain in $L$).

Theorem: Any lattice of finite height which contains no subposet isomorphic to $B$ or $B^d$ has a superstable theory. Corollary: Any lattice of finite height and dimension $\leq 2$ has a superstable theory. Theorem: Any lattice of height $4$ which contains no subposet isomorphic to $A_n$, $n \in \omega$, has a superstable theory. These results are further to Smith (these notices, June 1978, 78T-E49). (Received November 13, 1978.)
For a finite language $L$, we say that an $L$-theory $T$ is arithmetic if i. $T$ interprets Presburger arithmetic, and ii. $T$ contains full $L$-induction. Examples: $T = PA$, $ZFC$, $KM$. Remark: Isomorphism invariants for countable recursively saturated models of arithmetic theories are given by the theories and standard systems of the models.

**Theorem.** Let $T_0 \subseteq T_1$ be arithmetic theories in languages $L_0 \subseteq L_1$, respectively, with $T_1 \cong PA$ complete. Necessary and sufficient conditions for a countable recursively saturated model $M$ of $T_0$ to be expandable to a model of $T_1$ are: i. $Th(M) \subseteq T_1$, and ii. the sets of natural numbers representable in $T_1$ are included in the standard system of $M$. (Received December 4, 1978.)

Thomason and Lachlan showed that any countable distributive lattice can be embedded in the upper semi-lattice $\mathbb{R}$ of r.e. degrees by a map preserving meets and joins. Using a much more difficult argument, Lachlan showed that certain nondistributive lattices including the lattices $\Diamond$ and $\Box$ can also be embedded in $\mathbb{R}$. On the basis of these results it was conjectured that any finite lattice could be embedded in $\mathbb{R}$. We refute this conjecture. **Theorem.** Let $L$ be the 8 element lattice $\begin{array}{c} \Diamond \\ \Box \end{array}$

Then $L$ is not embeddable in $\mathbb{R}$ by any map preserving meets and joins. That this particular lattice might be nonembeddable was first suggested by M. Lerman. (Received December 4, 1978.)

The following system $C_m$ is proposed. It consists of three rules and ten axioms. The rules: substitution, detachment, and composition (if $A$ and $B$, then $AB$, i.e., $A \land B$). The axioms: $p \rightarrow \rightarrow p$;

(2) $[p \rightarrow (q \rightarrow r)] \rightarrow [(p \rightarrow q) \rightarrow (p \rightarrow r)]; (\rightarrow p \rightarrow q) \rightarrow (\rightarrow q \rightarrow p); (p \rightarrow q) + (\rightarrow q \rightarrow p); p + pp$;

$pq + p; pq + qp; (p \rightarrow q) (p \rightarrow r) + (p \rightarrow qr); p \rightarrow (\rightarrow q \rightarrow r) + (\rightarrow (pq) \rightarrow (pr))$. This system excludes $p \rightarrow p + q$ but includes (2), contrasting with modal systems. Shen Yuting has showed that it contains the Ackermann-Anderson system $E$ as a proper part; e.g., it contains $p \rightarrow [(p \rightarrow q) \rightarrow q]$ which is not a theorem of $E$. The system $C_m$ aims to retain all and only implicational theorems each having the following two properties: (a) there is a method to affirm its truth which does not depend on affirming the antecedent being false or the consequent being true; (b) the truth of the antecedent can be affirmed independently of affirming the truth of the consequent. (Received December 14, 1978.) (Authors introduced by John Riordan).

Fix a countable language $L$ and an odd prime $p$. A construction is given which associates with every $L$-structure $\mathcal{C}$ a nil-$2$ group $G(\mathcal{C})$ of exponent $p$. This construction preserves stability class (in the sense of Keisler [Handbook of Math. Logic, p.88]) as well as other properties.

**Theorem.** For every stability class, there is a nil-$2$ group of exponent $p$ in that stability class.
Theorem. There is a method (recursive in an oracle for T) which associates to any $T \subseteq L$ a theory $T^G$ of nil-2 groups of exponent $p$. Further $T$ and $T^G$ are in the same stability class and $d(DC(T)) = d(DC(T^G))$ (DC(T) is the deductive closure).

This reduces the problem of characterizing a stability class to characterizing that class for groups. This confirms a suspicion of Baur, Cherlin and Macintyre [On totally categorical groups and rings] that the problem of characterizing $\omega$-stable groups is intractable. (Received December 26, 1978.)


A graph is a set with a binary relation. If $\Gamma$ is a graph let $\Gamma^*$ denote the graph obtained by making the relation of $\Gamma$ symmetric. If $\lambda$ is a cardinal, $K^m_{\lambda}$ is the set of graphs obtained by subdividing the complete graph of cardinality $\lambda$ by inserting $m$ new vertices on each edge. A graph $\Gamma$ is very flat, if for some $n$ and for all $m$, $\Gamma^*$ has no partial subgraphs in $K^m_n$. Note all planar graphs, all graphs embeddable in surfaces of finite genus and all trees are very flat.

Theorem. If $\Gamma$ is very flat, then $\Gamma$ and $\Gamma^*$ are superstable.

Pazdewski and Ziegler [Stable graphs, Fund. Math. 100 (1978) 101-107] have defined a symmetric graph to be superflat if for all $m$ no elementary equivalent graph has a partial subgraph in $K^m$. They show these symmetric graphs are stable.

Theorem. If $\Gamma^*$ is super flat, then $\Gamma$ and $\Gamma^*$ are stable.

These results have applications to partial orders with chains of bounded length. The proofs use techniques of the second author developed for lattices (announced in Lattices of Finite Height [Not. Amer. Math. Soc. this issue]). (Received December 26, 1978.)

**79T-E16** SY D. Friedman, University of California, Berkeley, California 94720. Generalized Steel forcing and the pure part of $\text{HYP}(\mathcal{M})$.

Let $\mathcal{M}$ be a structure with finite similarity type. $\text{HYP}(\mathcal{M})$ is the least admissible set (with urelements) above $\mathcal{M}$ (see Barwise, Admissible Sets and Structures). The pure part of $\text{HYP}(\mathcal{M})$ consists of those elements of $\text{HYP}(\mathcal{M})$ whose transitive closure contains no urelements. It is always a resolvable admissible set (A is resolvable if $(A,E,f)$ is admissible for some $f : \text{On}(A) \to A$ such that $\cup \text{Range}(f) = A$). We develop a generalization of Steel forcing to prove: Theorem A countable admissible set is resolvable if and only if it is the pure part of $\text{HYP}(\mathcal{M})$ for some tree $\mathcal{M} = (T, \leq)$.

Steel’s conditions are finite trees of integers tagged with ordinals. We tag with pairs $(\alpha, x)$ where $x \in f(\alpha)$ (f as above), as well as ordinals. Partial results were obtained earlier by Nadel-Stavi, JSL, March, 1977. (Received January 8, 1979.)


Let $K$ be a non-empty set of non-logical constants. For each $n \geq 2$, let $L^n_K$ be the $n$-th order language over $K$. Interpretations for $L^n_K$ are pairs $i = (u, f^i)$ where $u$ is a non-empty set and $f$ is a function defined on $K$ in the usual way. For $i, j$ interpretations for $L^n_K$, $i$ is equivalent to $j$ in $L^n_K$ provided they make exactly the same sentences in $L^n_K$ true. A theory in $L^n_K$ is any set of sentences closed under logical consequence. A theory is complete provided all of its models are equivalent in $L^n_K$. A cardinal $\theta$ is describable in $L^n_K$ provided some sentence in $L^n_K$ is true on all and only interpretations of cardinality $\theta$.

Theorem: For all $n \geq 2$, every complete, satisfiable, and finitely axiomatizable theory in $L^n_K$ has models of a single cardinality $\theta$, where $\theta$ is describable in $L^n_K$. (Received January 8, 1979.)
We define a recursion theory for each structure, by making a simple and natural generalization of elementary formal systems (Theory of Formal Systems, R. M. Smullyan, Princeton U. Press, 1961). For the structure of arithmetic, we get ordinary recursion theory. We study morphisms between our recursion theories, some of which arise from familiar Gödel numberings. Using our notion of morphism, the collection of all recursion theories constitutes a category of some interest. Every recursion theory has an extension which is indexed in a way analogous to ordinary recursion theory, and in which the Second Recursion Theorem, Rice's Theorem, etc. have their analogs. For each recursion theory we define enumeration operators, in terms of elementary formal systems which accept input. This allows a study of relative recursion. The First Recursion Theorem holds in all our recursion theories, whether an indexing exists or not. The addition of an \(w\)-rule of derivation to the elementary formal system machinery leads to what we call the \(w\)-recursion theory for an arbitrary structure. It essentially coincides with the hyperelementary theory of that structure (Elementary Induction on Abstract Structures, Y. N. Moschovakis, Amsterdam, North-Holland, 1974). All the above work for recursion theories has analogs for \(w\)-recursion theories, generally with very similar proofs. (Received January 12, 1979.)

**Statistics and Probability (60, 62)**

Let \(X(t)\) be a stochastically continuous homogeneous process of independent increments having a representation \(X(t) = W(t) + \int_0^t u(t,x)dW(t)\), where \(W(t)\) is a Wiener process with parameter \(\sigma^2\) and \(u(t,x)\) is a mean centered Poisson random measure. Then for certain nice function \(u(t,x)\),

\[
u(t,x) = u(0,0) + \int_0^t u(s,x)dW(s) + \int_0^t \left[ u_1(s,x) + \frac{1}{2} \sigma^2 u_2(s,x) \right] ds + \int_0^t \left[ u_3(s,x) + \frac{1}{2} \sigma^2 u_4(s,x) \right] dW(s)
\]

where \(u(s,y,x) = u(s,y+x) - u(s,y) - xu'(s,y)\) and \(\sigma^2\) is the variance of \(V(l,dx)\). (Received November 1, 1978.)

**Topology (22, 54, 55, 57, 58)**

Let \(n\) be a large, even integer. Obtain a random string of \(n\) binary bits by obtaining one bit from each of \(n\) random and independent binary devices. Denote by \(r\) the ratio of ones to total bits. If the \(n\) bits are obtained one after the other, the expected value for \(r\) is \(E(r) = \frac{1}{2}\). But if the bits are obtained simultaneously, the probability that \(r = \frac{1}{2}\) is \([n!/(\frac{1}{2}n)!]^2 2^{-n} << 1\), \(n\) large, so that \(E(r) \neq \frac{1}{2}\). Hence it can be determined whether the bits are simultaneously obtained by looking at the relative frequency with which \(r = \frac{1}{2}\), and one can make the profound statement that simultaneity works against symmetry. This has all been confirmed via computer simulations. (Received November 30, 1978.)
X, Y, X', Y' such that X_\alpha < Y, X'_\alpha < Y' and X \times X' is homeomorphic to Y \times Y'. Proof. Take X = [0,1] (Cantor discontinuum), X' = [0,1]N_0 (Hilbert's brick), Y = X \times [0,1], Y' = X' \times [0,1]. Then evidently X' \neq Y and X_\alpha \neq Y'. There is no subset in X, homeomorphic to [0,1], hence to Y, therefore X_\alpha < Y. Compact Y' is not connected, therefore it cannot be a retract of a connected compact X', hence X'_\alpha < Y'. But X \times X' = Y \times Y' = [0,1]^N_0 \times [0,1]^N_0. The author is thankful to A. A. Ivanov and Yu. M. Smirnov for valuable discussions.


**Consider the well-known exact sequence:**

\[ 0 \rightarrow H_\alpha(U_\alpha[Z_p]) \rightarrow H_\alpha(U_\alpha) \rightarrow H_\alpha(U_\alpha[Z_p]) \rightarrow 0, \]


Let \( x_j, (1 \leq j \leq p - 1) \), denote the normal bundles (with group action) of CP^0 in CP^1 which are trivial bundles. Let \( U_\alpha[x_1, \ldots, x_{p-1}] \) be the polynomial ring generated by \( x_1, \ldots, x_{p-1} \) which may be considered as a subring of \( M_\alpha[U_\alpha] \). The purpose of this paper is to give the general formulae for computing \( \alpha: U_\alpha[x_1, \ldots, x_{p-1}] \rightarrow H_\alpha(U_\alpha[Z_p]). \) (Received October 20, 1978.) (Author introduced by James W. Weaver).

The relations between semi-homeomorphisms in the sense of Crossley and Hildebrand (shortly: s.h.C.H.; see "Semi-topological properties", Fund.Math 74(1972) 233-254) and homeomorphisms or weak homeomorphisms are studied. Sample theorems:

**Theorem 1.** Let a space Y be regular and dense in itself. If \( f: X \rightarrow Y \) is s.h.C.H. \( \text{then } f \) is a semi-homeomorphism in the sense of Biswas (shortly: s.h.B.).

**Theorem 2.** Let spaces X and Y be regular and Y be dense in itself. Let a function \( f: X \rightarrow Y \) be closed. Then \( f \) is a homeomorphism iff \( f \) is s.h.C.H.

Some conditions concerning X and/or Y are investigated under which the hypothesis that \( f \) is closed can be omitted in the above theorem. There are shown some examples, which prove the essentiality of some assumptions of the theorems. Answering to a question of T. Neubrunn, s.h.B. without being s.h.C.H. is constructed. (Received October 24, 1978.)

A link with Alexander module free which is not an homology boundary link. Preliminary report.

An example is given of a 2-component ribbon link with trivial components and such that the link group G satisfies \( G/G'' \simeq F(2)/F(2)'' \) \( \text{where } F(2) \) is the free group of rank 2 yet which is not even an homology boundary link. This link is also such that its longitudes lie in \( G'' \), \( G/[G,G''] \simeq F(2)/[F(2),F(2)'''] \) and G is a semirect product \( G \simeq G_\omega \rtimes G/[G,G_\omega] \). Furthermore it is a sublink of a 3-component homology boundary link for which the longitudes are also in the commutator subgroup of the link group. These examples settle two questions raised by Fox and Smythe at the 1965 Wisconsin Topology Seminar. (As the usual abelian invariants do not distinguish the first link from the trivial link, that it is not an homology boundary link is proven by showing that \( G/G_\omega \) is one of Baumslag's nonfree, parafree groups.)

It is also shown that the group of my earlier example of a non-homology boundary link with Alexander polynomial zero (Bull. Austral. Math. Soc. 16 (1977), 229-236) is not such a semirect product. (Received November 2, 1978.)
1. Assume CH. Then there is a hereditarily separable regular space in which no point is a \( G_\delta \).
2. Assume CH. Then there is a space which is regular, right separated, and left separated, but with no partition into a countable collection of discrete subspaces.

Result #1 relates to questions of Arhangelskii settled more satisfactorily (i.e. the space is compact) by Fedorcuk assuming \( \diamondsuit \). Result #2 answers a question of Juhasz and Gerlits. (Received November 6, 1978.)

Carlos R. Borges, University of California, Davis, CA 95616. Normality of Hyperspaces.

We show the existence of a \( \sigma \)-compact stratifiable space \( X \) such that the space \( C(X) \) of compact subsets of \( X \), with the finite topology, is not normal. We also give an example of a LOTS \( Y \) such that \( C(Y) \) is not normal. (Received November 7, 1978.)

Ronnie Levy, George Mason University, Fairfax, VA 22030. Some Set-Theoretic Properites of Franklin-Rajagopolin Spaces. Preliminary report.

A compactification \( \gamma N \) of the integers \( N \) is called a Franklin-Rajagopolin space (F-R space) if \( \gamma N-N=\{0,\omega_1\} \), \( \gamma N-\omega_1 \) is denoted \( \gamma N \). Proposition 1. (i) There is an F-R space \( \gamma N \) such that \( \gamma N \) is not pseudocompact. (ii) (LM) There is an F-R space \( \gamma N \) such that \( \gamma N \) is almost-compact. (iii) (MA + \( \sim CH \)) For any F-R space \( \gamma N \), \( \gamma N \) is not pseudocompact. Proposition 2. If \( \gamma N \) is an F-R space, any strengthening of the topology of \( \gamma N \) fails to be pseudocompact and any proper subspace of \( \gamma N \) which contains \( N \) fails to be pseudocompact. Proposition 3. (MA) There is a compactification \( \Gamma N \) of \( N \) such that \( \Gamma N-N=\{0, \exp N_0\} \) and such that for each \( f \in C^*(N) \), there is a \( \omega \exp N_0 \) such that \( f \) extends to a function \( F \in C^*(\nu [\omega, \exp N_0]) \). Corollary. (LM) There is an F-R space \( \gamma N \) such that for each \( f \in C^*(N) \) there is an \( \omega \leq \omega_1 \) such that \( f \) extends to an element of \( C^*(\nu [\omega, \omega_1]) \). (Received November 9, 1978.)

Phillip E. Parker, Syracuse University, Syracuse, New York 13210. Diffeomorphism of manifolds.

Let \( X, Y \) be smooth connected manifolds. Michor has recently shown [Manifolds of Smooth Maps II. preprint, 1978] that the diffeomorphism group \( Diff(X) \) is a Lie group using \( G_c \) smoothness of Keller [Springer LNM 417]. Theorem: \( X \) and \( Y \) are diffeomorphic iff \( Diff(X) \) and \( Diff(Y) \) are isomorphic Lie groups. Proof: It follows immediately that \( Diff(X) \cong Diff(Y) \) implies \( Diff_c(X) \cong Diff_c(Y) \), where the \( c \) denotes compact support. The Lie algebra of \( Diff_c(X) \) is the Lie algebra of compactly supported vector fields on \( X \) [Michor, pp. 7-8] and by the Pursell-Shanks Theorem [Proc.A.M.S. 5(1954)468-472], \( X \) and \( Y \) are diffeomorphic iff these Lie algebras are isomorphic. Corollary. The diffeomorphism groups of exotic structures are not Lie isomorphic. (Received November 1, 1978.)

RONALD M. DOTZEL, University of Texas at Austin, Austin, Texas, 78712. Abelian p-Group Actions on Homology Spheres.

The Borel Formula is extended to an identity covering actions of arbitrary Abelian p-groups. Specifically, a corollary of the main theorem states that if \( G \) is an Abelian p-group which acts on a finite CW-complex \( X \) which is a \( Z_p \)-homology \( n \)-sphere and if each \( X^K \) is a \( Z_p \)-homology \( n(H) \)-sphere, one has

\[
n = n(G) = \sum (n(K) - n(\frac{1}{p} K))
\]

sum over all \( K \) such that \( G/K \) is cyclic and the subgroup \( \frac{1}{p} K = \{ g \in G | pg \in K \} \). A converse is also proven. (Received November 15, 1978.)
Let $M$ be a closed $C^\infty$ differentiable manifold of dimension $n$. Denote by $\mu(M)$ the Morse-Smale characteristic of $M$, $\mu(M) = \min_{\Omega} \sum_{i=0}^{\dim M} c_i(M,\Omega)$, where $\Omega$ is the space of Morse functions defined on $M$, and $c_i(M,\Omega)$ is the number of critical points of index $i$ that $\Omega$ has.

**Theorem 1.** (a) Let $M$ and $N$ be two closed $C^\infty$ differentiable manifolds. Then, $\mu(M \times N) = \mu(M) \cdot \mu(N)$ and $\mu(M) = \mu(M') \cdot \mu(N)$, provided that $\mu(M) = R(M)$, $\mu(N) = R(N)$, where $R(M)$, $R(N)$ are the $k\text{th}$ Betti numbers of $M$, $N$ respectively.

(b) Let $M$ be a $k$-fold covering space of the manifold $M$. Then, $\mu(M) \leq \mu(M) - (k-1)$. If $M$ is the universal covering space of $M$, then $\mu(M) \equiv \mu(M)$ modulo the Poincaré conjecture, and provided that $\dim M = 3$.

**Theorem 2.** (a) Let $M$ be a compact $C^\infty$ differentiable 3-dimensional manifold with non-empty boundary. Then, $M$ admits a kind of Heegaard splitting, as follows: $M = H \cup H'$, where $H$, $H'$ are handlebodies of the same genus. (b) Let $M$ be a closed $C^\infty$ differentiable 3-dimensional manifold whose fundamental group is non-abelian. Then, $\mu(M) \equiv 0$.

The Morse-Smale characteristic of any open (i.e. non-compact without boundary) manifold equals to zero. Further results on the Morse-Smale characteristic are mentioned. (Received November 27, 1978.)

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**Let us denote by $C^\ast(X)$ the ring of all bounded continuous, real-valued functions on a Tychonoff space $X$. Then the following theorem seems new as far as the author knows, though the proof is similar to that of Theorem 0 in J. Nagata, On rings of continuous functions, General Topology and its Relations to Modern Analysis and Algebra IV, Springer Lecture Notes 609. (1977) p. 137.**

**Theorem.** A Tychonoff space $X$ is second-countable if and only if $C^\ast(X)$ has a countable subset $F$ such that for every $f \in C^\ast(X)$ and for every $\epsilon > 0$ there is a subset $\{f_n\}_{n=1}^\infty$ of $F$ satisfying $\inf_{n} f_n < f$, and $\|f - f_n\| < \epsilon$, where $\|f\| = \sup\{|f(x)| : x \in X\}$.

(Any information on references which may contain a similar theorem will be appreciated.) (Received December 1, 1978.)

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**If $X$ is a $g$-metrizable topological space [Siwiec, Pac. J. Math. 52 (1974), 233-245], then $X$ is stratifiable if any of the following hold: (1) $X$ is the union of countably many closed discrete subspaces, (2) the sequential order [Arhangelskii and Franklin, Mich. Math. J. 15 (1968), 313-320] of $X$ is finite, (3) given any point $p$ of $X$, there is a weak neighborhood of $p$ which is stratifiable in the relative topology. (Received December 11, 1978.)

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**Charles Waiveris, Wesleyan University, Middletown, CT 06457

Intersections of Countably Compact Spaces

**Definition:** $X$ is an extra countably compact subspace of $Y$ if every countable subset of $Y$ has an accumulation point in $X$.

**Theorem 1:** If $X$ is realcompact or an $F$-space then there exists a family $\{P_\xi : \xi < 2^\omega\}$ of extra countably compact subspaces of $Y$ such that $P_\xi \cap P_\eta = X$ whenever $\xi < \eta < 2^\omega$.

**Definition:** $X$ is topologically complete if $X$ is homeomorphic to a closed subspace of a product of metric spaces. It is well-known that every topologically complete space is realcompact if and only if there are no uncountable measurable cardinals.

**Theorem 2:** (a) If $X$ is topologically complete then there exists a family $\{P_\xi : \xi < 2^\omega\}$ of countably compact subspaces of $Y$ such that $P_\xi \cap P_\eta = X$ whenever $\xi < \eta < 2^\omega$.

(b) If there exists an uncountable measurable cardinal then there exists a topologically complete, non-realcompact space $X$ which cannot be written as the intersection of two extra countably compact subspaces of $Y$.

Our work is inspired in part by Z. Frolik [Czech. Math. J. 10 (1960), 329-228], who proved Theorem 2(a) in the case that $X$ is separable metric or discrete. (Received December 20, 1978.)
A subset of $E^n$ is said to have embedding dimension (dimension) less than or equal to $k$ if it can be treated as a $k$-complex with regard to general position operations. We have adapted techniques used by Daverman and Row to prove the following Theorem. If $G$ is a cell-like decomposition of $E^3$ so that the union of the non-degenerate elements of $G$ has dimension no greater than 1, then $E^3/G \times E^1$ is homeomorphic to $E^4$; in fact, $G \times E^1$ is shrinkable. (Received December 21, 1978.)

A space $X$ is called 'C-closed' if every countably compact subset of $X$ is closed in $X$. We study the properties of C-closed spaces. Every Hausdorff sequential space is C-closed. Countably compact C-closed spaces have countable tightness. C-closed = Sequential, for sequentially compact Hausdorff spaces. Under MA or $2^{\omega} < 2^\omega$, C-closed = Sequential, for compact Hausdorff spaces. For dyadic compact spaces C-closed = Metrizability. Furthermore, every hereditarily quasi-$k$ Hausdorff space is Fréchet, which generalizes a theorem of Arhangel'skii. Also every hereditarily $q$-space is hereditarily of point countably type, hence contains open dense first countable subspace. (Received December 20, 1978.)

Y is called a two-to-one image of $X$ if there exists a continuous mapping $f$ of $X$ onto $Y$ such that for every $y$ in $Y$ the equation $f(x)=y$ has at most two solutions in $X$. Theorem: Let $K$ be a Hausdorff space. Then the following are equivalent:
(a) $K$ is homeomorphic to a scattered compact ordered space.
(b) $K$ is a two-to-one image of a compact well-ordered space. (Received December 27, 1978.)

Let $M$ be a connected sum of $r \geq 2$ closed aspherical manifolds of dimension $n \geq 3$. We adapt the function space techniques of H. Federer to the space of self-homotopy-equivalences $\text{EM}$ to obtain a long exact sequence
\[
\cdots \rightarrow H^l(M;\pi_{q+2}M)^D_q \rightarrow H^l(M;\pi_{q+1}M)^D_{q-1} \rightarrow \pi EM \rightarrow H^l(M;\pi_{q+1}M)^D_{q-1} \rightarrow H^l(M;\pi_{q+2}M)^D_q \rightarrow \cdots
\]
for $1 \leq q \leq 2n - 5$, where the cohomology modules are with local coefficients. Calculations of these modules and the homomorphisms $D_q$ yield the following results:
1. $\pi EM \cong \bigoplus_{i=1}^{r-1} \pi_i(s^{n-1})$ for $1 \leq q \leq n - 4$
2. $\pi_{n-3} EM \cong \bigoplus_{i=1}^{r-1} (\pi_{2n-3}(s^{n-1})/[\pi_{n-1}(s^{n-1}),\pi_{n-1}(s^{n-1})])$, where $n \geq 4$ and brackets indicate Whitehead product.
(3) $\pi_{n-2}(EM)$ is infinitely-generated as an abelian group. As an application of (3), for the case $n = 3, r \geq 3$ we show that infinitely-many generators of $\pi_1(\text{Homeo}(M^3), id_M)$ can be realized as isotopies, to conclude that $\pi_1(\text{Homeo}(M^3), id_M)$ is infinitely-generated. (Received January 5, 1979.)

#721-027

DOUGLASS L. GRANT, College of Cape Breton, Sydney, Nova Scotia, Canada.

Arbitrary powers of the roots of unity are minimal Haussdorff topological groups.

Arbitrary powers of the group of complex roots of unity, the torsion subgroup of the circle group, are shown to have the $S(A)$ property defined by T. Husain ["Introduction to Topological Groups", Saunders, Philadelphia, 1966, p. 89-90]. For precompact groups, this implies the property of the title. This result provides an affirmative answer to a question of R. M. Stephenson ["Studies in Topology, Proceedings of the Charlotte Topology Conference", Academic Press, 1974, p. 249 - 256]. (Received January 22, 1979.)

LATE PAPERS – Presented at past meetings

763-47-37 P. M. ANSELONE and R. ANSORGE, Oregon State University, Corvallis, Oregon 97331. Compactness principles in nonlinear operator approximation theory.

This paper is concerned with the approximate solution of nonlinear operator equations in abstract settings and with applications to integral and differential equations. A given operator with certain continuity and compactness or inverse compactness properties is a suitable limit of a sequence of operators with analogous properties which hold uniformly or asymptotically. Both fixed point equations and inhomogeneous equations are treated. Solutions of the approximate problems converge to solutions of the given problem. This is an appropriate type of set convergence when there are non-unique solutions. (Received December 26, 1978.)

Abstracts for the 764th Meeting

University of Hawaii, Honolulu, March 30–April 1, 1979

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

764-Al DAVID J. WINTER, University of Michigan, Ann Arbor, Michigan 48109. Engel subalgebra triangulable Lie algebras.

Motivated by the Feit-Hall-Thompson work on centralizer nilpotent (c.n.) finite groups, Benkart-Isaacs determine the structure of (finite dimensional) c.n. Lie algebras (over algebraically closed fields of arbitrary characteristic). In the present paper, a Lie algebra $L$ is defined to be Engel subalgebra triangulable (E.t.) if its proper Engel subalgebras are ad-triangulable. Every c.n. Lie algebra is E.t. If $L$ is nonsolvable and E.t., then $L$ has an ideal $I$ such that $L/I$ is nilpotent and $I/nil$ is a simple Lie algebra. Core $L$ called the core of $L$. The core of $L$ is discussed and it is shown that for Lie $p$-subalgebras ($p > 3$), Core $L$ is $SL_2$ or $W$ or Hamiltonian (that is, Core $L$ is toral rank one). (Received October 30, 1978)
The Hopf algebra $F[x]$ over a field $F$ with primitive generator $x$ has a continuous dual Hopf algebra $H = F[x]^0$ consisting of all linearly recursive sequences over $F$. The Lie algebra of primitive elements of $H$ consists of the scalar multiples of the unit sequence $(0, 1, 0, 0, 0, \ldots)$. We give an algorithm for diagonalizing a sequence $f = (f_n)$ in $H$. If $f$ has minimal recursive degree $r$, then $D^r f$ is a basis for the subcoalgebra of $H$ generated by $r! f$. If $(s_{ij})$ is the inverse of the Hankel matrix of $f$, then $M = \sum_{i,j=0}^{r-1} (D^i f) \otimes (D^j f)$. For example, if $f$ is the Fibonacci sequence $(1, 1, 2, 3, 5, 8, \ldots)$, then $\Delta f = 2(f \otimes f) - f \otimes Df - Df \otimes f + Df \otimes Df$. We also discuss the solution space subcoalgebra determined by a given linearly recursive relation.

(Received November 15, 1978.)
We introduce two arithmetical invariants of integral quadratic forms and show how they may be applied in the classification of unimodular quadratic forms up to spinor genus. We illustrate the limitation of these invariants by the size of a corresponding obstruction group. An application to a cancellation theorem will also be discussed. (Received December 5, 1978.)

A. J. HAHN, University of Notre Dame, South Bend, Indiana 46556. Unipotent Transformations in Orthogonal Groups.

Let $O_n(V)$ be the orthogonal group of a nondegenerate, $n$-dimensional quadratic space over an arbitrary field. I will analyze the unipotent elements of $O_n(V)$ and examine their role in the theory of the spinor norm and the automorphism theory of the orthogonal groups. (Received December 7, 1978.)

ROBERT GRONE, Mathematics Department, Auburn University, Auburn, Alabama 36830. Markov Chains and Multiplications on $m$ - Dimensional Matrices. Preliminary Report.

Abstract: An $m$-dimensional matrix of order $n$ over a field $F$ is an array

$$A = \begin{bmatrix} a_{i1}, & a_{i2}, & \ldots, & a_{in} \end{bmatrix} ; \quad 1 \leq i, j \leq n; \quad 1 \leq i \leq m,$$

of $n^m$ elements of $F$. This definition coincides with the notion of an $n \times n$ matrix when $m = 2$. In this paper two multiplication on such objects are examined. The first is non-associative and is motivated by a generalization of the notion of a Markov chain. The second is associative, and related to the first by a certain generalized transpose operator. (Received December 7, 1978.)

Marshall Cates, California State University, Los Angeles, CA 90032. Coloring $n$-sets with $n$ colors, Preliminary report.

In abstract 78T-176 of these notices, volume 25, number 6, October 1978, Hindman addresses the following problem: Call a set $B$ of finite sets nearly disjoint provided any two distinct members have at most one element in common. Erdős, Faber, and Lovász have conjectured that, if $B$ is a set of $n$ nearly disjoint sets, each with at most $n$ elements, then there is an $n$-coloring of $B \cup \emptyset$ so that no member of $B$ gets the same color twice.

This report will consider conditions for the existence of non-existence of modular and quotient coloring of $B \cup \emptyset$. (Received December 8, 1978.)


High energy physics and the search for the ultimate building blocks of matter have generated renewed interest in nonassociative algebras. Two nonassociative algebras, the Lie-admissible algebras and the "algebra of color" have current application in the theory of heavy particles, the hadrons. The "algebra of color" (Domokos and Kovesi-Domokos, J. Math. Phys. 19(6), June 1978, p. 1477-1481) is shown to be a quadratic algebra with a nondegenerate norm. The construction of the "algebra of color" is generalized to higher dimensions. (Received December 11, 1978.)

STEPHEN DORO, University of Notre Dame, South Bend, Indiana 46556. Groups with triality.

A group with triality is a group $G$ which admits a group of automorphisms $D$ where $D$ is isomorphic to $S_3$ so that certain axiom are satisfied. It generalizes the situation with the groups $D_4(q)$. There is a category isomorphism between the
category of groups with triality and the category of Moufang loops. Thus, group theory may be applied to these loops and vice versa. For instance, \( D_2(q) \) corresponds to the simple loops \( M(q) \) associated with 8 dimensional composition algebras. New finite simple Moufang loops would correspond to new simple groups.

The loops \( M(q) \) have a structure similar to that of rank 2 Chevalley groups. They have parabolic subloops \( L_2(q) \cdot V \) - a semi-direct product of the group \( L_2(q) \) with a normal 2 dimension vector space over \( GF(q) \). This product is a loop but not a group. If \( L \) is such an extension of \( V \) by any group \( G \), where \( V \) is irreducible and \( L \) is not associative, then the dimension of \( V \) is 2 or 1 : thus the situation above is essentially unique. This limits the possibilities for rank 2 Moufang loops.

The loops \( M(q) \) have 7 dimensional irreducible representations on the traceless Cayley numbers. (Received December 11, 1978.)

**764-Al3** Morton Curtis, Rice University, Houston, Texas 77001. Characteristic spaces for semisimple Lie algebras.

Let \( \mathfrak{g} \) be a semisimple real Lie algebra. We show how to construct from \( \mathfrak{g} \) a topological space \( X(\mathfrak{g}) \) and prove that the homotopy type of \( X(\mathfrak{g}) \) is characteristic of \( \mathfrak{g} \). That is, \( X(\mathfrak{g}) \) and \( X(\mathfrak{g}') \) have the same homotopy type if and only if \( \mathfrak{g} \) and \( \mathfrak{g}' \) are isomorphic. Thus, in principal, the structure constants of \( \mathfrak{g} \) contain all of the Postnikov-tower information about \( X(\mathfrak{g}) \) and conversely. (Received December 12, 1978.)

**764-Al4** Craig M. Cordes, Louisiana State University, Baton Rouge, Louisiana 70803. Quadratic forms over fields with four quaternion algebras.

Let \( F \) be a field of characteristic different from 2, and assume \( F \) has exactly three non-split quaternion algebras \( Q_1, Q_2, Q_3 \). Denote the quaternion algebra over \( F \) with structure constants \( a, b \) by \([a,b] \). For \( i = 1,2,3 \) set \( A_i = \left\{ a \in \hat{F} \mid D(1,-a) \right\} \) has index 2 in \( \hat{F} \) and \([a,b] = Q_i \) if \( b \notin D(1,-a) \). If \( R \) is the Kaplansky radical of \( F \), let \( t \) be the index of \( R \) in \( \hat{F} \). If \( 8 < t < \infty \), then the following results for \( F \) hold: 1) \( D(1,-x) = D(1,-y) \) if and only if \( xy \in R \); 2) exactly one of \( A_1, A_2, A_3 \) is empty; 3) \( B_i = A_i \cup R \), \( i = 1,2,3 \), is a subgroup of \( \hat{F} \); 4) the Witt ring is determined by \( t \), the level of \( F \), whether \(-1 \) is in some \( B_i \), and the number of \( R \)-cosets in \( D(1,1) \) and in each of \( B_1, B_2, B_3 \).

(Received December 21, 1978.)


Becker (Monografias Math. 29, Inst. Mat. Pura et Applicada, Rio de Janeiro 1978) has defined orderings of level \( n \) of a field \( F \). A sequence \( W_n(F) \) of Witt rings for \( \hat{F}/\hat{F}^m \), with \( m = 2^n \), in the sense of Knebusch, Rosenberg, Ware (Amer. J. Math. 94 (1972), 119-155) is constructed. There is a bijection between the minimal non-maximal prime ideals of \( W_n(F) \) and the orderings of level \( n \) of \( F \). Moreover, there are ring surjections \( W_n(F) \rightarrow W_{n-1}(F) \) and \( W_1(F) \) is the usual Witt ring of \( F \). For \( n > 1 \), \( W_n(F) \) is never torsion free. Becker's results are given ring-theoretical interpretations. (Received December 22, 1978.)


Three special classes of abstract Witt rings are studied. The classical description of the annihilator of a round form is generalized as is the description of the torsion subgroup of the Witt ring of a field. We translate some results of a previous paper into this abstract setting and also study Pfister forms there. We show how our special classes of abstract Witt rings relate to the Witt ring of classes of nondegenerate symmetric bilinear forms over a semilocal ring. (Received December 22, 1978.)
Let \( q \) be an anisotropic Pfister form over a field \( F \) where \( 2 \notin F^* \). Suppose \( \dim q = n = 2^m \) and let \( X = (x_1, \ldots, x_n) \) and \( Y = (y_1, \ldots, y_n) \) be vectors of indeterminants. Pfister proved that there exists \( Z = (z_1, \ldots, z_n) \) where each \( z_i \) is linear in \( Y \) and a rational function in \( X \) such that \( q(X)q(Y) = q(Z) \). How many of these \( z_i \)’s can also be linear in \( X \)? The sharp upper bound is \( \varrho(n) \), the Hurwitz-Radon function: if \( m = 4a + b \) where \( b = 0, 1, 2, \) or \( 3 \), then \( \varrho(n) = 8a + 2^b \). Formulas with \( \varrho(n) \) bilinear \( z_i \)’s can be found for the usual diagonal presentation of \( q \). The correct answer when \( q \) is hyperbolic is unknown. (Received December 22, 1978.)

The Noether-Skolem theorem and a theorem due to Jacobson state that all derivations and automorphisms of \( M_n(A) \), \( n \times n \) matrices over an arbitrary (not necessarily associative) algebra \( A \) with 1, and of algebras obtained from \( M_n(A) \) using the Lie and Jordan products. With one exception, the derivations and automorphisms of the algebra of symmetric matrices relative to a canonical involution, provided \( n \geq 4 \), (Received December 26, 1976.)

Let \( L \) denote a non-nilpotent Lie algebra over a field \( F \) all of whose proper subalgebras are nilpotent, and let \( N \) denote the nilradical of \( L \). It is well-known that when \( F \) is algebraically closed \( L \) must be two dimensional. However, this is far from true over other \( F \) fields.

**Theorem 1.** \( L \) is solvable if and only if \( L = N + B, N = N + A \), where \( N \land B = N \land A = 0 \), \( A \) is spanned by \( e_1, \ldots, e_r \), \( B \) is spanned by \( x \) and \( \{e_{1,2}, \ldots, [e_{r-1,r}] = e_r \} \)

\[ e_{r+1}x = c_0 e_{r+1} \ldots c_2 e_1 e_r \] with \( c_0 \neq 0 \), the polynomial \( y - c_{r-1} y^{r-1} \ldots y - c_1 y - c_0 \) irreducible over \( F \) and \( adx \) \( \notin N \) nilpotent.

A consequence of this is that over the rational field and over any finite field \( L \) can have arbitrary dimension. Again if \( L \) is solvable we have

**Theorem 2.** (i) If \( N \) has an odd number of generators then \( N \) is abelian.

(ii) If \( N \) has an even number of generators and \( c_{2k+1} \neq 0 \) for some \( 0 \leq k \leq (r-2)/2 \) then \( N \) is abelian.

**Theorem 3.** If \( F \) is the real field then either \( L \) is solvable (in which case \( L \) can be determined from Theorem 1; in particular, \( L \) has dimension at most four) or \( L \) is the three-dimensional non-split simple Lie algebra. (Received December 28, 1978.)

Let \( L \) be a semisimple Lie algebra of characteristic 0, and let \( A \) be a nonassociative algebra whose derivation algebra contains \( L \). Then \( A \) can be decomposed uniquely as a direct sum \( \bigoplus \) of irreducible representations of \( L \). The product in \( A \) can be factored through the tensor product \( A \otimes A = \bigoplus \otimes \bigoplus \), and using the fact that each \( V_i \otimes V_j \) can be decomposed in a unique way as a sum of irreducible \( L \)-modules, we can express the multiplication in \( A \) as a linear combination of certain canonically given multiplications. The coefficients that occur in this linear combination we call the multiplication coefficients of \( A \). When \( L \) is \( sl(2) \) or \( sl(3) \) and for certain choices of...
which irreducible modules are present, we have determined necessary and sufficient conditions on
the multiplication constants for A to be power-associative, flexible, noncommutative Jordan, and
quadratic. The algebras considered here include certain algebras that have arisen in particle
physics, notably the algebras defined by Domokos and Domokos and those used by Gunaydin and Gursey.
(Received December 28, 1978.)

764-A21 J.P. Holmes, Auburn University, Auburn, Alabama 36830. Differentiable power associative
multiplications.

Suppose \( \mathbb{X} \) is a Banach space, \( D \) is an open set of \( \mathbb{X} \) containing 0 and \( V \) is a function from \( D \times D \) to
\( \mathbb{X} \) satisfying \( V(0,x) = V(x,0) = x \) for each \( x \) in \( D \). If \( x \) is in \( D \) let \( x^0 = 0 \) and if \( n > 0 \) and \( x^n \)
exists and is in \( D \) let \( x^{n+1} = V(x,x^n) \). \( V \) is power associative means \( V(x^n, x^m) = x^{n+m} \) whenever
each of \( x^n \) and \( x^m \) is in \( D \).

Theorem: If \( V \) is \( C^k \) and power associative for \( k > 2 \), there is a function \( f \) and neighborhoods
\( G \) and \( H \) of 0 in \( \mathbb{X} \) so that \( f \) is a homeomorphism from \( G \) onto \( H \), \( f(0) = 0 \), and \( f(V(x,y)) = W(f(x), f(y)) \)
defines a multiplication on \( H \times H \) which satisfies \( W(sx, tx) = (s+t)x \) whenever \( x \) is in \( H \) and each of
\( s \), \( t \) and \( s+t \) is in \( [0,1] \). Partial results are given for the case \( K=1 \) and an example is given to show
this is not a theorem if \( K = 0 \). Each power associative algebra with identity element satisfies this
theorem with \( K = \infty \). (Received January 5, 1979.)

764-A22 BERNARD R. MCDONALD, University of Oklahoma, Norman, Oklahoma 73019. The Orthogonal
Group and Witt Ring over a Full Ring.

The theory of the orthogonal group, the special orthogonal group and the Witt ring of symmetric inner
product spaces over "full" commutative rings will be discussed. A commutative ring having 2 as a unit
is called full if it satisfies certain polynomial conditions. Full rings have stable range one and
are exemplified by semilocal, von Neumann regular and zero dimensional rings. (Received January 6, 1979.)

764-A23 RICHARD E. BLOCK, University of California, Riverside, California 92521. The algebraically irreducible representations of certain Lie algebras.

Over a field \( K \) of characteristic 0, let \( A_1 = K[q][p] \) (where \( pq - qp = 1 \) be the
(associative) Weyl algebra; \( B = K(q)[p] \) its localization at \( K[q] - \{0\} \); \( \mathfrak{g} \) the
split simple 3-dimensional Lie algebra; \( \mathfrak{h} \) the 2-dimensional nonabelian Lie algebra;
and \( h \) the 3-dimensional nilpotent Heisenberg Lie algebra. The author's recent
(possibly infinite dimensional) irreducible representations of \( A_1 \) (and thus of \( \mathfrak{h} \),
\( \mathfrak{g} \) and \( \mathfrak{b} \)) in terms of those of \( B \) (the latter being a classical theory) will be
discussed, and an extension given to the case when \( K \) is not algebraically closed.
(Received January 8, 1979.)

764-A24 ROGER WARE, The Pennsylvania State University, University Park, Pennsylvania 16802. Quadratic forms and profinite 2-groups.

The connection between the structure of the Witt ring, \( W(F) \), of anisotropic quadratic forms
over a field \( F \) of characteristic not 2 and the structure of the Galois group, \( G_F(2) \), of the
quadratic closure of \( F \) is investigated. Among the results to be discussed are: Theorem 1. Let
\( F, K \) be fields with \( G_F(2) \cong G_K(2) \). If \( W(F) \) is not isomorphic to \( W(K) \) then in one of the

A-237
fields $-1$ is a square while in the other $-1$ is a sum of two squares, but not a square. (Example: $F = \mathbb{F}_3$ and $K = \mathbb{F}_5$). Theorem 2. For a field $F$ the following statements are equivalent:

1. $W(F) \cong \mathbb{Z}/n\mathbb{Z} [G]$ for some $n \geq 0$ and some group $G$.  
2. The closed commutator subgroup of $C_p(2)$ is abelian.  
3. $C_p(2)$ contains no closed free pro 2-subgroup of rank $\geq 2$. (Received January 11, 1979.)

Daniel Drucker, Wayne State University, Detroit, Michigan 48202 and David M. Goldschmidt, University of California, Berkeley, California 94720. Graphical evaluation of sparse determinants.

In this paper, we show that the determinant of a matrix with entries in a commutative ring can be recursively computed by use of an associated directed graph whose circuits are assigned weights in the ring. This result provides an efficient means of calculating the determinants of sparse matrices. As an application, we compute the determinants of the Cartan matrices associated to the simple complex Lie algebras. (This can be accomplished simply by looking at the corresponding Dynkin diagrams.) (Received January 12, 1979.)

RICHARD ELMAN, University of California, Los Angeles, Los Angeles, California 90024 and ALEXANDER PRESTEL, Universität Konstanz, Konstanz, West Germany. The Hasse and $\mu$-invariants. Preliminary report.

Properties of the Hasse and $\mu$-invariants will be discussed. In particular, the following theorem will be established: Theorem A field has finite Hasse invariant iff it has finite $\mu$-invariant and satisfies ED. (Received January 15, 1979.)


The radical $R(F)$ of a field $F$ of characteristic $\neq 2$ is the set of elements $a \in F$ such that the binary quadratic form $x^2 - ay^2$ is universal. This set $R(F)$ is a subgroup of $F$ which, in some sense, generalizes the role played by $F_2$ in the theory of quadratic forms. It was not known, until quite recently, whether there exist nonreal fields $F$ with $|F/F^2| < \infty$ which have a non-trivial radical, i.e. with $F^2 \subsetneq R(F) \subsetneq F$. Recently, many such fields have been constructed, independently by L. Berman, M. Kula and T. L. Lee. In order to tackle the problem of classifying finite Witt rings of fields, a more thorough understanding of the behavior of the radical seems to be crucial. This talk will be a brief introduction to the subject, together with an exposition of the constructions of Berman, Kula and Lee. (Received January 15, 1979.)

PAUL FONOMAREV, The Ohio State University, Columbus, Ohio 43210. Ternary quadratic forms and Shimura's correspondence.

G. Shimura has established a correspondence between modular forms of half integral weight and modular forms of integral weight. The effect of this correspondence on theta series of positive definite ternary quadratic forms is determined. The result is a linear combination of theta series associated to positive definite quaternary forms. The theta series appearing in the linear combination and their coefficients are explicitly determined. (Received January 15, 1979.)

MURRAY A. MARSHALL, University of Saskatchewan, Saskatoon, Canada S7N OW0. Rings of Witt Type. Preliminary report.

A $W$-ring is essentially a strongly representational abstract Witt ring in the terminology of Kleinstein and Rosenberg. A $Q$-structure is a triple $(G, -1, \equiv)$ where $G$ is a group of exponent 2, $-1$ is a distinguished element of $G$, and $\equiv$ is an equivalence relation on $G \times G$ s.t.
In this paper, we propose to define the linear center and the center of a quadratic Jordan algebra without 1 over a ring \( \mathcal{O} \). The center of \( J \) is a subalgebra (a \( \mathcal{O} \)-submodule which is closed under squaring and \( U \)-operation) of \( J \). We also show that, as in the linear case, if \( J \) is a prime quadratic Jordan algebra, then \( \Gamma(J) \), the centroid of \( J \), is an integral domain. Moreover, the algebra \( \Gamma(J) \) is a quadratic Jordan algebra over \( \Gamma \) which is \( \Gamma \)-torsion free and has a characteristic. (Received January 15, 1979.)

KIYOSI YAMAGUTI, Kumamoto University, Kumamoto 860, Japan. On generalizations of the metasymplectic geometry. Preliminary report. Part I. Let \( \alpha \) be \( Z \) or \( Z_2 \) and let \( U(\alpha) = \sum_{\alpha} U(\alpha_1, \alpha_2, \ldots, \alpha_n) \) be a \( \alpha \)-graded triple with product \( \langle \cdot, \cdot \rangle \) satisfying the conditions:

\[
\begin{align*}
-1 & (a_1, b_1) \langle c_1, d_1 \rangle = \langle a_1, b_1 \rangle \langle c_1, d_1 \rangle + \epsilon(-1)(a_1, b_1) \langle c_1, d_1 \rangle \\
K(\alpha_1, \alpha_2) \langle \alpha_3, \alpha_4 \rangle & = -1 (\alpha_1, \alpha_2) \langle \alpha_3, \alpha_4 \rangle - (\alpha_1, \alpha_2) \langle \alpha_3, \alpha_4 \rangle \\
& = 0,
\end{align*}
\]

where \( L(a_1, b_1) x = (a_1, b_1) x \) and \( K(a_1, b_1) x = (-1)^{\frac{m}{2}} a_1 x b_1 \). Put \( T(\alpha) = U_1(\alpha) U_1(\alpha) \), a certain triple product in \( T(\alpha) = \sum_{\alpha} U_1(\alpha) U_1(\alpha) \) makes \( T(\alpha) \) a \( \alpha \)-Lie-graded triple (\( \alpha \)-LGT) in the sense of H. Tilgner. Part II. (Jointly by R. Asano and the author) The triple \( U(\alpha) \) satisfying \( K(\alpha_1, \alpha_2) \langle \alpha_3, \alpha_4 \rangle = 0 \) is called a \( \alpha \)-Jordan-graded triple (\( \alpha \)-JGT). Let \( J \) be a \( \alpha \)-graded Jordan super-algebra (V.G. Kac, Comm. in Alg. 5), then \( J \) is a \( \alpha \)-JGT with respect to a product \( a_1 \langle b_1 \rangle c_1 \langle d_1 \rangle = -1 \langle a_1 \rangle \langle b_1 \rangle c_1 \langle d_1 \rangle \) and let \( \langle \cdot, \cdot, \cdot \rangle \) be a \( \alpha \)-JGT, then \( J \) is a \( \alpha \)-LGT relative to \( a_1 \langle b_1 \rangle c_1 \langle d_1 \rangle \). Also, we study graded generalizations of Malcev algebras and symplectic triple systems (cf. Proc. Japan Acad. 51) and their relations to \( \alpha \)-LGT. (Received January 15, 1979.)


To each nonassociative finite division ring is associated a homogeneous form of degree \( n \) in \( n \) variables which does not represent zero nontrivially. The form is then used to investigate more specific problems: e.g., flexibility implies commutativity; the existence of an embedding of the ring into a finite division ring containing a primitive element (i.e., an element whose right powers generate a vector space over its center equal to the entire ring). (Received January 16, 1979.)


A pair of formally real fields \( F \equiv K \) is called a SAP pair if every totally indefinite quadratic form over \( F \) becomes weakly isotropic over \( K \). Many of the diverse characterizations of SAP fields have relativized versions for SAP pairs. Going still further, there is a notion of a SAP triple of fields \( F \equiv L \equiv K \), though fewer of the properties of SAP fields seem to have analogues in this generality. (Received January 19, 1979.)
For varieties of varieties, alias hypervarieties see W. D. Neumann, J. Austral. Math. Soc. (A) 25 (1978), 103-117, and my abstract in these Notices 25 (1978), A-581. The variety of rings generates the variety of all varieties, but the variety of groups does not. There are two hypervarieties generated by lattice varieties; in fact distinct self-dual lattice varieties generate distinct hypervarieties. The varieties \( V_k \) of \( k \)th powers of sets define an increasing sequence of hypervarieties. We also obtain an increasing sequence of hypervarieties generated by some idempotent quasiprimal varieties. The hypervarieties generated by \( \mathbb{Z}_n \) modules are ordered by divisibility on \( n \). Our method is to define hypervarieties using the hyperidentities of J. Aczél, Algebra Universalis 1 (1971), 1-6. It is not hard to prove that every hypervariety is definable by hyperidentities.

For each \( n \), we write hyperidentities obeyed by varieties which have no operations depending on \( n \) variables for \( n \in \mathbb{N} \). Among these we easily find a nice infinite irredundant set of hyperidentities, and hence (again) \( \aleph_0 \) hypervarieties. (Received January 22, 1979.)

Andrew G. Earnest, University of Southern California, Los Angeles, Calif. 90007.

One-class spinor genera of definite quadratic forms.

A standard method of obtaining information regarding the number of isometry classes in a genus of definite quadratic lattices over the ring of integers of a fixed totally real algebraic number field is to analyze the factors appearing in the Minkowski-Siegel formula for the mass of the genus. In particular, by determining lower bounds for the class number, the number of isometry classes of genera consisting of a single class has been shown to be finite (see J. Nb. Thy. 3(1971), 373-411). We discuss here the problem of estimating the number of classes contained in a given spinor genus in terms of its rank and discriminant. One specific result, obtained jointly with D.R. Estes, implies that the number of isometry classes of one-class spinor genera is also finite. The methods used employ transformations introduced by G.L. Watson and generalized by L.J. Gerstein and the known results for the entire genus. (Received January 22, 1979.)

Lawrence Berman, University of Oklahoma, Norman, Oklahoma 73019.

Quadratic forms and power series fields.

Let \( F \) be a field of characteristic not 2. An element \( x \in \hat{F} = \mathbb{F} - \{0\} \) is rigid if the norm \( N(x) = \mathbb{F}x \to \hat{F} \) has the trivial image \( \mathbb{F}_2 \cup x\mathbb{F}_2 \). The set \( A(F) \) consisting of all \( x \in \hat{F} \) such that \( x \) or \( -x \) is nonrigid, together with \( \mathbb{F}_2 \cup -x\mathbb{F}_2 \), is a subgroup of \( \hat{F} \) with the following properties: (i) the Witt ring \( W(F) = T(F)[\hat{F}/A(F)] \), a group ring (here \( T(F) \) is a subring of \( W(F) \)); (ii) there exists a field \( K \) extending \( F \) such that if \( L = K(\{x_i\}), i \in \hat{F}/A(F) \), the field of iterated power series, with coefficients in \( K \), in \( \hat{F}/A(F) \) variables, then \( W(F) = W(L) \). (Received January 25, 1979.)

Patrick X. Gallagher, Columbia University, New York, New York 10027 and Ronald J. Proulx, 81 Nonantum Street, Brighton, Massachusetts 02135.

Group characters and metric invariants.

Let \( R_1, R_2, R_3 \) be irreducible complex representations of the finite group \( G \). Assume that the tensor product of the \( R_i \) contains the principal representation. Let \( g \) be an involution in \( G \), and let \( p_1 \) be the proportion of \(-1\)'s among the eigenvalues of \( R_i(g) \). Then the \( p_i \) are the sides of a triangle of perimeter at most 2. More generally, the average over \( G \) of the product of any three (or more) spherical functions on \( G \) is nonnegative. The proof depends on expressing the average as the trace of a product of two orthogonal projections. Let \( R \) be an \( r \)-dimensional irreducible complex representation of \( G \). Assume that \( R \) has real character. The tensor product of four copies of \( R \) on the direct product of four copies of \( G \) has a line of invariants, when restricted to the partial diagonal of all elements \( (x,x,y,y) \). Two more lines come from \( (x,y,x,y) \) and \( (x,y,y,x) \). The angle between any two of the three lines is \( \arccos(f^{-1}) \), and the three lines have the acute or obtuse configuration according as the Frobenius-Schur invariant of \( R \) is 1 or -1. The proof depends on a computation of the trace of a product of three orthogonal projections. (Received January 29, 1979.)

A-240
A functional topology is a functor which assigns to each abelian group in such a way that each group homomorphism is continuous. Theorem 1. If each group under a functorial topology has a neighborhood system at 0 consisting of a linearly ordered family of subgroups, then there exists a family \( R \) of radicals so that for each abelian group \( G \), the family \( \{RG : R \in R\} \) is a neighborhood system at 0. A functorial topology is ideal if each group homomorphism is an open map.

Theorem 2. If each group under an ideal functorial topology has a neighborhood system which consists of a linearly ordered family of subgroups, then there exists a sequence of integers \( n_1, n_2, \ldots \) so that for each group \( G \) the family \( \{n'_iG : 1 \leq i < \infty\} \) is a neighborhood system. (Received January 29, 1979.)

We establish a one-to-one correspondence between the compositions of quadratic forms over \( R \) and a class of step-2 nilpotent Lie groups (type H) which naturally generalizes the Heisenberg group. The main interest of this construction lies in the fact that the standard invariant sublaplacians on these groups possess elementary (analytic) fundamental solutions; in fact, they yield the known examples of this phenomenon plus infinitely many new ones. In this context, the classical Hurwitz-Radon-Eckmann theorem on the existence of composition of quadratic forms gives a measure of the size of the class of hypoelliptic operators so obtained. (Received January 30, 1979.)

We study the behavior of field invariants like \( u, \tilde{u} (= \text{Hasse number}), P (= \text{Pythagoras number}), q (= \text{number of square classes}) \), related to quadratic forms, under algebraic extensions and in particular under quadratic extensions. One of the problems investigated is persistence of the finiteness of an invariant by 'going up' or 'going down'. (Received January 30, 1979.) (Author introduced by Professor Ronald P. Brown.)

A monoid acting on a set (i.e., an automaton) can be represented as an endomorphism monoid of the disjoint union of the set with the original monoid. More generally, a finitary algebraic (equational) theory (acting on its constant polynomials) can be represented as a clone of finitary operations on the disjoint union of the polynomials of the theory. This can be generalized further up to any regular cardinal, and it gives a concrete representation of categories with products. There are applications to the study of automata and of type-free algebras. (Received January 30, 1979.)

**Analysis (26, 28, 30–35, 39–47, 49)**

Let \( \mathbb{Z} \) denote the integers and let \( \mathcal{B} \) be a pointwise Banach algebra of functions on \( \mathbb{Z} \) which vanish at infinity and in which the finitely supported functions on \( \mathbb{Z} \) are dense. A closed subalgebra \( \mathcal{Q} \) of \( \mathcal{B} \) is called a Rider subalgebra if (1) the closed span of the idempotents of \( \mathcal{Q} \) has codimension one in \( \mathcal{Q} \) and contains \( \mathcal{Q} \cdot \mathcal{Q} \) (so that in particular \( \mathcal{Q} \) is not the closed span of its idempotents), (2) \( \mathcal{Q} \) is singly generated and is the largest subalgebra of \( \mathcal{B} \) with given minimal idempotents, and (3) the minimal idempotents of \( \mathcal{Q} \) are a Schauder basis for their closed span. D. Rider showed
that \( \mathcal{T}_p \) has such a subalgebra when \( 1 \leq p < 2 \) [Duke Math. Journal, 1969], where \( \mathcal{T}_p \) denotes the algebra of Fourier transforms of functions in \( L^p(T) \), \( T = \) the circle group. Under certain mild additional assumptions on \( \mathcal{B} \) we generalize Rider's method to give a general criterion for when \( \mathcal{B} \) has a Rider subalgebra. Using probabilistic methods, we then show that the following algebras have "many" Rider subalgebras: \( \mathcal{T}_p \), \( 1 \leq p < \alpha \), \( \mathcal{C} \), where \( \mathcal{C} \) denotes the continuous functions on \( T \), \( m_p(Z) \), the compact multipliers of \( \mathcal{T}_p \), \( 1 < p < 2 \), and \( A_p(Z) \), the Figá-Talamanca-Herz algebra, \( 4/3 < p < 2 \). (Received November 22, 1978.)

**764-B2** Louis Pigno, Kansas State University, Manhattan, Kansas 66506. Transforms Which Almost Vanish at Infinity.

Let \( T \) be the circle group and \( M(T) \) the usual convolution algebra of measures on \( T \). Let \( Z \) denote the additive group of integers and \( \sigma \) the Fourier-Stieltjes transformation. K. deLeeuw and Y. Katznelson have proved that for \( \mu \in M(T) \) the size of \( \limsup_{n \to \infty} |\mu(n)| \) is controlled by that of \( \limsup_{n \to \infty} |\sigma(n)\mu(n)| \). Using the Cohen-Davenport procedure, we give a new proof of this result and also obtain a somewhat simpler dependency between the two limit superiors. Theorem. Let \( 0 < \epsilon < 1 \). Choose \( r \in \mathbb{Z}^+ \) such that \( \frac{1}{4^r} > \frac{1}{\epsilon} \). Put \( \delta = \epsilon e^{-r} \). If \( \mu \in M(T) \) satisfies \( \|\mu\| < 1 \) and 
\[
\limsup_{n \to \infty} |\mu(n)| < \delta \quad \text{then} \quad \limsup_{n \to \infty} |\sigma(n)\mu(n)| < \epsilon.
\]
An elaboration of the method of proof of the above theorem is then used to obtain quantitative results concerning the behaviour of transforms off certain lacunary sets. (Received December 19, 1978.)

**764-B3** AHARON ATZMON, Technion-Israel Institute of Technology, Haifa, Israel and University of Hawaii 96822. Boundary values of absolutely convergent Taylor series.

Let \( T \) denote the circle group, and let \( A^+(T) \) be the Banach algebra of functions \( F(t) = \sum_{n=0}^{\infty} a_n t^n \), \( t \in T \) such that \( \|F\| = \sum_{n=0}^{\infty} |a_n| < \infty \). For a closed subset \( E \subset T \) let \( A^+(E) \) be the restriction algebra of \( A^+(T) \) to \( E \).

**THEOREM.** Let \( E \) be a closed subset of \( T \) and assume that there exists a function \( F(t) = \sum_{n=0}^{\infty} a_n t^n \) in \( A^+(T) \) such that \( F = 0 \) on \( E \) and that the function \( f(z) = \sum_{n=0}^{\infty} a_n z^n \), \( |z| \leq 1 \), has \( \alpha \) finitely many zeros in \( |z| < 1 \). Then there exists a constant \( K > 0 \) such that if \( G \) is any \( C^\alpha \) function on \( T \) which satisfies:
\[
|G(n)(t)| \leq K(n!)^\alpha, \quad t \in T, \quad n = 0, 1, \ldots,
\]
then \( G \) belongs to \( A^+(E) \).

**COROLLARY.** If \( E \) is an exact zero set for \( A^+(T) \), in particular if \( E \) is a Carleson set, then the conclusion of the Theorem holds for \( E \). (For definitions see: J.P. Kahane, Series de Fourier absolument convergent, Chap. XI, Springer-Verlag, New York, 1970.)

The above is best possible by virtue of a result of Kahane and Katznelson (Journal d'Analyse, 1970) who showed that there exists a Carleson set \( E \) and a \( C^\alpha \) function \( G \) in \( T \) such that for every \( \alpha > 2 \),
\[
\sup \left\{ \left| \left( \frac{G(n)(t)}{n!} \right)^{1/n} \right|^{1/n} : t \in T, n = 0, 1, \ldots < \infty \right. \] but \( G \notin A^+(E) \). (Received January 2, 1979.)

**764-B4** JOHN J.F. FOURNIER, University of British Columbia, Vancouver, Canada V6T 1W5. On constructions of bounded functions with some prescribed Fourier coefficients.

In 1930, Banach used a duality argument to show that if \( \{a_k\}_{k=1}^\infty \) is a Hadamard sequence, and if \( \sum_{k=1}^\infty |a_k|^2 < \infty \), then there exists a continuous function \( f \), on the unit circle, such that \( \hat{f}(a_k) = a_k \) for all \( k \). Subsequently, various authors have found explicit constructions of such functions. In this talk, we will compare these constructions, and discuss some of their applications, including a new proof of Blei's multilinear Grothendieck inequality, and some variants of theorems of Gundy and Varopoulos about backwards martingales on the unit circle. (Received January 11, 1979.)
**764-B5**  HENRY HELSON, University of California, Berkeley, CA. 94720.  **Cocycles in function theory.**

K is a compact abelian group dual to a discrete group densely embedded in the real line. Define \( e_t(\lambda) = \exp(it\lambda) \); then \( (e_t) \) is a dense subgroup of \( K \) and determines the flow:

\[
x \rightarrow x + e_t \quad \text{on} \ K.
\]

An additive cocycle on the flow is a real measurable function \( v \) on \( RxK \) such that

\[
v(t+u, x) = v(t, x)+v(u, x+e_t).
\]

\( v \) is a coboundary if \( v(t, x) = w(x+e_t) - w(x) \) for some \( w \) real and measurable on \( K \). A function \( v \) is called trivial if \( v(t, x) + ct \) is a coboundary for some \( c \).

A function \( A(t, x) \) of modulus one is a multiplicative cocycle, coboundary, or trivial cocycle if analogous multiplicative formulas hold. A recent theorem of K. Schmidt asserts that \( v \) is additively trivial if \( \exp(isv) \) is multiplicatively trivial for every real \( s \).

This result enables us to show that certain functions in \( L^2(K) \) generate simply invariant subspaces whose spectral type is continuous. This is a partial answer to an old question in the theory of compact groups with ordered duals. (Received January 12, 1979.)

764-B6  V.V. RAO, University of Regina, Regina, Saskatchewan, Canada, S4S 0A2.  **Identities Involving Fourier Coefficients of Automorphic Wave Forms**

In this paper we consider Fourier coefficients of Automorphic Wave Forms of dimension \( -1 \) (in the sense of H. Maass) corresponding to a real wave parameter \( r > \frac{1}{2}, r \neq 1 \). We then express the average \( \frac{1}{N} \sum_{n=0}^{N} a_n(x-n)^{\alpha} \) as a convergent series of analytic functions for \( \alpha > \alpha_0 \), where \( \alpha_0 \) depends on the wave form. It turns out that the analytic functions so occurring can be expressed in terms of Meijer's functions. (Received January 17, 1979.)

764-B7  BENJAMIN F. WELLS, JR., University of Hawaii, Honolulu, Hawaii 96822.  **Quotient spaces of Fourier transforms.** Preliminary report.

Let \( T \) denote the circle group and \( E \) a subset of the integers \( Z \).

Let \( A(E), B(E), B_0(E) \) respectively denote the restrictions to \( E \) of Fourier transforms of \( L^1 \)-functions on \( T \), measures on \( T \), discrete measures on \( T \). \( B_0(E) \) denotes the intersection of \( B(E) \) with \( c_0(E) \), and all spaces are furnished with the quotient norm.

**Theorem.** Let \( D \) be an \( \epsilon \)-Kronecker subset of \( Z \), and suppose that \( E \) is contained in \( D \cdot D \). Then \( E \) is Sidon if and only if \( A(E) = B_0(E) \).

**Theorem.** If \( B(E) = B_0(E) \), then \( \sup( \min( \#P, \#Q) : P+Q \text{ is contained in } E ) \) is finite. (Received January 22, 1979.)

764-B8  JACK CEDER, University of California at Santa Barbara, Santa Barbara, California 93106 and T. L. PEARSON, Acadia University, Wolfville, Nova Scotia, Canada.  **Most functions are weird.**

The graph of a "typical" (in the sense of category) function in \( C[0,1] \) intersects the graph of "most" (in the sense of category and measure) polynomials in a set whose \( x \)-projection is perfect. (Received January 22, 1979.) (Author introduced by Professor Kenneth A. Ross.)

764-B9  ROY A. JOHNSON, Washington State University, Pullman, Washington 99163.  **Nearly Borel sets and Borel measures.**

A set in \( (X, \tau) \) is called \( \omega \)-bounded if it contains the closure (in \( X \)) of each of its countable subsets and if that closure is compact. The class of nearly Borel sets in \( X \) will be the smallest sigma-ring containing the \( \omega \)-bounded sets. A (nonnegative) measure on the nearly Borel sets will be called a regular nearly Borel measure if it is inner regular with respect to the
ω-bounded sets. It is shown that a regular Borel measure on a compact space can be extended to a regular nearly Borel measure on that space. Applications are given to the product of two Borel measures, one of which is regular. (Received January 26, 1979.)

764–E10  JOHN E. GILBERT, Washington University, St. Louis, Missouri 63130. Transplantation theorems and $H^p$-theory. Preliminary report.

Using Mellin Transforms and a simple form of the Marcinkiewicz multiplier theorem, P. G. Rooney (Canad. J. Math., 24 (1972), 25 (1973)) has developed a very elegant theory which, for instance, establishes the $L^p$-boundedness of the ‘conjugate’ integrals in radial $H^p$-theory. The latter was developed by Muckenhoupt and Stein (Trans. Amer. Math. Soc., 118 (1965)) and their results can be interpreted as transplantation theorems. We shall discuss various generalizations of all these results. (Received January 26, 1979.)


Let $\dot{x} = f(x,y)$, $\dot{y} = g(x,y)$ be a two dimensional system (S) of autonomous differential equations with an isolated asymptotically stable equilibrium point. We discuss a class $F$ of Liapunov Functions for S generated by a class of weight functions. We consider the general problem of maximizing estimates of regions of asymptotic stability by level curves of functions in $F$ and develop an interesting procedure for estimation. This procedure yields the following for the (modified) Van der Pol Equation (E):

$\dot{x} = y - \epsilon \left( \frac{x^3}{3} - x \right) \ (<0)$, $\dot{y} = -x$. Theorem:

There exists a class $F$ of Liapunov Functions for (E) such that the estimate of the diameter of the unique limit cycle of (E) by members of $F$ is maximal over $F$. This estimate is a function $G(\epsilon)$ such that $G(\epsilon)>2\sqrt{\epsilon}$ and $|\epsilon|^\frac{-5}{2} G(\epsilon)+ 4.3^{-\epsilon} \ll |\epsilon|^\infty$. (Received January 23, 1979.)

764–E12  COLIN C. GRAHAM, Northwestern University, Evanston, Illinois 60201. Quotients of $L^\infty$ and WAP.

Let $A \subseteq B$ be algebras of functions on the space $X$. Sometimes there exist $f \in B$ such that $f, f^2, \ldots, f^n \subseteq \subset A$ and $f^{n+1} \not\subseteq A$. When $A = \bigcup_{1 \leq p < 2} B_p$, that occurs. When $\Gamma$ is ordered, with dual group $G$, $A = H^\infty(G) + C(G)$, and $B = L^\infty(G)$, that occurs. The offending sets of $f$ are shown to be large. (Received January 29, 1979.)


A $C^*$-bundle $E$ over $X$ is a type of fibre space such that each fibre $E_x$ is a $C^*$-algebra. However, the isomorphism type of $E_x$, the fibre, may vary as $x$ varies in $X$, even when $X$ is connected. We can show that if $E$ and $F$ are $C^*$-bundles over $X$ and $Y$, where all fibres are approximately finite dimensional $C^*$-algebras, then there is a $C^*$-bundle $E \otimes F$ over $X \times Y$ unique so that the fibre of $E \otimes F$ over $(x,y)$ is $E_x \otimes F_y$ and so that $s \otimes t$ is a section of $E \otimes F$ whenever $s$ is a section of $E$ and $t$ is a section of $F$. Moreover, if $X$ and $Y$ are compact Hausdorff spaces, then $\Gamma(E \otimes F) = \Gamma(E) \otimes \Gamma(F)$ under the obvious correspondence. As a corollary, when $X = Y$, we obtain

$\Gamma(E \otimes_X F) = \Gamma(E) \otimes C(X) \Gamma(F)$.

This is used to study stable isomorphisms of section algebras and to elucidate the structure of certain bundles by obtaining tensor product decompositions. In particular, if $E$ is a homogeneous finite rank $C^*$-subbundle of $F$ over $X$, then the commutant of $E$ in $F$ exists, denoted $E'$, and $F \cong E \otimes_X E'$. (Received January 29, 1979.)
Z denotes the group of integers and B(Z) its Bohr closure.

Proposition 1. (done with Y. Katznelson) There is no set E of integers whose Bohr group cluster points consist of exactly those members of the Bohr group B(Z) which annihilate the rationals in measure on n points, provided the original Proposition 1.

The circle group.

Proposition 2 (in response to a question of Hartman's). (done with Y. Katznelson and also done independently by Gordon Woodward of Nebraska) There is a set E of integers such that every restriction to E of the F.S. transform of a measure is also the restriction of the F.S. transform of a discrete measure. Then, given a fixed error, every restriction of an F.S. transform can be approximated within that error in the relevant quotient norm by the F.S. transform of a discrete measure on n points, provided the original F.S. transform is bounded by 1 in quotient norm. n is independent of the F.S. transform and is O(logarithm of the error). (Received January 29, 1979.)

Let F be a contraction mapping of the Banach space X, C<q<1 being the Lipschitz constant. Banach's fixed point theorem can be strengthened as follows. Theorem. If (3) n=1 and Leq(nx) +0 as n+∞, then the convex iterates (1) x_{n+1} = (1-\lambda)x_n + \lambda Fx_n converge to the unique fixed point x^0 = Fx^0, and (2) \|x_n - x^0\| \leq (1-q)^{-1} x_0 = Fx_0, for arbitrary x_0 of X, where t_0 = 0, t_n = \sum_{i=1}^{n-1} \xi_1. The convergence of (1) without error estimate (2) follows from Banach's fixed point theorem and from the well-known fact that \prod_{n=0}^{\infty} (1 - (1-q)) < 0. A proof is given which is not based on Banach's theorem. (Received January 24, 1979.)

Use of Laplace Transform for solving differential equations has been quite common for some time. In this paper, it is quite interesting to observe that techniques of Laplace Transform can be used very conveniently to obtain generalization of sums of various infinite series from which, in particular, results on a variety of well known series precipitate. As a result, evaluation of \zeta(2n) is achieved for every positive even integer 2n in the form of a corollary to a certain generalized infinite sum.

In fact, it is deduced that \zeta(2n) = (-1)^{n-1} \prod_{i=1}^{n-2} \psi'(2n-i), where \psi(x) satisfies the first order ordinary differential equation D\psi(x) + (7/2)\psi'(x) = x/2 with the initial condition \psi(0) = 0. Furthermore, noting the classical results on \zeta(2n), a very convenient closed form formula for providing Bernoulli numbers B_n is obtained. This avoids derivation of the numbers B_n through a recurrence relation and uses rather a direct formula given by B_n = (-1)^{n-1} \prod_{i=1}^{n-2} \psi'(2n-i)

with \psi(x) described as above; in fact, \psi(x) = \tanh(x/2). Sums of many other infinite series are also derived some of which are quite well known. (Received January 30, 1979.) (Author introduced by Professor L. J. Simonoff).

Since the discovery by Menchoff in 1916 that continuous singular measures on the circle may have F-S transforms that are o(1), much attention has been paid to finding smaller and smaller transforms of this kind. We construct a class of measures with full support whose transforms go to zero more rapidly than previously published examples. (Received January 30, 1979.)

We are concerned with linear differential and/or difference equations of the form x^{1-p}y/dx = A(x)y(x) + b(x), y(x^{p+1}) = A(x)(x^{p}) + b(x), dy/dx = A(x)y(x) + B(x)y(qx), q > 1, where y and b are n-vectors and A and B are n x n matrices, analytic in some sectorial neighborhood of x = \infty, having formal expansions A(x) =...
\[ \sum_{k=0}^{\infty} A_k x^{-k}, \quad B(x) = \sum_{k=0}^{\infty} b_k x^{-k}. \] It is well known that even \( A, B \) and \( b \) holomorphic at \( x = \infty \) will not ensure that formal solutions converge. We show the existence of two suitable classes \( Q \) of analytic functions for which \( A, B, b \) in \( Q \) implies that a formal solution \( y \) is also in \( Q \), namely functions representable in the form of Laplace integrals with asymptotic or factorial series representations. (Received January 30, 1979.)

**Applied Mathematics** (65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)

*764-C1* JAMES R. BUNCH and CHRISTOPHER P. NIELSEN, University of California, San Diego, La Jolla, California 92093. *Updating Matrix Decompositions.*

After having obtained some decomposition of a matrix \( A \), one then often needs the same decomposition of a matrix \( B \) which is a small modification of \( A \), i.e. \( B \) is a rank-one modification of \( A \) or \( B \) is obtained from \( A \) by appending or deleting a row or a column.

Here we shall present algorithms for (1) computing the eigensystem of the rank-one modification of a symmetric matrix with known eigensystem, (2) computing the singular value decomposition of a matrix obtained by appending or deleting a row or column from a matrix with known singular value decomposition, and (3) computing the least squares solution to a problem obtained from a known least squares problem by appending or deleting an equation or an unknown. (Received January 17, 1979.)

*764-C2* JUNIOR STEIN and HON-MING CHAN, The University of Toledo, Toledo, Ohio 43606. *Convergence Criterion for a class of conjugate gradient algorithms in Hilbert space.*

**Theorem.** Let \( X \) be a Hilbert space. Let \( F \) be a real-valued functional defined on \( X \). Suppose there is a real number \( k \) for which \( C_k = \{ x \in X : f(x) \leq k \} \) is a convex set and for which the following conditions hold: \( F \) is bounded below on \( C_k \); \( F \) and its Frechet derivatives \( df(x) \), \( d^2 F(x) \) are continuous on \( C_k \); and the second Gateaux derivative \( D^2 F(x) \) of \( F \) exists, is linear, and satisfies

\[ m ||h||^2 \leq d^2 F(x,h) \leq M ||h||^2 \]

for \( x \in C_k \), \( h \in X \) where \( m > 0 \), \( M > 0 \). Let \( (x_n) \) be a sequence generated by a class of conjugate gradient algorithms for which \( ||p_n|| \leq B \ ||F(x_n)|| \) for some \( B > 1 \) with starting value \( x_0 \) in \( C_k \). Then \( DF(x_n) \to 0 \), \( p_n \to 0 \), there is a vector \( x^* \) in \( X \) such that \( x_n \to x^* \), \( F(x_n) \to F(x^*) \), \( DF(x_n) \to DF(x^*) \), and \( DF(x^*) = 0 \). Furthermore, \( x^* \) is a local minimum for \( F \) on \( X \) and a unique minimum for \( F \) on \( C_k \). (Received January 29, 1979.)

**Geometry** (50, 52, 53)

*764-D1* LEON W. GREEN, University of Minnesota, Minneapolis, Minnesota 55455. *The tangent space of an ideal boundary.* Preliminary report.

Let \( B \) denote the ideal boundary of a simply-connected, complete Riemannian manifold of negative curvature, constructed out of asymptote classes of geodesic rays as in Eberlein and O'Neill [Proc. J. of Math. 46 (1973), 45–109]. When the sectional curvatures are strictly \( \frac{1}{2} \)-pinched we show that there is a tangent bundle defined by a naturally occurring class of Lagrangian subspaces of Jacobi fields. Certain choices of transverse Lagrangian subspaces induce Riemannian metrics on \( B \), and the way these change under isometries of the original manifold is discussed. (Received January 29, 1979.)
For a regular surface $S \in \mathbb{R}^3$, represented by a map $X: M \to \mathbb{R}^3$, it is possible to define a generalized Gauss map from $M$ into $Q \subseteq CP$. This map is antiholomorphic if and only if $S$ is minimal. For a minimal surface the area of the Gaussian image is (minus) the total curvature of $S$. The curvature, $K$, of the Gaussian image is an intrinsic quantity on $S$, but need not be identically one as is the case for minimal surfaces in $\mathbb{R}^3$. We offer here two characterizations of classes of minimal surfaces by properties of their Gaussian images. These and others will appear in a forthcoming paper. First, a minimal surface in $\mathbb{R}^3$ has $K \geq 0$ if and only if it lies in an affine $\mathbb{R}^2$ and in that $\mathbb{R}^3$ is a complex curve with respect to some orthogonal complex structure. Second, all complete simply connected minimal surfaces in $\mathbb{R}^3$ with total curvature $4\pi$ belong to a family parametrized by the disk; Enneper's surface corresponds to points on the unit circle.

The proofs involve, among other things, an investigation of the geometry of $Q$. (Received January 30, 1979.)

**Logic and Foundations (02, 04)**

**#764-E1**

Let $X$ be a topological space. If $L$ is a Borel subset of $2^X$, and if for each finite sequence $s$ of natural numbers, $B_s \subseteq X$, we put

$$C = \{x \in X : \forall m_0 \exists m_1 \forall m_2 \exists m_3 \ldots \forall m_n \exists \ldots \in L \}.$$

(We write $\forall \alpha \exists \beta \ldots P(\alpha_{\beta \ldots})$ to mean that Player II has a winning strategy in the game $P$. $Q_L$ is called a Borel game operation. All the results below depend on Martin's theorem, that all Borel games are determined.)

By a classical theorem, the operation $(A)$ (the 'simplest' Borel game operation) preserves the Baire property in any space $X$, i.e., if each $B_s$ has the Baire property, so does $(A)(\lambda B_s)$. Solovay proved that every Borel game operation preserves the Baire property in any separable metric space. Recently Kechris proved by a new method that the same thing holds for another class of topological spaces, all still having countable bases. By modifying Kechris's method, we obtain the result for all spaces $X$, i.e.,

**Theorem 1:** Borel game operations preserve the Baire property.

The method of Kechris establishes simultaneously a theorem due to Burgess for Polish spaces, which now also extends to arbitrary spaces. Let $B$ be the Boolean algebra of Borel sets of $X$ modulo meager sets. Let \( 'd' \), \( s \) range over a dense set of non-zero elements of $B$. Put $c = \{c \in \text{meager}, \ b_s \subseteq X \}$, and $b_s = B_s / \text{meager}$.

**Theorem 2:** $e \leq c$ iff $\forall \ d_0 \leq e \exists \ d_0 \exists m \leq \ d_0 \exists m_1 \ldots \{n: \exists k \leq d_0 \leq d_1 \exists \ldots \leq d_n \leq a_{\ldots n} \in L \}.$

Let $k$ be an infinite cardinal, and $b_s \subseteq X$ for each finite sequence $s$ of ordinals $< k$.

Given $L$ as before, $C$ is defined by playing the game with ordinals below $k$. Then both theorems hold for $k$-meager, $k$-Baire property. (Received December 12, 1978.)

**#764-E2**

The topological logic $L(I)$, introduced by Srbo and the author, has a surprisingly nice axiomatization which allows the use of consistency properties and Back and Forth techniques. We give a survey of similar logics (modal, topological, monotone) reporting recent results of Caicedo, Seese, Weese, Ziegler and others. (Received December 27, 1978.)

**#764-E3**
NIGEL CUTLAND, University of Wisconsin, Madison, Wisconsin 53706 and MATT KAUFMANN, Purdue University, W. Lafayette, Indiana 47907. On wellfounded $L_1$-compactness. Preliminary report.

Let $A$ be an admissible set, and $E$ a binary relation of the infinitary language $L_A$. An $L_A$ structure is wellfounded if the interpretation of $E$ is wellfounded. $L_A$ is $L_1$ w.f.c. if it is $L_1$-compact with respect to wellfounded structures. In [Cutland J.S.L. 43 (1978) 508-520] it was shown that $L_A$ is $L_1$ w.f.c. iff $A$ reflects $s$-$\Pi^1_1$-Suslin formulae of the form $s \exists \phi \land \forall \phi \phi(f(n))$, where $\phi$ is $L_0$ over $A$. The same techniques, together with a normal form theorem for $s$-$\Pi^1_1$-Suslin formulae, are used to show:
Theorem 1. If $\mathcal{L}_A$ is $\Sigma_1$ w.f.c., then the languages $\mathcal{L}_{A,WF}$ (i.e. $\mathcal{L}_A$ + wellfoundedness quantifier) and $\mathcal{L}_{A,G}$ ($\mathcal{L}_A$ + game quantifier) are $\Sigma_1$-compact. These are instances of the following abstract result of Oikkonen (established by abstract methods). Theorem 2 (Oikkonen). If $\mathcal{L}_A$ is $\Sigma_1$-w.f.c. and $\mathcal{L}_A'$ is any logic that is absolute with respect to KP + $\Sigma_1$-separation, then $\mathcal{L}_A'$ is $\Sigma_1$-compact. Further results about $\Sigma_1$-w.f.c. $\mathcal{L}_A$ include: Theorem 3. If $A$ is countable and resolvable, then $\mathcal{L}_A$ is $\Sigma_1$-w.f.c. iff $A$ satisfies $\Pi_2$-reflection. Theorem 4. (a) If $\mathcal{L}_A$ is $\Sigma_1$-w.f.c., then (i) $A$ is stable and (ii) there is $\beta > \alpha$ such that $L_\alpha \prec L_\beta$. (b) If $\alpha \leq \omega_1^L$ or $\forall = L$, then the converse of (a) holds. Let $\alpha^P = \text{least } \beta \text{ s.t. } L_\beta \models \exists \phi (\forall \phi)$ whenever $L \models \exists \phi$ (for all $\phi \in L_1$ over $L_\alpha$). Theorem 5. Let $\alpha \leq \omega_1^L$ or $\forall = L$. The following are equivalent. (a) $\mathcal{L}_A$ is $\Sigma_1$-w.f.c. (b) $\exists \alpha < \omega_1^L$. (c) $\alpha^P$ is not admissible. (d) $\alpha^P$ is not stable. (Received January 8, 1979.)

Equivalence of intuitionistic semantics.

We formulate the usual intuitionistic sentential calculus as a category $S$. At the same time we introduce the concept of an abstract semantical structure and make them into a category $M$. The familiar semantics for intuitionism (e.g. Kripke, Beth, Topological) are then functors from $S$ to $M$, and thus we define a semantics to be any functor $F : S \to M$ (subject to some natural conditions). Two semantics $F, G$, are then defined to be equivalent iff there is a natural equivalence $\sim : F \cong G$. We then consider which of the usual semantics for intuitionism are equivalent. (Received January 10, 1979.)

Scott sentences and admissible sets.

M. Nadel (Annals Math. Logic 7 (1974), 267-294) has shown that an $A$-finite structure $M$, $A$ an admissible set, might have no $A$-finite Scott-sentence; however, it always has one with quantifier-rank $\leq \text{ord}(A) + \omega$. This talk will survey results, some of which are mentioned below, concerning more refined possibilities for the behaviour of Scott-sentences as well as connections of this behavior to questions concerning the number of countable models of theories. The author recently (these Notices, *78T-E82) proved the existence of an $A$-finite structure $M$, for $A = \text{HYP}(\omega)$, such that $M$ has no $A$-finite Scott sentence but its $L_\omega$-theory is categorical. J. Steel has strengthened a theorem essentially due to G. Sacks (cf. the author, Annals Math. Logic, 11 (1977), 1-30) saying that if $\varphi \in L_\omega \omega$ and every model $M$ of $\varphi$ has its canonical Scott-sentence in $\text{HYP}(M)$, then $\varphi$ satisfies Vaught's conjecture. (Received January 11, 1979.)

Recent results and open problems concerning $\mathcal{H}_\omega$-categorical partially ordered sets will be discussed. The emphasis will be on classifying those countable $\mathcal{H}_\omega$-categorical partially ordered sets which have either finitely axiomatizable or decidable theories. (Received January 24, 1979.)

Feferman-Vaught-type theorems for topological logic.

We present some preservation theorems for the language $L_t$ for topological structures. In particular we show: Theorem (a) The topological product preserves $L_t$-equivalence. (b) If $\mathcal{R}$ is a class of topological structures with decidable theory then the class of products of elements of $\mathcal{R}$ is decidable. (Received January 22, 1979.) (Author introduced by Professor H. D. Ebbinghaus).

Stability, Complete Extensions, and the Number of Countable Models.

We present a result concerning theories with a finite number of countable models. Definitions. Fix a complete theory $T$, a non-principal type $\Gamma$ of $T$, and a model $A$ realizing $\Gamma$.
1. \( F^*_\Gamma = \{ \theta(\bar{x}, \bar{y}) | (\bar{x}, \bar{y}) \in \Gamma(\bar{x}) \} \) and \( T \models [\theta(\bar{x}, \bar{y}) \leftrightarrow (\Gamma(\bar{x}) \leftrightarrow \Gamma(\bar{y}))] \)

2. For \( \bar{a}, \bar{b} \in |A|^n \) realizing \( \Gamma \)

\[ \bar{a} \sim_{\Gamma, A} \bar{b} \] there is a \( \theta(\bar{x}, \bar{y}) \in F^*_\Gamma(\bar{x}, \bar{y}) \) such that \( \langle \bar{a}, \bar{b} \rangle \) satisfies \( \theta(\bar{x}, \bar{y}) \) in \( A \).

(Note that \( \sim_{\Gamma, A} \) is an equivalence relation).

Theorem. Let \( T \) be a complete theory with exactly \( p \) countable models up to isomorphism, \( 1 < p < \omega \), such that for every non-principal type \( \Gamma \) of \( T \):

(i) \( \Gamma(\bar{a}) \) as a theory has only finitely many countable models; and

(ii) \( \sim_{\Gamma, A} \) is definable in \( T \).

Then \( T \) is unstable. (Received January 19, 1979.)

764-E9 JOHN S. SCHLIPF, University of Illinois, Urbana, Illinois 61801

Next Admissible Sets and Structures for Infinite Languages. Preliminary report.

The notion of a structure for an infinite recursive language being recursively saturated is obvious. The corresponding notion of next admissible set of ordinal \( \omega \) was more elusive; the study seemed intrinsically tied to finite languages.

Definition: An admissible set \( \langle M; A, E, \sim \rangle \) is for a recursive language if \( \langle M; A, E, \sim \rangle \models \text{KPU} \), each \( R \in A \) is in \( A \), and \( \sim = \{(n,R) : n \in \omega \} \).

Theorem: A structure \( M \) is recursively saturated if and only if there is an admissible set above \( M \) of height \( \omega \).

The theorem generalizes nicely to admissible sets above \( M \) of height \( \alpha \) just as for finite languages. We will discuss briefly generalizations of other nice properties of admissible sets and next admissible sets above structures for finite languages. (Received January 29, 1979.)

764-E10 ROBERT VAUGHT, University of California, Berkeley, California 94720.

\( \mathcal{Q} \) sets in effective spaces.

If \( A_n \subseteq X \) for each \( n \), then the sequence \( \lambda \in A_n \) generates the set \( \mathcal{A} \) of all \( \lambda \in \bigcup_n A_n \) such that each \( \{f(n,m,k) : k \in \omega \} \) is finite and \( f \) is hyperarithmetic. Such an \( X = (X, \mathcal{A}) \) is called a space. If \( (A, A, A, \ldots) \in \mathcal{A} \), \( A \) is called hyper-open and \( -A \) hyper-closed. \( \text{Hyper-G}_0 \) is taken similarly, as by Louveau.

Theorem. (1) Any presentable \( X \) is isomorphic to a subspace of \( \mathbb{H} \). (2) Any presentable subspace of \( \mathbb{H} \) is hyper-G_0 in \( \mathbb{H} \). (3) Any hyper-G_0 subspace of \( \mathbb{H} \) is isomorphic to a hyper-closed subspace of \( R^\omega \). (4) Any normal and hyper-closed subspace of \( R^\omega \) is presentable. Some hyper-G_0 subspaces of \( \mathbb{H} \) are not presentable. But such spaces are still rather good; for example, they clearly satisfy Louveau's Theorem. (Received January 26, 1979.)


We develop theorems in recursive model theory to cover current work in the recursive content of algebra. A recursive atomic presentation (rap) \( \mathcal{U} \) is one with recursive domain \( |\mathcal{U}| \) and satisfaction predicate for atomic formulas. Relation \( R(x) \) on \( \mathcal{U} \) is intrinsically re if there are \( a_1, \ldots, a_n \) from \( |\mathcal{U}| \) and an re sequence of formulas \( \phi_1(x, a_1, \ldots, a_n) \) such that in \( \mathcal{U} \) \( R(x) = \bigwedge \phi_1(x, a_1, \ldots, a_n) \). Simplest theorem. Suppose \( \mathcal{U} \) is rap, \( R(x) \) is recursive, and there is a test whether existential formulas with parameters imply \( R(x) \) in \( \mathcal{U} \). Then there is a
in an isomorphism on $\mathcal{B}$ onto $\mathcal{B}'$ carrying $R$ to $S$ such that: if $R$ is not intrinsically re, then $S$ is not re; if $R$ has no infinite intrinsically re subrelation, then $S$ has no infinite re subrelation. Examples. Recursive $\omega$ orderings with nonrecursive successor, recursive $\omega^*+\omega$ orderings with the $\omega$, $\omega^*$ not re, recursively presented algebraically closed fields of transcendence degree infinite, but with no infinite re independent subset. (Received January 30, 1979.)

**Topology (22, 54, 55, 57, 58)**

### ELDON VOUGHT, California State University, Chico, California, 95929.

**Monotone decompositions of continua.**

Let $M$ be a compact, metric continuum and let $\mathcal{L}$ be a class of subcontinua of $M$. Define a monotone, upper semi-continuous decomposition $D$ of $M$ to be admissible with respect to $\mathcal{L}$ if, given $Y \in \mathcal{L}$, $D \in D$ such that $Y \cap D \neq \emptyset$, then $Y \subseteq D$. The continuum $M$ has a unique minimal (in the sense of refinement) admissible decomposition $D_1$ with respect to $\mathcal{L}$. Of interest here are $\mathcal{L}_1$, the class of layers of irreducible subcontinua of $M$, $\mathcal{L}_2$, the class of indecomposable subcontinua of $M$, and $\mathcal{L}_3$, the class of continua of convergence of $M$. Then the quotient spaces $(M,\mathcal{L}_1)$, $(M,\mathcal{L}_2)$, $(M,\mathcal{L}_3)$ are hereditarily arcwise connected, hereditarily decomposable, and hereditarily locally connected, respectively. Furthermore, if $M$ is a certain type of continuum, e.g. hereditarily unicoherent or atriodic or irreducible, then $\mathcal{L}_1$, $\mathcal{L}_2$, and $\mathcal{L}_3$ are the unique minimal monotone upper semi-continuous decompositions such that $(M,\mathcal{L}_1)$, $(M,\mathcal{L}_2)$, and $(M,\mathcal{L}_3)$ are hereditarily arcwise connected, hereditarily decomposable, and hereditarily locally connected, respectively. Internal characterization of $\mathcal{L}_1$, $\mathcal{L}_2$, and $\mathcal{L}_3$ are established using collections of closed separators (closed sets that separate $M$ with certain properties, and these characterizations describe precisely when the decompositions are non-degenerate. (Received January 8, 1979.)

### DENNIS L. JOHNSON, Jet Propulsion Laboratory, Pasadena, California 91103.

**Conjugacy Relations in Subgroups of the Mapping Class Group and a Group-Theoretic Description of the Rochlin Invariant.**

Let $G$ be the mapping class group of a genus $g$ orientable surface $M$ with one boundary component, and $I$ the subgroup acting trivially on $H_1(M,\mathbb{Z})$. Powell produced a set of generators for $I$; it is the purpose of this paper to determine when two of Powell's generators are conjugate in $I$, or more generally in any subgroup of $G$ containing $I$. This is done by assigning to each of Powell's generators a subspace of $H_1(M,\mathbb{Z})$ such that conjugacy in $I$ is equivalent to equality of the corresponding subspaces. These results are then used to compute a certain commutator quotient of $I$, namely $I/[I_\omega, I]$ where $I_0$ is the subgroup of $G$ fixing a quadratic form $w$ on $H_1(M,\mathbb{Z})$. This quotient is found to be $Z_2$ and $[I_\omega, I]$ to be precisely the kernel of a specific Birman-Craggs homomorphism; in this way we obtain a (non-computational) algebraic characterization of the Rochlin invariant. The corresponding quotient for closed surfaces is also computed and found to be $Z_2$ for forms $\omega$ of zero arf invariant and 0 otherwise. (Received January 15, 1979.) (Author introduced by Professor Hugh M. Hilden).

### NOBUYUKI SATO, The University of Texas, Austin, Texas 78712.

**Alexander polynomials of boundary links.** Preliminary report.

Let $L = \{L_1, \ldots, L_m\}$ be a boundary link of $n$-spheres in $S^{n+2}$. Associated to such a link is a doubly indexed collection $(\Delta_{i,q})$ of polynomials in $m$ variables over $\mathbb{Z}$, where $i \geq 0$, $0 \leq q \leq n$ and $\Delta_{i,q} = 1$ for $i$ sufficiently large. We prove: Theorem. For $1 \leq q \leq n$, the polynomials $\Delta_{i,q}$ satisfy: (a) $\Delta_{i+1,q} | \Delta_{i,q}$ for all $i$, $q$, (b) $\Delta_{i,q}(1,1,\ldots,1) = 1$ for all $i$ if $q > 1$ and for all $i \geq m-1$ if $q = 1$, (c) $\Delta_{i,1} = 0$ for $i \leq m-2$. Conversely, suppose $n > 2$ and $(p_{i,q})$, $i \geq 0$, $0 \leq q \leq \left[\frac{n}{2}\right]$ are integral polynomials in $m$ variables such that $p_{i,q} = 1$ for $i$ sufficiently large and they satisfy (a), (b) and (c) above. Then there exists a boundary link of $n$-spheres in $S^{n+2}$ with these polynomial invariants (through $q = \left[\frac{n}{2}\right]$). The cases $n = 1, 2$ and the case of a simple link of $(2q-1)$-spheres in $S^{2q+1}$ will also be discussed. (Received January 17, 1979.)
ROBERT OLIVER, Stanford University, Stanford, CA 94305. Periodic fixed point free diffeomorphisms of \( \mathbb{R}^n \).

For any \( k > 7 \), \( \mathbb{R}^k \) has a periodic fixed point free diffeomorphism of period \( n \) if and only if \( n \) is not a prime power (this was shown for \( k > 8 \) by Kister (Amer. J. Math. 85, 316-319)). \( \mathbb{R}^6 \) has a periodic fixed point free diffeomorphism of period \( n \) if and only if \( n \) is divisible by at least three distinct primes. This leaves only \( \mathbb{R}^5 \) where it is unknown whether periodic diffeomorphism without fixed points can occur. (The necessity of the conditions on \( n \) described above was shown by P. A. Smith (Bull. A.M.S. 66, 401-415)). (Received January 17, 1979.)

WU-CHUNG HSiang, Princeton University, Princeton, New Jersey 08540, PETER-SIE PAO, University of Georgia, Athens, Georgia 30602. The Homology 3-Spheres with involutions.

Let \( \Sigma \) be a homology 3-sphere which supports an orientation reversing involution. Then \( \Sigma \) bounds an orientable, parallelizable 4-manifold of index zero. Hence its Rochlin invariant \( \mu(\Sigma) = 0 \). (Received January 18, 1979.)

WITHDRAWN

KENNETH C. MILLETT, University of California, Santa Barbara, Cal. 93106. Fibered general position in the smooth category. Preliminary report.

An extension of fibered geometrical techniques in the piecewise linear category, cf. Millett, Piecewise linear concordances and isotopies, Mem. AMS No. 153, will be described. These techniques will then be employed to study the homotopy groups of some spaces of smooth embeddings. (Received January 23, 1979.)

BOHUMIL CENKL and RICHARD PORTER, Northeastern University, Boston, Massachusetts 02115. Differential forms and torsion in the fundamental group.

We give a geometric construction of an inverse of the Campbell-Hausdorff formula for certain groups containing torsion in the quotients by lower central series subgroups. The construction extends the 1-minimal differential graded algebra of Sullivan so that it contains torsion information. (Received January 26, 1979.)

Martin Scharlemann, U. C. Santa Barbara, Santa Barbara, California 93106. Some connections between property \( R \) and the Schoenflies problem.

Lemma: Let \( \mathcal{W} \) be obtained from \( S^1 \times D^2 \) by removing a tubular neighborhood of an arc \( (I, \delta I) \subset (S^1 \times D^2, \partial D^2) \). If \( \mathcal{W} \) is compressible, then there is an imbedding \( h: (D^2, \partial D^2) \rightarrow (\mathcal{W}, \mathcal{W}(S^1 \times \partial D^2)) \) such that \( h(\partial D^2) \) is isotopic in \( S^1 \times \partial D^2 \) to \( (p) \times \partial D^2 \).

Using the lemma we discuss the relation between property \( R \) for Heegaard genus two knots and the Schoenflies problem for smooth 3-spheres admitting a genus two splitting in \( \mathbb{R}^n \). (Received January 29, 1979.)

JAMES M. VAN BUSKIRK, University of Oregon, Eugene, OR 97402. Determinants of strongly amphicheiral knots are squares.

A strongly amphicheiral knot \( K \) (invariant under reflection in a point \( p \notin K \)) has an Alexander polynomial of the form \( A(t) = \begin{vmatrix} A(t) & B(t) \\ B(t^{-1}) & A(t^{-1}) \end{vmatrix} \).
where the transposes of $A(t)$ and $B(t)$ are $A(t^{-1})$ and $-B(t)$.

It follows that $\Delta(t)$ is a square in $\mathbb{Z}[t,1/t]/(t^2-1)$ and that $\Delta(-t)$ is a square.

Of the 20 classical ($\leq 10$ crossing) amphicheiral knots, each of which is strongly amphicheiral $(p \in K)$, only 3 satisfy the determinant condition: the knots $10_3$ and $10_{38}$ (Conway's $2.2.20.20$ and $10^6$), which (as closures of the braids $\sigma_1^2 \sigma_2^2 \sigma_1^{-1} \sigma_2^{-1} \sigma_1 \sigma_2^{-1}$ and $\sigma_1^2 \sigma_2^{-1} \sigma_1 \sigma_2$) are indeed strongly amphicheiral, and $8_9$, which R. Hartley and A. Kawauchi report is not. Others (of the 13 known to be invertible) are rigidly amphicheiral of period $2^n$ (invariant under a rotation of $2^{n+1}$ composed with a reflection in a plane normal to the axis of rotation, $n$ minimal; so strongly amphicheiral knots are rigidly amphicheiral of period 1). For example, $6_3$ and $8_18$ (as closed braids $(\sigma_1^2 \sigma_2 \sigma_3 \sigma_4 \sigma_1^{-1} \sigma_2^{-1} \sigma_3^{-1} \sigma_4^{-1})^2$ and $(\sigma_1 \sigma_2^{-1} \sigma_1 \sigma_2 \sigma_3 \sigma_4)^4$) are rigidly amphicheiral; the former of period 2, the latter likely of period 4. (Received January 29, 1979.)

A pseudo-free circle action on a homotopy sphere is a circle action such that all orbits are 1-dimensional and the exceptional orbits are isolated. The work of Montgomery-Yang-Petrie shows that there are many non-linear smooth pseudo-free circle actions on homotopy $(2k+1)$-spheres, $k \geq 3$, and it is known that any pseudo-free circle action on a homotopy 3-sphere is equivalent to a linear action. The only known smooth pseudo-free circle actions on $S^5$ are the linear ones with $\leq 3$ exceptional orbits. In this talk we construct for any $k \geq 1$ topological pseudo-free circle actions on $S^5$ with $k$ exceptional orbits and with one wild orbit which can be either principal or exceptional. We also construct free topological circle actions on $S^5$ whose orbit space is a polyhedral homotopy $\mathbb{C}P^2$ with one singularity. (Received January 30, 1979.)

A theorem of Bott is generalized to include the nonsmooth case. (Received January 30, 1979.)

Recent results of Thurston-Bass-Shalen on the existence of closed incompressible surfaces in knot complements, together with an equivariant version of the loop theorem-Dehn lemma, recently proved by Meeks-Yau, imply that if $K$ is a knot in a homotopy 3-sphere $M$ which is the fixed-point set of a smooth periodic homeomorphism of $M$, then $K$ is unknotted (i.e. bounds a smooth disc). (Received January 30, 1979.)

A theorem of Bott on smooth circle group actions is generalized to include the nonsmooth case. (Received January 30, 1979.)

Every closed oriented 3-manifold is the graph of a multivalued (actually 3-valued) function from $S^3$ to $S^2$. This observation follows from a theorem relating embeddings of 3-manifolds to branched covering spaces of 3-manifolds. (Received January 30, 1979.)

$\pi$ is a group, $M$ is a $\mathbb{Z}\pi$-module and $n$ is an integer $> 1$ and equivariant Moore space of type $(M, n; \pi)$ is a topological space $X$ with the following properties: (1) $\pi_1(X) = \pi$; (2) $H_1(\tilde{X}) = \mathbb{Z}$, $i \neq 0$, $n$; (3) $H_0(\tilde{X}) = \mathbb{Z}_n$; (4) $H_n(\tilde{X}) = M$. Here $\tilde{X}$ is the universal covering space of $X$ and the action of $\mathbb{Z}\pi$ on $H_n(\tilde{X})$ must agree with
its action on $M$. Steenrod proposed the problem of determining for which $M, n$ and $\tau$ such spaces exist. The present paper develops an obstruction theory for the existence of such spaces and shows that in some cases (which include all known examples) the obstructions vanish. (Received January 30, 1979.)

764-G17 ROBERT LITTLE, University of Hawaii, Honolulu, Manoa, Hawaii 96822. Minimal immersions of low dimensional manifolds.

An integral obstruction in dimension four to stable bundle isomorphism is computed and application made to problems of immersing manifolds of dimension $\leq 7$ into Euclidean space. (Received January 30, 1979.)

Miscellaneous

764-H1 HENRY A. DYE, Department of Mathematics, University of California, Los Angeles, Los Angeles, California 90024. Orbit equivalence in ergodic theory.

Two measurable invertible nonsingular transformations of a Lebesgue space are called orbit equivalent if there exists an automorphism of that space intertwining almost all orbits of the two transformations. This expository address presents Krieger's classification of such transformations under orbit equivalence along with related results of K. Schmidt, Ornstein, Weiss, and others. (Received January 30, 1979.)

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Bryn Mawr College has openings for two regular positions in mathematics to begin September 1979, one at the rank of Associate Professor, the other at the rank of Assistant Professor. Candidates should have distinguished records and be committed to research in pure or applied mathematics and to excellence in teaching at all levels. Women and minority candidates are encouraged to apply. Send applications as soon as possible, and not later than March 32, with vita and three letters of recommendation to: F. Cunningham, Jr., Chairman, Department of Mathematics, Bryn Mawr College, Bryn Mawr, Pennsylvania 19010, Bryn Mawr College is an Equal Opportunity/Affirmative Action Employer.

CHAIRPERSON

DEPARTMENT OF STATISTICS

The UNIVERSITY OF WASHINGTON is in the process of establishing a Department of Statistics, with an initial faculty of (about) five, largely made up of statisticians from within existing departments (Mathematics, Biostatistics, and Social Science departments). The position requires a statistician with a distinguished record of research, teaching and administration to help develop and chair the new department, starting September, 1979. Applicant should send curriculum vita, selected reprints/preprints and four letters of recommendation by March 31, 1979 to Associate Dean Paul Hodge, College of Arts and Sciences GN-15, University of Washington, Seattle, Washington 98195.

AA/EOE

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The State University of New Jersey

Applications are invited especially in the fields of applied mathematics, topology, or algebraic geometry. The candidate must have Ph. D., show outstanding promise in research and a concern for teaching. Inquiries should be directed to: Daniel Gorenstein, Chairman Department of Mathematics at New Brunswick Rutgers University, The State University of New Jersey New Brunswick, New Jersey 08903 Rutgers University is an Equal Opportunity/Affirmative Action Employer.

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The State University of New Jersey

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HEAD, DEPARTMENT OF MATHEMATICS
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The Department of Mathematics and Statistics of the UNIVERSITY OF MASSACHUSETTS AT AMHERST expects to have positions available for the academic year 1979-1980. These positions include a junior level tenure track position in statistics, and a junior level 2- or 3-year visiting position in applied mathematics which may lead to a tenure track position. In addition, another junior level appointment in statistics may be possible.

Resume, 3 letters of recommendation and graduate transcripts should be sent to Professor E. A. Connors, Head, Department of Mathematics and Statistics, Graduate Research Tower, University of Massachusetts, Amherst, MA 01003. The University is an Affirmative Action/Equal Opportunity Employer.

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CHAIRMAN
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AND STATISTICS

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Professor Peter Pesch
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Department of Mathematics and Statistics
Case Western Reserve University
Cleveland, OH 44106

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Department of Mathematics
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Please send resumes and have three letters of recommendations sent to:

James A. Donaldson, Chairman
Mathematics Department
Howard University
Washington, D.C., 20059

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Albion, Michigan

Applications are invited for a tenure-track position in the Mathematics Department at the Assistant Professor level starting in August, 1979. Responsibilities include teaching three courses per semester plus the usual participation in departmental and college affairs. Should have a Ph.D. in Mathematics with work and/or experience in statistics, computers and applications. Salary negotiable.

Send inquiries and/or credentials to Professor W. K. Moore, Department of Mathematics, Albion College, Albion, MI 49224, AA/EOE.

ALBION COLLEGE
Albion, Michigan

POSITIONS AVAILABLE

CHAIRPERSON - DEPARTMENT OF MATHEMATICS
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Applicants must have an earned doctorate, teaching experience within a college mathematics department and a record of mathematical research. Administrative experience is preferred. The position is at the rank of Associate Professor and is available August, 1979 contingent upon funding. The Department has 15 faculty members. It grants the BA and MA degrees in mathematics and offers a wide variety of service courses. Applied mathematics and statistics options for the masters program are under development. By March 2, 1979 a resume should be sent to Professor David Cusick, Search Committee, Department of Mathematics, Marshall University, Huntington, WV 25701. Late applications may be considered if the position is unfilled. Marshall University is an Equal Opportunity/Affirmative Action Employer.

OLD DOMINION UNIVERSITY anticipates appointing up to three FULL PROFESSORS for 1 August 1979, including (1) Full Professor of Applied Mathematics; (2) Full Professor of Numerical Analysis; and, (3) Full Professor of Computer Science. Applicants should have an outstanding research record. For the applied math position, solid mechanics is the preferred research area. Applicants in computer science should be compatible with an applied math department. Closing date is 15 March 1979 and bi-weekly thereafter until positions are filled. Send vitae and three letters of reference to: Dr. W. D. Lakin, Department of Mathematics & Computing Sciences, Old Dominion University, Norfolk, VA 23508. AA/EEO.

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Proceedings of the International Conference held in Khartoum, 6-9 March, 1978

edited by M.E.A. EL TOM, Reader in Mathematics, Khartoum University, Sudan.

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