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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 the 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 *supplementary* announcements of the meetings will have appeared in earlier issues.

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MEETING #	DATE	PLACE	ABSTRACT DEADLINE	ISSUE
821	August 12–15, 1985 (89th Summer Meeting)	Laramie, Wyoming	May 28	August
822	October 26–27, 1985	Amherst, Massachusetts	August 19	October
823	November 1–2, 1985	Columbia, Missouri	August 21	October
824	November 8–9, 1985	Claremont, California	August 26	October
825	January 7–11, 1986 (92nd Annual Meeting)	New Orleans, Louisiana	October 16	January
	April 11–12, 1986	Indianapolis, Indiana		
	October 10–11, 1986	Logan, Utah		
	January 21–25, 1987 (93rd Annual Meeting)	San Antonio, Texas		
	January 6–11, 1988 (94th Annual Meeting)	Atlanta, Georgia		
	August 8–12, 1988 (AMS Centennial Celebration)	Providence, Rhode Island		
	January 11–15, 1989 (95th Annual Meeting)	Phoenix, Arizona		

DEADLINES: Advertising (*August* 1985 *Issue*) *June* 24, 1985 (*October* 1985 *Issue*) *Sept.* 24, 1985
News/Special Meetings (*August* 1985 *Issue*) *May* 23, 1985 (*October* 1985 *Issue*) *Aug.* 19, 1985

Other Events Sponsored by the Society

May 27, 1985, Symposium on Some Mathematical Questions in Biology, Plant Biology, Los Angeles, California.

June 23–August 31, 1985, Joint Summer Research Conferences in the Mathematical Sciences, Humboldt State University, Arcata, California.

June 30–July 13, 1985, AMS-SIAM Summer Seminar on Reacting Flows: Combustion and Chemical Reactors, Cornell University, Ithaca, New York.

July 8–26, 1985, AMS Summer Research Institute on Algebraic Geometry, Bowdoin College, Brunswick, Maine.

August 10–11, 1985, AMS Short Course; Actuarial Mathematics, Laramie, Wyoming.

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Combinatorics and Topology

by Anders Björner

> I would rather schematize the structure of mathematics by a complicated graph, where the vertices are the various parts of mathematics and the edges describe the connections between them. These connections sometimes go one way, sometimes both ways, and the vertices can act both as sources and sinks. The development of the individual topics is of course the life and blood of mathematics, but, in the same way as a graph is more than the union of its vertices, mathematics is much more than the sum of its parts. It is the presence of those numerous, sometimes unexpected edges, which makes mathematics a coherent body of knowledge, and testifies to its fundamental unity. A. Borel [8]

> I have the feeling that we don't understand at all the extraordinary interplay of combinatorics and what I would call "conceptual" mathematics. J. Dieudonné [11]

Since the creation of the field of topology at the turn of the century, there has existed a potent but often elusive force-field between topological and combinatorial ideas. This can perhaps be seen as one instance of the fertile polarity between the *continuous* and the *discrete*, which pervades much mathematical thought. As is well known [2], the combinatorial method in topology dates back to Poincaré's famous *Analysis situs* papers of 1895 and 1899, which mark the beginning of topology as an autonomous field. Less familiar and much more recent is the use of topological methods for solving problems in combinatorics. The connection established by traditional combinatorial topology was of course originally created as a "one way edge", intended only for topological purposes. The aim of this article is to draw attention to the fact that this "edge" can be profitably used also in the opposite direction. Some examples will be discussed which illustrate different uses that topology has lately found in combinatorics.

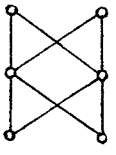
1. It will be assumed that the reader has a nodding acquaintance with the basic ideas of combinatorial topology. Of particular importance here will be the (abstract) *simplicial complex* C and its *topological realization* $|C|$. Also, some elementary use of the concepts of homology and homotopy will be made.

In many parts of combinatorics the fundamental objects of study are themselves, or are else related to, structured families of subsets of some finite set. One can then often associate a simplicial complex, usually in several ways. This will be the main link to topology considered here. It should be mentioned that some combinatorial contexts naturally suggest other topological constructions, such as convex cell complexes, regular CW complexes, or finite topological spaces.

Let us look at an example. Suppose that P is a *poset* (short for partially ordered set). There are two standard ways of forming a topological space from P. Both date back at least to Aleksandrov [1].

(1) Define a topology directly on the ground set P by letting all *hereditary* subsets I (i.e., subsets $I \subseteq P$ such that $x \leq y \in I$ implies $x \in I$) be the open sets. Denote this space by $T(P)$.

(2) Define a simplicial complex $C(P)$ on the vertex set P by letting all finite *chains* (totally ordered subsets) be the faces. For instance, consider the following poset P:



Here $T(P)$ is a finite topological space with precisely ten open sets. On the other hand, $C(P)$ is homeomorphic to the 2-dimensional sphere (combinatorially, $C(P)$ is isomorphic to the boundary of an octahedron). Judging from such finite examples, one might think that, in general, the spaces $T(P)$ and $C(P)$ are totally unrelated topologically. Surprisingly, this is not the case. The mapping $|C(P)| \to T(P)$, which sends each $x \in |C(P)|$ to the least element in its carrier chain, was shown by McCord [17] to be a weak homotopy equivalence. This means, in particular, that $C(P)$ and $T(P)$ have isomorphic homotopy groups and isomorphic singular homology groups in all dimensions. Incidentally, the poset depicted above could also be interpreted as describing the incidence relations of the six cells in the minimal regular CW decomposition of the 2-dimensional sphere.

Once a simplicial complex C has been identified in a given combinatorial context, there is a ready machinery at our disposal inherited from combinatorial topology: an associated space $|C|$, homology groups, homotopy properties, and so on. In one sense this situation is simpler than when the

same machinery is applied to topological spaces, since no uniqueness problems arise. Everything is given in terms of a fixed simplicial complex. The difficulty, of course, lies in assessing whether the topology of some simplicial complex is likely to be at all relevant for a given combinatorial problem. This question brings us to the main part of this article: the discussion of specific combinatorial examples in the following three sections.

2. Complexity of graph properties. Recall that a *graph* $G = (V, E)$ consists of a finite set V of *vertices* and a set $E \subseteq V^{(2)} = \{A \subseteq V \mid \operatorname{card} A = 2\}$ of *edges*. By a *graph property* we shall understand a property which is isomorphism invariant: if $G_1 \cong G_2$ then G_1 has the property if and only if G_2 does. The following discussion will usually concern graphs having some fixed vertex set V. These graphs can then simply be identified with the various subsets of $V^{(2)}$. Also, it is convenient to identify a graph property with the subset of the power set $2^{V^{(2)}}$ which consists of all graphs having the property.

The problem we are going to discuss has its origin in the area of combinatorial algorithms. Consider algorithms which test whether graphs G on n vertices have a certain property $\mathcal{P}$ (such as, say, planarity). It is known that the efficiency of such algorithms in many cases (e.g., for planarity) depends on the choice of graph representation (or data structure). For a given representation of G it is, in this context, relevant to ask how much of the total information which it provides about G is actually needed in the worst case to decide whether $G \in \mathcal{P}$.

A very common way of representing a graph G is via its *adjacency matrix*. This is a $(0,1)$-matrix whose rows and columns are indexed by V and whose 1-entries are in precisely those positions which correspond to edges of G. In terms of this representation the basic question becomes how many entries in the adjacency matrix of G must be inspected in the worst case to decide whether $G \in \mathcal{P}$.

It is helpful to approach this question in game-theoretic terms. Suppose that we are to play the following game with the Devil. A specific graph property $\mathcal{P} \subseteq 2^{V^{(2)}}$ has been chosen, and we are expected to figure out whether a graph $G \subseteq V^{(2)}$, known to the Devil but not to us, has property $\mathcal{P}$. We are allowed to ask questions such as "Is $\{u, v\}$ an edge of G?" to which the Devil will answer "yes" or "no". Our aim is to decide with as few questions as possible whether G has property $\mathcal{P}$. The Devil, of course, will do his best to keep us asking as long as possible. Assuming that both sides play optimally, the total number of questions asked will be called the *complexity* of $\mathcal{P}$, written $c(\mathcal{P})$. Clearly, if $\operatorname{card} V = n$, then $0 \leq c(\mathcal{P}) \leq \binom{n}{2}$. The properties of complexity 0 are called *trivial*. They are properties which all graphs have or which no graphs have. The properties of maximum complexity $\binom{n}{2}$, on the other hand, are at the center of attention. For them no algorithm can be guaranteed to perform with less than complete information about the graph. Such properties are called *evasive*.

Let us call a graph property $\mathcal{P} \subseteq 2^{V^{(2)}}$ *monotone* if it is preserved under deletion of edges; i.e., if $G = (V, E), G' = (V, E')$, and $E \subseteq E' \in \mathcal{P}$ implies $E \in \mathcal{P}$. For instance, being circuit-free or planar are monotone properties. Testing for the negation of a property $\mathcal{P}$ obviously has the same complexity as testing for $\mathcal{P}$, so it is reasonable to also call monotone those properties which are preserved under addition of edges; e.g., being connected or having chromatic number $\geq k$.

Work by several authors over the last fifteen years has led to the

EVASIVENESS CONJECTURE. *Every nontrivial monotone graph property is evasive.*

For references and a thorough discussion of work in this area, see Chapter 8 of [7].

Our purpose in this section is to discuss the interesting recent work of J. Kahn, M. Saks, and D. Sturtevant [13] and, in particular, the following result.

THEOREM. *The evasiveness conjecture is true for properties of graphs on a prime-power number of vertices.*

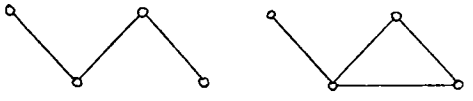
The proof of Kahn, Saks, and Sturtevant uncovers certain topological information, which is inherent in the situation. This information is then used to sanction the application of a pertinent theorem about stationary points of simplicial group actions. Here is an outline of their argument.

Suppose that $\operatorname{card} V = p^k, p$ prime, and that $\mathcal{P} \neq \emptyset$ is a monotone nonevasive graph property. $\mathcal{P}$ is a family of subsets of $V^{(2)}$ closed under the formation of subsets—i.e., a simplicial complex. We want to draw the conclusion that $\mathcal{P}$ is a trivial property, which, since $\mathcal{P} \neq \emptyset$, must mean that $V^{(2)} \in \mathcal{P}$: i.e., topologically $\mathcal{P}$ is a simplex. The cornerstones of the proof are the following two facts, which we will later comment on separately: (α) *The topological space $|\mathcal{P}|$ is contractible.* (β) *There exists a group Γ of simplicial automorphisms of $\mathcal{P}$ which acts transitively on $V^{(2)}$ and which has a normal p-subgroup Γ_1 such that Γ/Γ_1 is cyclic.* Taking these facts momentarily for granted, we can call on the following theorem of R. Oliver [18]: *Any action of a finite group Γ, having a subgroup Γ_1 with the stated properties, on a finite $\mathbb{Z}_p$-acyclic complex must have stationary points.* This means in our situation that there exists some point $x \in |\mathcal{P}|$ such that $\gamma(x) = x$ for all $\gamma \in \Gamma$. The point x is carried by the relative interior of a unique face $A \in \mathcal{P}$, and the fact that x is stationary implies that $\gamma(A) = A$ for all $\gamma \in \Gamma$. But since Γ is transitive on $V^{(2)}$, this is impossible unless $A = V^{(2)}$. Hence, $V^{(2)} \in \mathcal{P}$, and we are done.

The group Γ is constructed as follows. Identify V with the finite field $\mathrm{GF}(p^k)$. Let $\Gamma = \{x \mapsto ax+b \mid a,b \in \mathrm{GF}(p^k), a \neq 0\}$ and $\Gamma_1 = \{x \mapsto x+b \mid b \in \mathrm{GF}(p^k)\}$. Now, define a mapping $\phi : \Gamma \to \mathrm{GF}(p^k)^*$ by $\phi(x \mapsto ax+b) = a$ to see that $\Gamma_1 = \mathrm{Ker}\,\phi$ is a normal p-subgroup and that $\Gamma/\Gamma_1 = \mathrm{GF}(p^k)^*$. Then use the well-known fact that the multiplicative group of a finite field is cyclic. Finally, check that Γ is doubly transitive on $V = \mathrm{GF}(p^k)$, and hence transitive on $V^{(2)}$. The assumption that $\mathcal{P}$ is an isomorphism-invariant property of graphs on V means that if γ is any permutation of V—in particular, if $\gamma \in \Gamma$—then $A \in \mathcal{P}$ if and only if $\gamma(A) \in \mathcal{P}$. Hence, Γ is a group of simplicial automorphisms of $\mathcal{P}$ having the properties claimed in part (β).

It remains to discuss part (α) of the proof: namely, that $|\mathcal{P}|$ is contractible and therefore, in particular, $\mathbb{Z}_p$-acyclic. As the attentive reader must suspect, this is the place where the assumption that $\mathcal{P}$ is nonevasive is used. The relationship between nonevasiveness (an algorithmic property) and contractibility (a topological property) turns out to be of a very general nature. It is most clearly formulated in the setting of general simplicial complexes.

Suppose that $\mathcal{C}$ is a finite simplicial complex on the vertex set W. Does there exist an algorithm that, in the worst case, decides membership in $\mathcal{C}$ for subsets A of W without having complete information about which elements belong to A? In analogy with our earlier discussion, we can approach this question by letting $\mathcal{C}$ define a game that is to be played with the Devil. Again, we are allowed to ask questions for all $v \in W$, such as, "Is v an element of A?", with the goal to decide as soon as possible whether $A \in \mathcal{C}$. If the Devil, answering only "yes" or "no", can force us, no matter how skillfully we play, to ask all $\mathrm{card}\, W$ possible questions, we say that the complex $\mathcal{C}$ is *evasive*. For instance, consider the following one-dimensional complexes. It is easy to find an algorithm for us showing that the left complex is nonevasive, and a strategy for the Devil showing that the right complex is evasive.



Now recall the following auxiliary definitions from combinatorial topology. A vertex v in a complex $\mathcal{C}$ determines the subcomplexes *deletion*, $\mathrm{dl}_{\mathcal{C}}(v) = \{A \in \mathcal{C} \mid v \notin A\}$, *link*, $\mathrm{lk}_{\mathcal{C}}(v) = \{A \in \mathcal{C} \mid v \notin A,\ A \cup \{v\} \in \mathcal{C}\}$, and *star*, $\mathrm{st}_{\mathcal{C}}(v) = \{A \in \mathcal{C} \mid A \cup \{v\} \in \mathcal{C}\}$. Clearly, $\mathcal{C} = \mathrm{dl}_{\mathcal{C}}(v) \cup \mathrm{st}_{\mathcal{C}}(v)$ and $\mathrm{dl}_{\mathcal{C}}(v) \cap \mathrm{st}_{\mathcal{C}}(v) = \mathrm{lk}_{\mathcal{C}}(v)$. Define recursively a class **NE** of finite simplicial complexes as follows: (1) Every singleton vertex lies in **NE**. (2) If v is a vertex of $\mathcal{C}$ and $\mathrm{dl}_{\mathcal{C}}(v), \mathrm{lk}_{\mathcal{C}}(v) \in \mathbf{NE}$, then $\mathcal{C} \in \mathbf{NE}$. It is easy to prove by induction on the size of vertex sets that **NE** coincides with the class of all nonevasive complexes. Briefly, the underlying idea is that the element v in the definition of **NE** is the counterpart of a good opening question to ask the Devil. Using this characterization it is quite plain how to prove that nonevasive complexes are contractible. By induction we may assume that $\mathrm{dl}_{\mathcal{C}}(v)$ and $\mathrm{lk}_{\mathcal{C}}(v)$ are contractible. Hence, from the topological point of view, we form $\mathcal{C}$ by gluing together two contractible complexes $\mathrm{dl}_{\mathcal{C}}(v)$ and $\mathrm{st}_{\mathcal{C}}(v)$ (which is a cone) along their contractible intersection $\mathrm{lk}_{\mathcal{C}}(v)$. A simple topological lemma then implies the contractibility of $\mathcal{C}$. A noteworthy reformulation is that any compact triangulable space of nontrivial homotopy type guarantees a winning strategy for the Devil in every game that it defines.

Further progress along topological lines could possibly result from work on the following conjecture of Kahn, Saks and Sturtevant: *A nonevasive simplicial complex whose automorphism group acts transitively on the vertices must be a simplex.* It should be clear from the preceding discussion that an affirmative solution would imply the full truth of the evasiveness conjecture for graphs.

3. Fixed points in ordered sets. A mapping $f : P \to Q$ of posets is called *monotone* if $x \leq y$ implies $f(x) \leq f(y)$ for all $x, y \in P$; it is an *endomorphism* if, in addition, $P = Q$. It is natural to say that a poset P has the *fixed point property* if every endomorphism $f : P \to P$ has a fixed point $x = f(x)$. *Which posets have the fixed point property?* A complete answer to this question, posed by Crawley and Dilworth [**10**] and others, seems today to be just as elusive as an answer to the corresponding question for topological spaces [**5**]. Incidentally, the fixed point question for posets is just a special case of the topological fixed point question, which can easily be seen by passing to the associated spaces $T(P)$ defined in §1. However, it is not this connection with topology that has led, or is likely to lead, to progress in the discrete case.

Let us restrict the discussion here to finite lattices. Recall that a *lattice* is a poset for which every pair of elements x and y has a greatest lower bound $x \wedge y$ and a least upper bound $x \vee y$. In a finite lattice L there are special elements $0 = \wedge L$ and $1 = \vee L$ such that $0 \leq x \leq 1$ for all $x \in L$. If $f : L \to L$ is monotone, then $0 \leq f(0) \leq f^2(0) \leq f^3(0) \leq \cdots$. This chain must eventually become stationary, and this will happen at a fixed point. Hence, *every finite lattice has the fixed point property.* This conclusion is a special case of a fixed point theorem due to Tarski [**10**, p. 16].

To avoid that fixed points in L are trivially induced by the existence of 0 and 1 as in the preceding argument, we shall pay closer attention to the restricted poset $\overline{L} = L - \{0,1\}$. This *proper part* $\overline{L}$ of a finite lattice may or may not have the fixed point property. It is of interest also from the point of view of lattice automorphisms to consider $\overline{L}$, since $f(0) = 0, f(1) = 1$, and $f(\overline{L}) = \overline{L}$

for all automorphisms f of L. In this respect the situation is analogous to that in group theory, where by a "fixed point free automorphism" of a group G is naturally understood one lacking fixed points in $G-\{e\}$.

Suppose L is a finite lattice and $x \in L$. Then $y \in L$ is said to be a *complement* of x, written $x \perp y$, if $x \wedge y = 0$ and $x \vee y = 1$. Let $\perp(x) = \{y \in L \mid x \perp y\}$. The lattice L is called *complemented* if $\perp(x) \neq \emptyset$ for all $x \in L$.

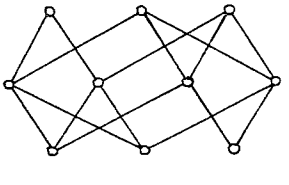
The following connection between complements and fixed points was found by Baclawski and Björner [3]. A stronger version, showing, in particular, that only a minor part of the full lattice property is really needed for this result, was later given by Björner and Walker [6].

THEOREM. *Let L be a finite lattice and $x \in \overline{L}$. Then $\overline{L} - \perp(x)$ has the fixed point property. In particular, if L is noncomplemented, then $\overline{L}$ has the fixed point property.*

For an easily available example consider the Boolean lattice $\mathbf{2}^A$ of all subsets of a finite set A, $\operatorname{card} A \geq 2$. Any circular permutation of A induces a fixed point free automorphism of the proper part $\overline{\mathbf{2}^A}$. However, by the theorem the removal of any one element from $\overline{\mathbf{2}^A}$ results in a poset with the fixed point property.

The proof uses topology in the following way. For any finite poset P let $\mathcal{C}(P)$ be the simplicial complex on the vertex set P whose faces are the chains $y_0 < y_1 < \cdots < y_k$ (as in §1). One shows that (α) *$\mathcal{C}(\overline{L} - \perp(x))$ is contractible*; and (β) *for any finite poset P if $\mathcal{C}(P)$ is $\mathbb{Q}$-acyclic, then P has the fixed point property.*

Part (β) is a discrete variant of the Lefschetz fixed point theorem. The order structure and monotonicity of P and its maps play a role here; the principle cannot be entirely reduced to mere simplicial complexes and maps. An analysis of the situation based on the Hopf trace formula will in fact show that the fixed point sets $P^f = \{x \in P \mid f(x) = x\}$ have more structure than just being nonempty. Let $\chi(P^f)$ denote the Euler characteristic of $\mathcal{C}(P^f)$—i.e., the number of chains in P^f of even length minus the number of chains of odd length. One finds that $\chi(P^f) = 1$ *for every endomorphism f of a $\mathbb{Q}$-acyclic finite poset P.* This stronger combinatorial property is quite special, as is shown, e.g., by the following poset P, which has the fixed point property, but for which $\chi(P^f) \neq 1$ for all four automorphisms f.



Part (α), showing that $\mathcal{C}(\overline{L} - \perp(x))$ is contractible, is rather more technical [6] and will not be discussed here. Let it suffice to suggest the plausibility of such a result by a vague analogy. The complements of x are in some sense the points "furthest away" from x in the space $|\mathcal{C}(\overline{L})|$. Hence, one is reminded of situations where a metric space of finite diameter can be contracted along geodesics once the points at maximal distance from some given point x have been removed.

The proof of this theorem does not generalize beyond the finite case, since the Hopf-Lefschetz argument is intrinsically finite. However, no counterexample is known to the conjecture that the condition "finite lattice" can be relaxed to "lattice of finite length".

4. Extremal set theory. Consider the collection of all n-element subsets of a $(2n+k)$-element set, $n \geq 1, k \geq 0$. It is an easy combinatorial exercise to partition this collection into $k+2$ classes so that every pair of n-sets within the same class has nonempty intersection. Can the same be done with only $k+1$ classes? M. Kneser conjectured in 1955 that the answer is no. This conjecture was confirmed more than twenty years later by L. Lovász [15].

THEOREM. *If the n-subsets of a $(2n+k)$-element set are partitioned into $k+1$ classes, then some class will contain a pair of disjoint n-sets.*

In preparation for a discussion of Lovász's proof, it is useful to consider a reformulation. Recall that a graph is said to be *k-colorable* if it is possible to assign k different colors to the vertices in such a way that no edge connects vertices of the same color. Now define a graph $KG_{n,k}$ as follows: The vertices are the n-subsets of some fixed set of cardinality $2n+k$; the edges are formed by the disjoint pairs of n-sets. Then the theorem can be concisely reformulated: *The graph $KG_{n,k}$ is not $(k+1)$-colorable.*

A few more auxiliary definitions are needed. For any finite graph $G = (V, E)$ let $\mathcal{N}(G)$ denote the simplicial complex, called the *neighborhood complex*, whose simplices are the subsets $A \subseteq V$ such that all elements have a common neighbor (i.e., $A \in \mathcal{N}(G)$ if and only if there exists $v \in V$ such that $\{v, a\} \in E$ for all $a \in A$). Let $S^d = \{x \in \mathbb{R}^{d+1} \mid \|x\| = 1\}$ and $B^d = \{x \in \mathbb{R}^d \mid \|x\| \leq 1\}$ denote the standard *d-dimensional sphere* and *ball*, respectively. Finally, recall that a topological space T is said to be *k-connected* if every continuous mapping $S^d \to T$ can be continuously extended from S^d across the interior of the $(d+1)$-dimensional ball B^{d+1} for $d = 0, 1, \ldots, k$.

Lovász's proof is the conjunction of the following independent parts: (α) *$\mathcal{N}(KG_{n,k})$ is $(k-1)$-connected*; and (β) *for any finite graph G, if $\mathcal{N}(G)$ is $(k-1)$-connected, then G is not $(k+1)$-colorable.* The second part, establishing a surprising connection between a topological property of $\mathcal{N}(G)$ and a combinatorial property

of G, is of principal interest, as is the functorial argument (due to Lovász (unpublished notes) and Walker [**20**]) by which it can be derived from the Borsuk-Ulam theorem of algebraic topology. We shall limit the discussion here to an outline of these ideas, setting aside the more special part (α).

Let $G=(V,E)$ be a finite graph. The mapping $\nu : \mathcal{N}(G) \to \mathcal{N}(G)$ defined by $\nu(A) = \{v \in V \mid \{v,a\} \in E \text{ for all } a \in A\}$ has the properties (i) $A \subseteq B$ implies $\nu(A) \supseteq \nu(B)$, and (ii) $\nu^2(A) \supseteq A$. Let $\tilde{\mathcal{N}}(G)$ denote the chain complex $\mathcal{C}(\cdot)$ (in the sense defined in §§1 and 3) of the poset of fixed points of ν^2 ordered by containment. Thus, $\tilde{\mathcal{N}}(G)$ is a subcomplex of the barycentric subdivision of $\mathcal{N}(G)$. In fact, the subspace $|\tilde{\mathcal{N}}(G)|$ is a strong deformation retract of $|\mathcal{N}(G)|$, so $\tilde{\mathcal{N}}(G)$ and $\mathcal{N}(G)$ are of the same homotopy type. This construction is illustrated below, where part (a) shows a graph G, (b) the neighborhood complex $\mathcal{N}(G)$, (c) its barycentric subdivision, and (d) the retract complex $\tilde{\mathcal{N}}(G)$.

A few more definitions are needed at this point. Suppose that T is a topological space and $\nu : T \to T$ is a continuous mapping such that $\nu(x) \neq x$ for all $x \in T$ and ν^2 equals the identity. Then the pair (T,ν) is called an *antipodality space*. The canonical example is (S^d,α), the standard d-sphere with its antipodal map $x \mapsto -x$. A map $f : T_1 \to T_2$ between antipodality spaces $(T_i,\nu_i), i = 1,2$, is *equivariant* if $\nu_2 \circ f = f \circ \nu_1$. By a *graph map* $g : G_1 \to G_2$ of graphs $G_i = (V_i,E_i), i = 1,2$, we will understand a mapping $g : V_1 \to V_2$ such that $\{u,v\} \in E_1$ implies $\{f(u),f(v)\} \in E_2$ for all $u,v \in V_1$.

Property (i) of the mapping $\nu : \mathcal{N}(G) \to \mathcal{N}(G)$, which was stated above, shows that ν restricts to a simplicial mapping $\nu : \tilde{\mathcal{N}}(G) \to \tilde{\mathcal{N}}(G)$, and from property (ii) it follows that $\nu^2 =$ identity. Hence, $(\tilde{\mathcal{N}}(G),\nu)$ (or, to be precise, $(|\tilde{\mathcal{N}}(G)|,|\nu|)$) is an antipodality space. Furthermore, it can be shown that every graph map $g : G_1 \to G_2$ induces an equivariant map $\tilde{g} : \tilde{\mathcal{N}}(G_1) \to \tilde{\mathcal{N}}(G_2)$. As these facts suggest, the construction $\tilde{\mathcal{N}}(\cdot)$ actually sets up a functor from the category of finite graphs and graph maps to the category of antipodality spaces and homotopy classes of equivariant maps (cf. [**20**]). For the example illustrated in Figure 1(d), the induced antipodal mapping of $\tilde{\mathcal{N}}(G)$ coincides with its antipodal map $x \mapsto -x$ as a circle.

We now have all the ingredients for a proof of statement (β). Suppose that graph G is $(k+1)$-colorable. This is clearly equivalent to the existence of a graph map $G \to K_{k+1}$ to the complete graph $K_{k+1} = (V, V^{(2)})$, card $V = k+1$. Hence, we deduce the existence of an equivariant map $\tilde{\mathcal{N}}(G) \to \tilde{\mathcal{N}}(K_{k+1})$. However, $\tilde{\mathcal{N}}(K_{k+1}) = \mathcal{N}(K_{k+1})$ is combinatorially the barycentric subdivision of the boundary of a k-simplex, and it is easy to verify that, as an antipodality space, $\tilde{\mathcal{N}}(K_{k+1})$ is isomorphic to the standard sphere (S^{k-1},α). So, $(k+1)$-colorability of G implies the existence of an equivariant map $\tilde{\mathcal{N}}(G) \to S^{k-1}$. But according to one version of the Borsuk-Ulam theorem a $(k-1)$-connected antipodality space cannot map equivariantly into S^{k-1}. Hence, $\tilde{\mathcal{N}}(G)$ cannot be $(k-1)$-connected, which was to be shown.

It has often been pointed out how the functorial aspects of algebraic topology serve to translate problems about topological spaces into algebraic problems, which, it is then argued, can more easily be handled. A standard textbook example is the homological proof of the Brouwer fixed

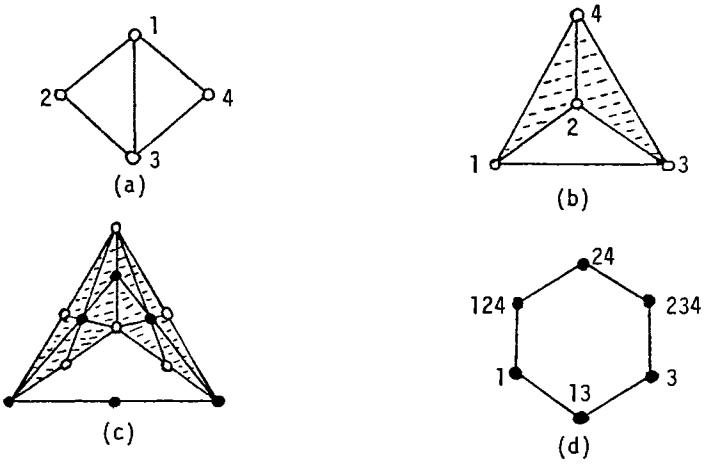


Figure 1

point theorem, which runs roughly as follows. The existence of a fixed point free mapping $B^{d+1} \to B^{d+1}$ is first shown to be equivalent to the existence of a retraction $B^{d+1} \to S^d$. Then, by passing to d-dimensional homology, the existence of such a retraction is shown to imply the existence of group homomorphisms with absurd properties. Hence, in short, the nonexistence of a certain morphism in the algebraic category implies the desired nonexistence of a certain morphism in the topological category. The proof we have just discussed is evidently of the same general form. The nonexistence of a certain morphism in the topological category (Borsuk-Ulam) implies the nonexistence of another morphism in the combinatorial category (colorability).

In closing, we remark that a simplified proof of Kneser's conjecture has been found by I. Bárány [4]. It avoids the neighborhood complex, but is still dependent on topology. On the other hand, Lovász has found lower bounds for the chromatic number also of other graphs by using k-connectedness of the neighborhood complex [16].

5. Final remarks. The three proofs we have discussed in this article share the following general layout. After a relevant simplicial complex C has been identified in the combinatorial context, it is shown that (α) *C has a certain topological property* (contractible, k-connected, $\mathbb{Q}$-acyclic,...); and (β) *this property* (or a weaker one, usually the vanishing of some special homology) *in the particular situation implies a desired conclusion because of some theorem of topology* (Oliver, Hopf-Lefschetz, Borsuk-Ulam). We have for these examples mainly discussed part (β), since this is the part of the proof that best reveals how topology is actually used to solve the particular problems. To be able to deal effectively with various instances of part (α), it becomes of interest to develop general methods for determining homotopy properties of combinatorial structures. Actually, several very useful tools exist, such as various versions of gluing, shelling, nerves of coverings, etc.

It is natural to wonder whether the use of topology in our examples is really needed. After all, it ought to be possible, one should think, to draw a combinatorial conclusion from combinatorial hypotheses by straightforward combinatorial reasoning. Indeed, in a certain weak sense, topology is probably avoidable. Since the use of topology in these examples can be reduced to the use of homology, there should exist discrete (piecewise linear algebraic) approximations to the existing proofs. Such a discrete proof would, however, be completely uninteresting. It would amount to replacing the present conceptual proof based on clear topological ideas by an impenetrable and tedious algebraic computation. The interesting question is whether there exist constructive and genuinely combinatorial proofs, since such proofs are likely to reveal more about problem structure and may also lead to useful algorithms for practically solving particular instances of the problem (say, for finding fixed points of monotone mappings). No such combinatorial proofs are known for the three theorems in our examples.

The results we have so far discussed are purely combinatorial in the sense that topology does not enter into their formulations, only their proofs. Sometimes it can make sense to let the topological aspect of combinatorics be explicit. For instance, it may happen, as is the case with Cohen-Macaulay complexes [19] and oriented matroids [12], that a particular class of combinatorial objects can be equivalently characterized in topological terms. Or, it may happen that a combinatorial fact, new or old, is understood to be a consequence of, or a special case of, some more general result, whose formulation naturally requires topology. We shall end by describing one such recent result.

Consider the collection $V^{(k+1)}$ of all $(k+1)$-element subsets of an n-element set V. Let us call a family $T \subseteq V^{(k+1)}$ a *k-tree* if (i) $\operatorname{card} T = \binom{n-1}{k}$ and (ii) T contains no cycles (i.e., no nontrivial integral linear combination of the sets in T has vanishing algebraic boundary). Thus, for $k = 1$ we get the ordinary notion of a tree as used in graph theory. For $k = 2$ some more exotic possibilities arise: e.g., the ten triangles of the minimal 6-vertex triangulation of the real projective plane is a 2-tree. If T is a k-tree, let C_T denote the simplicial complex formed by all subsets of members of T. One can prove that C_T has a complete $(k-1)$-skeleton (i.e., $V^{(d)} \subseteq C_T$ for $d = 0, 1, \ldots, k$). Hence, $\tilde{H}_d(C_T) = 0$ for $d \leq k-2$, and $\tilde{H}_k(C_T) = 0$ by assumption (ii). Here $\tilde{H}_d(\cdot)$ denotes reduced integral homology. An Euler characteristic argument then shows that actually all Betti numbers are zero, so the group $\tilde{H}_{k-1}(C_T)$ is finite. The following formula was found by G. Kalai [14]. The summation is over all k-trees:

$$\sum_T (\operatorname{card} \tilde{H}_{k-1}(C_T))^2 = n^{\binom{n-2}{k}}.$$

This generalizes to arbitrary dimensions A. Cayley's [9] well-known formula n^{n-2} for the number of labelled trees on n vertices.

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The article above is the eleventh in the series of Special Articles published in the *Notices*. The author, Anders Björner, did his undergraduate and graduate work at the University of Stockholm, Sweden, receiving his Ph.D. in 1979. During the next several years he taught at the University of Sweden, the University of California at San Diego, La Jolla, and the Mittag-Leffler Institute. He joined the faculty of the Massachusetts Institute of Technology in 1984, where Björner is now an Assistant Professor of Applied Mathematics. In 1983 he was the corecipient of the George Polyá Prize in Applied Combinatorics, awarded by the Society for Industrial and Applied Mathematics (SIAM).

The series of Special Articles was created to provide a place for articles on mathematical subjects of interest to the general membership of the Society. The Editorial Committee of the *Notices* is especially interested in the quality of exposition and intends to maintain the highest standards in order to assure that the Special Articles will be accessible to mathematicians in all fields. The articles must be interesting and mathematically sound. They are first refereed for accuracy and (if approved) accepted or rejected on the basis of the breadth of their appeal to the general mathematical public.

Items for this series are solicited and, if accepted, will be paid for at the rate of $250 per page up to a maximum of $750. Manuscripts to be considered for this series should be sent to Ronald L. Graham, Associate Editor for Special Articles, *Notices of the American Mathematical Society*, Post Office Box 6248, Providence, Rhode Island 02940.

National Science Foundation Budget Request for Fiscal 1986

The Administration's budget for the fiscal year 1986 was sent to Congress in February 1985. This report examines the budget requests for the National Science Foundation. As in recent years, the report concentrates on NSF support for research in the mathematical sciences and on the fate of support for science education within the Foundation. These reports have appeared annually for more than a decade—the most recent one was published in the April 1984 issue of the *Notices*, pages 242 to 259.

This year there are again four components to the report:

First is the customary set of tables depicting the part of the entire NSF budget request allocated to support of the mathematical sciences (Table I), the fraction of the budget request for the Directorate of the Mathematical and Physical Sciences (MPS) which is devoted to the mathematical sciences (Table II), and the effects of inflation on the NSF budget over the past decade (Table III).

The other three parts consist of excerpts from the submissions to Congress made by the three groups at the Foundation concerned with the Mathematical Sciences (not including computing), Computer Research, and Science and Engineering Education. These pieces, prepared by members of the Foundation's staff, serve to describe the projects for which Congressional funding is sought and to place in context the work supported by the Foundation.

Tables I and II, for the third year in a row, suggest that support of mathematical research by the Foundation shows prospects for improvement over the stagnant condition which prevailed for so many years. Before 1982 less than 3% of the NSF budget was devoted to support of research in the mathematical sciences. Simce 1982 it has been moving toward 4%, more or less fitfully. The FY1985 budget originally called for mathematical research to receive 3.75%, for example, a figure now reduced to an expected 3.55%; what will have happened a year from now to this year's prediction of 3.80% for FY1986 remains to be seen.

For most of the past decade, Mathematical Sciences' share of the MPS pie has been between 11% and 12%. In the original FY1985 budget it was predicted to exceed 12%. Now we are told that it will be held at 12% for FY1985 and may reach 12.8% in FY1986. Because the increase originally anticipated in this fraction for FY1985

Table I. National Science Foundation Budget

(Millions of Dollars)

	1982 Actual	Change	1983 Actual	Change	1984 Actual	Change	1985 Plan	Change	1986 Request
(1)**Mathematical Sciences Research Support**	**$ 30.5**	**14.1%**	**$ 34.8**	**18.7%**	**$ 41.3**	**15.0%**	**$ 47.5**	**15.2%**	**$ 54.7**
(2)Other Research Support (Note A)	875.7	9.7%	960.6	17.9%	1132.8	13.9%	1290.8	7.2%	1383.8
(3)Education, Information, Foreign Currency Program (Note B)	29.7	–17%	24.7	169%	66.5	40.1%	93.7	–1.3%	92.5
(4)Program Development and Management ("Overhead") (Note C)	63.2	4.0%	65.7	0.9%	66.3	6.6%	70.7	–1.1%	69.9
(5)**Totals**	**$999.1**	**8.7%**	**$1085.8**	**20%**	**$1306.9**	**15%**	**$1502.7**	**6.5%**	**$1600.9**
(6)(1) as % of (1) and (2)	3.37%		3.50%		3.52%		3.55%		3.80%
(7)(1) as % of (5)	3.05%		3.21%		3.16%		3.16%		3.42%

NOTE A. Scientific research and facilities (excluding mathematics and science information). National and special research programs, and national research centers. Support for mathematics has been excluded, cf. items (1) and (3).

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. Division of Mathematical and Physical Sciences

(Millions of Dollars)

Section	1982 Actual	1983 Actual	1984 Actual	1985 Plan	1986 Request
Mathematical Sciences	$ 30.5 (11.2%)	$ 34.8 (11.5%)	$ 41.3 (11.6%)	$ 47.5 (12.0%)	$ 54.7 (12.8%)
Computer Research	25.7 (9.4%)	29.3 (9.7%)	33.7 (9.5%)	39.1 (9.6%)	41.7 (9.7%)
Physics	75.3 (27.6%)	89.1 (29.5%)	104.4 (29.4%)	115.5 (29.1%)	123.4 (28.8%)
Chemistry	61.4 (22.5%)	67.6 (22.4%)	79.4 (22.4%)	87.4 (22.0%)	93.5 (21.8%)
Materials Research	79.9 (29.3%)	81.1 (26.9%)	96.3 (27.1%)	107.1 (27.0%)	115.7 (27.0%)
Total	$272.8	$301.9	$355.1	$396.6	$429.0

Table IIIa. Ten-Year Compilation of the NSF Budget

(Millions of Dollars) Current dollars are converted to 1967 dollars using the wholesale/producer index

	1977 Actual	1978 Actual	1979 Actual	1980 Actual	1981 Actual	1982 Actual
(1) Mathematical Sciences Research Support	$ 20.1	$ 21.4	$ 22.8	$ 25.0	$ 28.3	$ 30.5
1967 dollars	*10.4*	*10.2*	*9.7*	*9.3*	*9.6*	*10.2*
(2) Other Research Support	642.9	702.8	761.0	817.7	873.7	875.7
1967 dollars	*331.1*	*335.9*	*322.7*	*304.2*	*295.3*	*292.5*
(3) Education, Information, Foreign Currency Program	83.3	84.3	88.4	95.4	80.6	29.7
1967 dollars	*42.9*	*40.3*	*37.5*	*35.5*	*27.2*	*9.9*
(4) Program Development and Management ("Overhead")	45.5	48.7	54.7	58.2	59.2	63.2
1967 dollars	*23.4*	*23.3*	*23.2*	*21.7*	*20.0*	*21.1*
(5) Totals	$791.8	$857.2	$926.9	$996.3	$1041.8	$999.1
1967 dollars	*407.8*	*409.7*	*393.0*	*370.6*	*352.1*	*333.7*

Table IIIb. Ten-Year Compilation *(Continued)*

(Millions of Dollars) Current dollars are converted to 1967 dollars using the wholesale/producer index

	1983 Actual	1984 Actual	1985 Plan	1986 Request	Increase 1977–1984	Increase 1977–1986
(1) Mathematical Sciences Research Support	$ 34.8	$ 41.3	$ 47.5	$ 54.7	105%	172%
1967 dollars	*11.5*	*13.2*			*27%*	
(2) Other Research Support	960.6	1132.8	1290.8	1383.8	76%	172%
1967 dollars	*317.0*	*364.8*			*10%*	
(3) Education, Information, Foreign Currency Program	24.7	66.5	93.7	92.5	20%	54%
1967 dollars	*8.2*	*21.4*			*-50%*	
(4) Program Development and Management ("Overhead")	65.7	66.3	70.7	69.9	46%	54%
1967 dollars	*21.7*	*21.3*			*-9%*	
(5) Totals	$1085.8	$1306.9	$1502.7	$1600.9	65%	102%
1967 dollars	*358.3*	*420.8*			*3%*	

(half of a percent) was so much smaller than the expected increase for the mathematical sciences from FY1984 to FY1985 (over twenty percent), it follows that the other physical sciences were expected to do about as well as mathematics in FY1985, at least on the basis of percentage growth in NSF support for research. The picture now presented for FY1986 is different: Table II shows that the increases announced for FY1986 in Mathematics and Computing are to be made at the expense of Physics and Chemistry, whose share of the pie is to be reduced. This phenomenon is confirmed in Table I in a much broader context: the anticipated increase for mathematical research (15.2%) is over twice as great as the anticipated increase for all other research support (7.2%).

The FY1985 budget submitted to Congress a year ago included $75.7 million for Science and Engineering Education (SEE), a figure later raised by Congress to $82.0 million for FY1985. This year's SEE budget request for FY1986 is also $82.0 million (see the report below on the SEE program).

Last year Tables IIIa and IIIb suggested that support for research in the mathematical sciences had made significant progress over the level of support of a dozen years ago (22% above inflation in 1983), while all the other lines (including the total NSF budget) reflected losses when measured against inflation over the same interval. This year, mathematical research support shows a 22.7% increase in constant dollars over the period 1977 to 1984 and Other Research Support shows an increase of 10% over inflation for the same interval. LKD

The following report was prepared by the staff of the Mathematical Sciences Division of NSF and was submitted to Congress as a part of the material which accompanied the Administration's Budget Request for the Fiscal Year 1986.

Mathematical Sciences Subactivity
$54,690,000

(Millions of dollars)

Activity	Actual FY1984	Plan FY1985	Request FY1986
Classical Analysis	$3.9	$4.6	$5.4
Modern Analysis	4.1	4.7	5.5
Geometric Analysis	3.9	4.4	5.2
Topology & Foundations	5.0	5.7	6.6
Algebra & Number Theory	6.6	7.8	9.1
Applied Mathematics	5.3	6.4	7.6
Statistics & Probability	4.7	5.6	6.7
Special Projects	7.8	8.2	8.6
Total	$41.2	$47.5	$54.7

Objectives and Description

The objectives of the Mathematical Sciences subactivity are to foster the creation and development of mathematical ideas, methods, and techniques and to promote their use in improving our understanding of physical, biological, and social phenomena. To achieve these objectives, support is provided for significant research in the mathematical sciences. This support serves to ensure the continuing vitality and long-range health of the discipline. Each subdiscipline of the mathematical sciences, from those with a sharpest focus to those that reach out to other areas of knowledge, is supported in such a way as to encourage their interaction and to provide a healthy balance between them.

Mathematics has been defined as the science of order. While all of the sciences search for order in their individual disciplines, the mathematical sciences study order for its own sake. From this perspective it becomes clear why mathematics has found such widespread application. Indeed, research in the mathematical sciences is driven both by the internal needs of the discipline and by interactions with the various areas of application. The relative importance of these two forces has fluctuated over time, but in recent years the areas of application of mathematics have multiplied and new applications have been found in the traditional areas. Simultaneously, the borders between the subdisciplines of the mathematical sciences have begun to break down. The result is a healthy turmoil in the field which is leading to results of great intrinsic beauty and of high applicability. The opportunities for research in the mathematical sciences have never been greater.

Some of the applications of the mathematical sciences are predictable; others are not. The predictable applications make use of mathematical modeling, computational mathematics, and statistics. The implementation of sophisticated mathematical models of chemical processes on large-scale computers has reduced the need for pilot plants in the chemical industry. Statistical methods of quality control have resulted in greatly improved reliability of manufactured goods. On the other hand, the realization that certain profound results in algebraic geometry make possible the development of sophisticated error correcting codes could not have been predicted. Similarly, it could not have been anticipated that elementary facts from projective geometry, developed decades ago, would be the key to the recent development by N. Karmarkar of Bell Laboratories of new techniques for solving linear programming problems. Frequently the interaction of mathematics with applications is synergistic and has profound consequences for both areas. For example, the realization that differential geometry is the natural mathematical framework for the gauge theories of physics has had ramifications for both sciences. Recently this particular interaction has been important in the surprising discovery of an exotic Euclidean 4-space, a result that is far from being understood,

the study of which will undoubtedly lead to new insights into the topology of four dimensions.

The mathematical sciences are the epitome of small science. Most research is done by individuals, or by small groups. Little equipment is needed with the exception of computers. The research is not focused on one or even a few central, agreed-upon problems, but rather research proceeds on many, seemingly unrelated fronts. What does tend to unify mathematics are the concepts that arise and the methods and techniques that are used. The result is a science characterized by its generality and flexibility. With increasing frequency mathematical scientists are finding both inspiration for new research and applications for established results in fields seemingly unconnected with their own.

In line with the nature of the discipline, the core of the Foundation's program of research support in this area has been the Scientific Research Project Support (SRPS) awards. Within the SRPS activities, significant emphasis has been given to increasing the level of support for the young mathematicians to whom the field owes so much for its vitality. This emphasis began in FY 1984 and receives a significant enhancement in FY1986. The mathematical sciences community recognizes a need for greater opportunities for communication between mathematical scientists in the same or related fields, as well as with scientists in other disciplines. To provide for this need the subactivity has a program of special projects, which includes the bulk of funding for research institutes at the University of Minnesota and in Berkeley, California, postdoctoral and visitor support at three other research centers, a program of postdoctoral fellowships, and support for research conferences and workshops. In addition, researchers are encouraged to join colleagues in obtaining funds for computing equipment that no single project could justify. Activities of this kind will continue to augment the SRPS awards in FY1985 and FY1986.

A brief description of research areas supported under the Mathematical Sciences subactivity follows:

- *Classical Analysis* centers on properties of solutions of differential equations and the development of mathematical techniques to estimate these solutions. Equations of primary concern are those that model natural phenomena and, consequently, often display nonlinearities or discontinuities in their definition. The theories of special functions, several complex variables, harmonic analysis and complex function theory form an interdependent network of research that provides a theoretical base for classical analysis.
- *Modern Analysis* is that part of mathematical analysis that has been developed in the 20th century by abstracting and refining the essential concepts from classical analysis and introducing new algebraic, geometric, and topological methods. A major goal is to provide unified approaches that explain both phenomena and results from analysis and have more general applicability. Recent thrusts are leading to new interactions with theoretical physics, engineering, and other sciences.
- *Geometric Analysis* encompasses the study of geometric objects such as curves and surfaces and the use of geometric models in the analysis of nonlinear phenomena such as those that arise in ordinary and partial differential equations, in functions of several complex variables, and in variational problems. Many of these mathematical phenomena have exciting connections to theoretical problems in physics and other sciences.
- *Topology and Foundations.* Topology studies in a formal and abstract manner those properties of geometric objects that persist after deformation by stretching, shrinking, and twisting without tearing or cutting. Numerous and varied problems have topological formulations, for example, the stability of orbits. Foundations research involves the study of the logical structure and basic concepts that undergird mathematics. It has intimate connections with the theory and application of computing.
- *Algebra and Number Theory* embraces such classical algebraic structures as the theory of integers and primes, polynomials and their sets of solutions, transformations between spaces, and combinatorial designs and enumeration. Further, it includes the evolution of these mathematical ideas to sophisticated algebraic structures labeled groups, rings, fields, algebras, lattices, and categories, providing not only a generalization of these specific concepts, but an algebraic framework and descriptive theoretical context for questions throughout mathematics, science, and engineering.
- *Applied Mathematics* is an activity that arises from the needs of the empirical sciences for the formulation and analysis of mathematical models. At its best it involves the development of original, generic mathematical concepts and techniques in the context of complex real world phenomena rather than the study of abstract mathematical structures for their own sake. Applied mathematicians not only continue to study problems with origins in the physical and engineering sciences, but are also developing programs around sciences that have seen more recent mathematical advancement, such as the life, behavioral, and operational sciences.
- *Statistics and Probability.* Statistics is the study of methods for the collection, organization, and analysis of data for the purpose of uncovering fundamental mathematical relationships among variables. There is a necessary creative tension between mathematical statistics and statistics viewed as a methodological

science. The latter is receiving increased emphasis in the exploration of new computer-based methods of data analysis. Probability theory deals with phenomena that are random in the sense of combining long-term regularity with short-term unpredictability. Active areas such as ergodic theory, stochastic differential equations, and probability in abstract spaces lie on the border between probability and analysis. The demands of today's communications systems along with the continuing demands of the biological and physical sciences provide motivation for much of the recent work in probability.

- *Special Projects* fosters the increasingly fruitful interactions among researchers in different mathematical subfields and their areas of application. Research conferences and workshops encourage these interactions directly. The Mathematical Sciences Postdoctoral Research Fellowships and grants to the research institutes and other research centers provide such opportunities for junior investigators. Increasing requirements for special-purpose computer equipment for mathematical sciences research are addressed through awards for equipment.

NSF Role

Over the last few years, a major structural problem in the support for research in the mathematical sciences has become visible. There has been a serious lack of support for graduate students, postdoctoral associates, and young investigators. This problem is part of a general lack of funding for the mathematical sciences documented in the recent report from the National Research Council entitled, *Renewing U.S. Mathematics: Critical Resource for the Future* [*Notices*, August 1984 (pages 434–466), October 1984 (pages 570–616)]. Beginning in FY1984, a major effort was made by the Mathematical Sciences subactivity to correct this problem. This effort is being expanded in FY1985 and it will be a continuing area of emphasis in FY1986.

NSF is the only Federal agency with responsibility for support across the entire spectrum of the mathematical sciences. Research in the mathematical sciences is also funded by the Department of Defense (DOD), the Department of Energy (DOE), the National Institutes of Health (NIH), and the National Aeronautics and Space Administration (NASA). For the past decade, the mission-oriented research agencies have focused their support on applied mathematics and statistics. Even in these areas, Foundation-supported research generally involves a broader range of topics than the more project-oriented research sponsored by the mission agencies.

The NSF role in support of academic basic research in the mathematical sciences is crucial. In FY1984, the Foundation provided 28 percent of the support in applied mathematics, 43 percent in statistics and probability, and 99 percent in the other mathematical sciences disciplines, for an overall total of 60 percent.

NSF coordinates its support of research in the mathematical sciences with its counterpart Federal agencies through the Interagency Committee for Extramural Mathematics Programs. This group meets regularly to share information on policies of support and to discuss areas of emphasis and of unusual scientific opportunity. Extensive day-to-day contact between program officers at the various Federal agencies is maintained by telephone and personal visits. Conferences, workshops, and activities at research centers are sometimes supported jointly by the Foundation and one or more of the other agencies.

Major Programmatic Topics

The concepts, methods, and techniques of any one area of the mathematical sciences transcend that area to illuminate and unify the research enterprise as a whole. The breadth of the mathematical sciences makes it difficult to single out particular aspects as major topics of concentrated programmatic effort. The topics listed below provide but a few examples.

- Traditional descriptive methods in statistics (bar graphs, histograms, etc.) have enabled practitioners to visualize simple data sets. With more complex data sets involving multi-dimensional data, visual insight has not previously seemed plausible. Approaches involving complex methodology and graphics are being rapidly developed. They enable scientists to go to work-stations and, guided by a sophisticated statistical data analyst, look at high-dimensional data in order to identify important features and clusters. There is potential for significant impact on the basic nature of the statistical sciences.
- Investigations currently being carried out on traditional questions of existence and uniqueness of solutions to differential equations are shifting emphasis and focusing on long-term behavior of solutions. In many contexts, singularities in solutions to differential equations can occur spontaneously after a finite period of time. Researchers are attempting to use information on initial disturbances, the degree of nonlinearity of the equation, and the dimension of the underlying space to predict the occurrence of such singularities. There is great concern over the lack of understanding of the mechanism by which solutions develop irregular behavior.
- Crossed product C^*-algebras are noncommutative generalizations of dynamical systems, sets endowed with some mathematical structure together with an evolution operator that moves points in the set with time (such as particles in a physical system). They were introduced to provide an algebraic framework

for the study of symmetry groups of quantum statistical mechanics, and they also provide an algebraic approach to the theory of continuous group representations. These and related structures are at the heart of much of the current work in operator algebras. Their investigation involves noncommutative versions of shape-theoretic topology, algebraic topology, foliations, and index theory of differential equations.

- Connections have been discovered between the geometry and topology of a manifold (e.g., a surface) and the analytic properties of certain differential operators on the manifold. Classical dynamical systems, ergodic theory, and group theory are brought into investigations in this area in a significant way. Understanding these connections has led to important results in mathematics and physics, from the classification of manifolds to geometric quantization in theoretical physics.
- Drawing on concepts from areas such as topology and differential geometry, algebraic geometers have developed a vast array of sophisticated tools for the study of simultaneous solutions to systems of polynomial equations. The past decade has seen a burst of activity in the application of these to the solution of problems arising from such diverse areas as mathematical physics, combinatorics, and number theory. A generation of vigorous young mathematicians has grown up with these tools, so this activity will accelerate as they and their students seek out new, creative applications.
- A large variety of real world problems (e.g., optimal utilization of natural resources, most efficient routing schedules) can be mathematically modeled as constrained extreme problems, that is, finding the maximum or minimum of an objective function subject to constraints determined by physical or practical considerations. Such problems are subsumed under the heading nonlinear programming (NLP) problems. Establishing the existence of solutions to NLP problems, characterizing these solutions, and estimating them numerically under conditions on the objective function and constraints often encountered in practical applications form a major topic of investigation in applied mathematics.
- Progress in understanding the transition from periodic to chaotic motion in physical systems has been significant during the past decade. Renormalization, strange attractors, multiple bifurcation, and the sensitive dependence on initial conditions for long-term behavior of dynamical systems have been investigated based on geometric and ergodic theories. Recent experimental results on turbulent fluid flow, semiconductor devices, and Josephson junctions have exhibited some chaotic behaviors that seem to agree with these mathematical discoveries.
- In the classical view of statistics, an experimental design is constructed, data are then collected according to the dictates of the design, and subsequently the data are analyzed. In sequential analysis, the data are examined after each value or batch of values is collected. At each stage a decision is made to terminate the data collection or to continue sampling. Elegant theoretical results of the recent past must now be translated to practical statistical methodologies, particularly in clinical trials and quality control.
- Scientific and engineering models whose solutions are well beyond current analytical tools are being attacked through the use of mathematical models employing modern computers and computational techniques. A continuing need exists for improved mathematical models and numerical methods for multi-phase flows, chemical reaction kinetics, and turbulence.

Significant Recent Achievements

Singular Perturbation Methods for Exit Rates in Random Processes. Many processes in physics, chemistry, biology, control and communication, statistics, and economics exhibit random behavior. For example, a chemical reaction occurs when chemical bonds are broken through the random collision of a molecule with those of the surrounding medium.

The mathematical description of the dynamics and evolution of a large number of random (Markov) processes is based on the so-called Master Equation. In its most general form, the Master Equation is an integro-differential-difference equation. Because of its complexity, explicit, exact solutions can be obtained only for relatively few problems. Therefore, considerable effort has been devoted to equations that approximate the Master Equation. Among the most widely used is the diffusion approximation (sometimes referred to as the Fokker-Planck equation). Though the predictions obtained from the diffusion approximation often yield results close to those of the Master Equation, important cases are known where such predictions lead to large discrepancies. By introducing new singular perturbation techniques, Bernard Matkowsky of Northwestern University and Zeev Schuss of Tel Aviv University, together with their collaborators, have recently determined conditions for, as well as limits of, the validity of such approximations. In addition, they showed how to extract key information for the description of the process either from the diffusion approximation or, where the approximation is not valid, directly from the Master Equation. An example of such a random process involves the motion of particles acted upon by both deterministic and random forces, and an important problem is the determination of the rate at which such particles exit

a region of space (the Kolmogorov Exit Problem). By solving the Kolmogorov Exit Problem and its generalizations, they were able to derive explicit analytical expressions for, among others, (i) chemical reaction rates, (ii) effective diffusivities and superionic conductivities in crystals, (iii) transition rates in multi-stable systems such as individual and coupled Josephson junctions, (iv) click rates in frequency modulated phase-locked loops, (v) reliability of random access protocols for large communication systems, and (vi) performance measures in queueing systems, such as the rate at which customers are lost.

Unanticipated Connection Between von Neumann Algebras and Knot Theory. von Neumann algebras were introduced in the 1930s to help study quantum mechanics. They remain a fertile field for mathematical analysis, and continue to have physical implications. Recently Vaughan Jones, a young analyst at the University of Pennsylvania, made some startling discoveries about characteristics of von Neumann algebras and, in the process, made some wide-ranging discoveries in the topological theory of knots.

Jones assigned to certain subalgebras of von Neumann algebras a characteristic number which he called the index. In the process he needed to look at finite-dimensional von Neumann algebras with certain defining conditions. His surprising result was that when the index is greater than 4 it can be any real number, but when it is between 1 and 4 the index can only take specialized values. It is expected that this outstanding result will have ramifications for future work in the field of von Neumann algebras.

The analysis involved in Jones' proof of this index theorem had exciting spin-offs in the seemingly unrelated area of topological knot theory. Jones noticed that the defining relations for his finite-dimensional algebras were very similar to the defining relations for the so-called braid group, a group of transformations that describe the interchanges in strings resulting in a given braid. The new ingredient in Jones' treatment is the description of a trace function that can be used to recover numerical information leading to an invariant associated with the braid. This trace invariant is significantly more sensitive than others used in the past. Its easy computability has allowed Jones and others to solve a number of longstanding problems in knot theory and to make progress on many others.

The surprising connection between von Neumann algebras and knot theory provided by Jones' results fortuitously appeared just before the start of the current year at the Mathematical Sciences Research Institute in Berkeley. By coincidence, the two major programs at the Institute this year are in von Neumann algebras (in which Jones is a participant), and in low dimensional topology, a major component of which is knot theory. A spurt of activity centered around Jones' work has occurred at the Institute and has already resulted in significant new results by several mathematicians.

Curvature in Higher Dimensional Spaces. Mathematicians and physicists are intensely interested in the curvature of spaces. The curvature of a surface (i.e., a manifold of dimension 2) is readily defined and visualized. The surface of a sphere or a football is positively curved; by contrast, the outer region of a doughnut is positively curved, while the inner region is negatively curved. A surface whose curvature is everywhere positive can be deformed until its curvature is constant, after which it will look like a perfect sphere or one other possible model called the projective plane.

For manifolds of higher dimension, there is a corresponding notion of curvature, generalizing that for surfaces. There was an outsanding question: If a three-dimensional manifold has positive curvature everywhere, can it be deformed until its curvature is constant?

Richard Hamilton at the University of California at San Diego has shown that the answer to the question is yes, by inventing an explicit process that deforms three-dimensional spaces of positive curvature. The process is modeled on the flow of heat in a material body. Here it is curvature that flows, from regions where it is plentiful, to regions where it is scarce. Difficult methods involving partial differential equations are used to construct this curvature-flow process, and to verify that the curvature is constant at the end.

Changes Between FY 1985 Budget Request and FY 1985 Current Plan

The FY1985 Current Plan of $47,490,000 is $3,010,000, or 6.0 percent, below the FY1985 Budget Request. This decrease corresponds to adjustments for Advanced Scientific Computing, the unspecified Congressional Appropriation reduction, International Cooperative Research programs, Program Development and Management funds, and the Distributed programs. The decrease was distributed over the programs in accordance with perceived scientific opportunities and needs. A result is that the number of senior investigators supported is unchanged, rather than increasing slightly as anticipated. The decrease in the budget for Special Projects from $9,650,000 to $8,200,000 is due to a shift of some funding for postdoctorals and computer equipment from Special Projects to the research programs, as well as to the overall decrease in the budget.

FY 1986 Budget Highlights and Explanation of Increases, Decreases, and Continuing Emphases

Obligations

FY1984 Actual	$41,234,081
FY1985 Current Plan	$47,490,000
FY1986 Request	$54,690,000
Difference FY1986/FY1985	$ 7,200,000

The FY1986 Budget Request of $54,690,000 is $7,200,000, or 15.2 percent, above the FY1985 Current Plan.

The increase of 15.2 percent for the Mathematical Sciences Subactivity provides a partial response to the recommendations of the recent report from the National Research Council entitled, *Renewing U.S. Mathematics: Critical Resource for the Future.*

Most serious among the needs of the Mathematical Sciences is stronger research support for graduate students and young faculty investigators. Since FY1984, the budget of the Mathematical Sciences subactivity has contained increments dedicated to the support of young people. The significant increase in the Mathematical Sciences Budget in FY1985 provided the opportunity to continue this emphasis, and the FY1986 Budget Request provides for further enhancement of the support for these areas. In addition, increased funds are provided for computational equipment and access to computers in order to respond to research opportunities in computational mathematics. There will be a modest increase in the number of senior investigators supported in FY 1986.

- Funds for the support of postdoctoral researchers will increase by $1,300,000 to a total of $7,600,000. The most significant increase, $1,000,000, will be in SRPS programs. The number of Mathematical Sciences Postdoctoral Research Fellowships awarded by the Special Projects Program will be held constant at 30. The number of postdoctoral researchers supported is expected to increase from about 200 in FY1985 to about 250 in FY1986.
- Funds for the support of graduate students will increase by $2,700,000 to a total of $8,600,000. All funds for graduate student support are located in SRPS programs. The number of graduate students supported is expected to increase from about 620 in FY1985 to about 750 in FY1986.
- Funds for the purchase of computer equipment and access to computational facilities will increase by $720,000 to a total of $2,780,000. Emphasis will be given to the provision of local equipment needs for access to large-scale scientific computing facilities. Funds are distributed across all programs with some emphasis on Applied Mathematics and Statistics and Probability.
- Funds for the support of research by senior investigators in the SRPS programs will increase by $2,480,000 to a total of $32,380,000. This includes support for the Mathematical Sciences aspects of Foundation-wide activities such as the Presidential Young Investigator awards, Research Opportunities for Women, Research in Undergraduate Institutions, Minority Research Initiation, and the Experimental Program to Stimulate Competitive Research. Of this increase, $1,000,000 will be devoted to the support of researchers in the early stages of their careers. It is expected that the total number of investigators supported will increase from about 1,285 in FY 1985 to about 1,300 in FY1986. The additional investigators will be concentrated among those who have had their Ph.D. degree less than six years.
- The operation of the mathematical sciences research institutes at Berkeley and Minnesota will be maintained at a constant level of effort of $3,300,000 with emphasis on support of postdoctoral researchers. The Berkeley institute will concentrate on Number Theory and Connections to Algebraic Geometry; the Minnesota institute, on Scientific Computation.

The increases for the eight program elements over the FY1985 Current Plan are:

	Change, FY 1985 to FY 1986	
	$Millions	Percent
Classical Analysis	$0.77	16.8%
Modern Analysis	0.78	16.6
Geometric Analysis	0.78	17.6
Topology & Foundations	0.94	16.5
Algebra & Number Theory	1.28	16.4
Applied Mathematics	1.24	19.4
Statistics & Probability	1.06	18.8
Special Projects	0.35	4.3
Total Mathematical Sciences	$7.20	15.2%

The following report was prepared by the staff of the Computer Research Division of NSF and was submitted to Congress as a part of the material which accompanied the Administration's Budget Request for the Fiscal Year 1986.

Computer Research Subactivity
$41,730,000

(Millions of dollars)

Activity	Actual FY1984	Plan FY1985	Request FY1986
Theoretical Computer Science	$3.9	$4.1	$4.8
Software Systems Science	3.7	4.0	4.4
Software Engineering	3.4	3.5	3.8
Intelligent Systems	3.4	5.4	3.6
Computer Systems Design	3.5	3.8	4.2
Coordinated Experimental Research	13.6	15.7	16.3
Special Projects	0.9	1.1	1.1
Computer Research Equipment	1.4	1.5	1.8
Total	$33.7	$39.1	$41.7

Objectives and Description

The objectives of the Foundation's Computer Research program are to generate fundamental knowledge about the structure and design of computer systems, both hardware and software, synthesize accumulated knowledge into coherent

theories that point out new directions for exploration and testing, and train sophisticated research personnel essential to the continuing development of both computer research and the computer industry.

Computer research is a young and developing discipline, dating from the early 1940s when the first modern electronic computer was conceived and built at a university with government support. Unlike mathematics, physics, and chemistry, which have had the benefit of centuries through which to develop and refine an intellectual tradition and a coherence of basic paradigms, computer research still displays the somewhat confusing but exciting vitality characteristic of an emerging intellectual discipline. Computer research, from its background in the mathematical sciences, electrical engineering, and logic has become a unique and vital academic discipline in its own right. The ubiquitous use of computers throughout all segments of life has given great impetus to computer research as a discipline; in turn, computer research is essential to the continued long-term development of the computer industry.

Computer research is the study of computers, information processing and computing. Its universe for study consists of strategies and algorithms for solving problems, methods of representing and transforming information, programs for carrying out computation procedures, and machines for executing programs. Its central unity arises from the concept of computational complexity as a measure of the feasibility of finding a solution to a given problem. It seeks to understand the irreducible limits of complexity in given problems and discover optimal ways of finding those solutions which are feasible. Unlike the physical sciences, which deal with the intrinsic properties of physical matter, computer research studies the intrinsic properties of problem-solving procedures and computing systems. It is therefore necessary to discover their underlying concepts and laws, to test their validity, and to examine their implications for design.

Basic computer research is carried out by a few of the largest companies, but most industrial activities emphasize applied research and technological development. The computer industry as a whole is technologically driven and intensely competitive. It is paced by the constant demand for new or improved products, which imposes short-term requirements on most research and development projects. Companies protect their innovation by secrecy. By contrast, universities encourage the study of new concepts even without any apparent market demand and insist upon open publication of research results. While industry is highly successful in exploiting and developing existing technology and making rapid incremental improvements, academic institutions provide a more conducive environment for long-range computer research. Several university research projects are performed in collaboration with industrial scientists.

Beginning in FY1981, Computer Research, in addition to providing support for research projects and research equipment, developed a coordinated program for establishing a modern experimental research capability in U.S. academic institutions. This Coordinated Experimental Research (CER) program consists of research facilities at selected universities and is also responsible for developing the Computer Science Network (CSNET), a self-supporting computer communications network which links academic and industrial researchers. The purpose of the CER program is to provide academic institutions with the resources to undertake improved, long-range experimental research in this rapidly expanding field, and to provide the forefront academic research environment required to attract and retain the advanced students and faculty so urgently needed in computer research. By the end of FY1985 about 22 CER facilities will have been initiated. Approximately 80 academic, industrial and government research organizations are currently using CSNET on a regular basis.

In FY1984 the Computer Research subactivity assumed additional responsibilities for research in undergraduate institutions, Presidential Young Investigators, and certain aspects of international cooperative scientific projects. These responsibilities will continue in FY1986.

The Foundation's support of computer research is divided among eight programs. A brief description of each program follows:

- *Theoretical Computer Science* research is the study of the foundations of computation. It uses tools from the mathematical disciplines of algebra, combinatorics, and logic. Questions concerning the inherent limitations and possibilities of computation are addressed.
- *Software Systems Science* research includes theoretical and experimental studies of the structure and semantics of programs and other software concepts such as the structure of programming languages, highly parallel processing systems, and other systems for describing and controlling computation processes.
- *Software Engineering* studies the processes of designing and creating useful software. Particular emphases are on design methodology, software testing, and tools for use by software engineers. The program also supports research in computational mathematics.
- *Intelligent Systems* research involves computer-based systems that can exhibit some of the characteristics of intelligence in assisting human problem-solvers. Current areas of inquiry include knowledge engineering, automated theorem-proving, mechanical inferencing, problem-solving, computer vision, and language understanding systems.

- *Computer Systems Design* deals with the structure and measurement of computer systems and the principles and processes of design for highly complex computer systems. Subareas include Very Large Scale Integration (VLSI) Design Methodology, Computer Architecture, Fault-Tolerant Computer Systems, Computer Systems Performance Measurement and Evaluation, and Computer Graphics. The major thrust concerns the impact of VLSI electronic technology on all of these areas.
- *Coordinated Experimental Research* projects involving multiple investigators are supported through the establishment and enhancement of experimental research facilities at academic institutions. Grants provide partial support for hardware, software, technical and professional support personnel, and necessary maintenance and operating costs to carry out projects of a magnitude and breadth too large for consideration under other research programs.
- *Special Projects* is focused on subareas of computer science with special topical significance. They include privacy and security of computer systems and data bases, computer networks, and the management of very large data bases.
- *Computer Research Equipment* grants are for partial support of the purchase of research equipment to be shared by several researchers for conduct of experimental or theoretical computer research. Grants are for one year only and cover only equipment purchases and partial support for maintenance during the year of the grant.

NSF Role

Computer research is funded by several Federal agencies, but NSF is the agency with primary responsibility for the support of basic research in this area. Other Federal programs support computer research that is relevant to their respective missions; NSF responds to unsolicited proposals which are evaluated by peer review. As a result, NSF support plays a unique role in strengthening the academic base of computer research and developing the research discipline. Overall, in FY 1984 the Foundation supported approximately 32 percent of the Nation's university-based computer research, but the relative fraction of NSF support varies widely among subareas. An accurate characterization is that NSF supports a much larger fraction of the theoretical or fundamental conceptual research and a smaller proportion of the research that requires construction of experimental systems. On the other hand, NSF provides a large fraction of the support for research equipment and facilities for academic experimental research. This is an important contribution to the infrastructure of academic research and enables much research that is conducted for other agencies.

Computer vendors and other companies that are interested in the information processing industry also support academic computer research. This support takes the form of discounts or gifts of equipment, faculty work or study contracts, visiting or consulting opportunities for faculty, a small number of graduate student fellowships or forgivable loans, and a small number of unrestricted departmental grants. The total investment by industry has been increasing in response to the critical situation in academic computer research and is now comparable to the total NSF support in this area.

The programs in Computer Research are coordinated closely with other Federal agencies and with industry. In *Coordinated Experimental Research*, the Foundation is coordinating its activities especially with the Defense Advanced Research Projects Agency (DARPA), and the Office of Naval Research (ONR). In some cases, the enhancement of research facilities has been jointly sponsored with DARPA. In most cases, the revitalized research capabilities at universities have attracted support from industry and a variety of Federal agencies, as well as from the Foundation, for expanded research efforts. The CSNET project was coordinated with DARPA and benefited from close technical collaboration between NSF and DARPA staff throughout its development.

The Computer Science Advisory Subcommittee includes one or more representatives of industry on a rotating basis, and approximately 20 percent of mail reviewers solicited to evaluate proposals are industrial scientists. In addition, members of the NSF staff visit industrial laboratories to learn about industrial research activity. The CSNET brings industrial and academic researchers into closer and more frequent interaction.

The Computer Engineering program of the Division of Electrical, Computer, and Systems Engineering and the programs of the Division of Information Science and Technology complement the Computer Research activities. There is continual coordination among the staff of all of these units, and several projects are jointly evaluated and supported.

Major Programmatic Topics

Computer research spans a broad range of research areas that have been greatly enriched by the development of microelectronics technology. Not only has this technology led to new tools for research but it has also suggested new problems for investigation and created new opportunities for academic researchers, in particular, to apply their skill in theoretical or conceptual research to problems in hardware and software design. A few of the many important topics being investigated by academic researchers are:

- A topic of central importance is the distribution of computing tasks among several or many processors or specialized computing resources

in order to benefit from concurrent processing of mutually independent program segments. This concept is motivating research in the architecture of parallel computers, software systems for controlling and optimizing the use of parallel computers, and problem strategies and algorithms that use parallel structures to enlarge the domain of feasible problems. Several of the Coordinated Experimental Research awards are devoted to one or more aspects of this study. Researchers working on the Crystal project at the University of Wisconsin, for example, are studying the design, construction, and use of a dynamically reconfigurable set of processing elements, in which each element contains substantial computing power.

- Conceptually, the design of complex systems of logical elements on a chip using Very Large Scale Integrated (VLSI) circuit technology and the design of complex software systems have much in common. Neither can be carried very far by humans without assistance in managing the complexity of detail required for successful completion of a task. One of the most important research topics in computer science is to understand how the computer, itself, can be used best to assist with the design of both hardware and software in computer systems.
- The development of VLSI technology makes it possible to design and build advanced experimental models of computer architectures that are very different from any previously constructed. It also makes it possible for university research groups to carry out such design studies and be active participants in computer architecture research to a much greater degree than they have been since the earliest days of computer history. A central topic of research is how novel ideas in computer architecture may be implemented in VLSI technology and applied to improve greatly our ability to solve different classes of problems.
- Much has been learned about the classification of computation problems according to their degree of complexity, and it has been discovered that many common problems are too complex to allow the computation of a solution in all cases. Computer scientists have been able to show that even though mathematicians may be able to prove that solutions exist for a class of problems, it is impossible to devise an algorithm that will always compute the solution in a finite length of time using the fastest computers that are theoretically possible to construct. This makes it important to study algorithms that yield approximations of known accuracy to intractable computational problems.
- In many cases it is possible to devise probabilistic algorithms for computationally infeasible problems. Such algorithms depend upon random numbers and have a small probability of yielding an incorrect result. If the answer is correct, however, it is exactly, not only approximately, correct. Discovering fast probabilistic algorithms for important classes of computationally infeasible problems is another area of theoretical research that is of great current interest.
- One of the important activities of recent interest in Intelligent Systems is Expert Systems Research, which is finding significant application in industry and defense. These systems require the capture of some area of human expertise (e.g., molecular structure) in a computer, and the definition and programming of search and reasoning rules to solve problems using that expertise. While there has been progress for many years in building expert systems, there are still major problems that require further research. The knowledge acquisition process is long, difficult and uncertain. The internal representation of human knowledge in a computer is poorly understood and leads to inefficient computer inference systems. The reasoning methods used in all systems are primitive and need refinement. Research in logic, programming tools, distributed problem-solving, and automatic reasoning are contributing to progress in this field.
- Exchange of ideas and software among those doing computer-related research is one of the most difficult facets of research using computers. Lack of good exchange retards the rate of research progress. Methods to improve exchange would lend permanent archival value to the results of software research and are the subject of active inquiries in software engineering. For example, the symbolic and algebraic manipulation (SAM) research community does much of its research on medium-size computers and uses the programming language LISP. The biggest potential user community for SAM systems, however, consists of researchers who do large-scale scientific computing. This group uses FORTRAN and tends to use very large computers. These two communities have built up different infrastructures and do not have much interaction. One important goal of software engineering research is to develop methods for making complex software systems such as SAM understandable and useful to other research communities.

Significant Recent Achievements

Probabilistic Analysis of Combinatorial Algorithms. Most earlier research on the analysis of algorithms has been concerned with worst-case limits on running time and memory space. Such bounds guarantee the performance of algorithms no matter what input is presented, but they

often do not reveal their practical utility. The famous simplex algorithm of linear programming, for example, is known to have very bad worst-case behavior but in practice it is extremely useful and forms the basis for all of the commercial and industrial applications of operations research. The inputs that make it exhibit bad behavior do not arise in practice and are really pathological. A more useful characterization of an algorithm would be one that shows what could be expected in typical applications instead of in the worst-case that could arise.

Richard Karp of the University of California, Berkeley, proposed a probabilistic analysis to augment the worst-case analysis. In this method, the set of inputs for analyzing the behavior of an algorithm is chosen by applying a reasonable probability distribution to the set of all possible inputs. Since pathological cases are exceptional, they seldom appear in the test inputs chosen this way, and the resulting theoretical measures of performance compare better with the running times actually experienced in practice. Professor Karp and his colleagues have now developed a methodology for performing probabilistic analyses of algorithms for a class of problems called combinatorial problems, which are of great practical importance. These problems include linear programming, bin packing, shortest path problems, multiprocessor scheduling, and many others.

A Novel Very Large Scale Integrated (VLSI) Layout for Systolic Computers. The declining cost of VLSI components and the recent advances in wafer-scale integration make it technically possible and economically feasible to build computers with hundreds of thousands of processors. Since each processor can be physically connected only to a limited number of other processors, the choice of interconnection pattern is a crucial architectural decision.

Systolic algorithms are rectangular arrays of processes in which sets of processes accept inputs from their predecessors and pass outputs to their successors in a rhythmic manner reminiscent of the pulsing of blood through a biological system. This scheme can be applied to many algorithms of importance, for example, in the solution of large sets of linear equations. A systolic computer is an array of processors that can execute systolic algorithms by assigning one or more of the processes to each processor. The main problem in the design of a general purpose systolic computer is that the hard-wired array of processors may have different dimension and shape than the array of processes for a given problem. As a result, some processors may have to execute several processes (i.e., timeshare) while others may be relatively idle. This can lead to severe load imbalance even for problems with many fewer processes than there are processors in the computer. In early systolic architectures, for a computer with N processors, timesharing may be necessary for problems with as few as $\sqrt{N}$ processes. The load imbalance, (i.e., the difference between the most used and least used processors) can be as high as $\sqrt{N}$. For example, if the computer has one million processors, problems with as few as one thousand processes may require timesharing of the processors and the load imbalance for some problems may be as high as one thousand.

Amos Fiat and Adi Shamir of the Weizmann Institute of Science, Israel, have discovered a novel interconnection pattern for the processors of a systolic computer that overcomes these difficulties. Part of this research was supported by NSF at the University of Chicago and the Massachusetts Institute of Technology when Fiat and Shamir were visiting the United States. This wiring scheme, called a polymorphic array, provides a borderless pattern in which each processor is connected to four other processors by constant length wires, a feature that makes the realization of the interconnection pattern in VLSI circuit technology possible. The symmetry of the pattern also makes the architecture fault tolerant to any single failure. In such a polymorphic array, timesharing is not necessary for problems with as many as $N/\sqrt{5}$ processes, and the load imbalance does not become large. Computer analysis of many cases showed that the load imbalance did not exceed one or two.

Changes Between FY 1985 Budget Request and FY 1985 Current Plan

The FY1985 Current Plan of $39,092,000 is $258,000, or 0.66 percent, below the FY1985 Budget Request. This decrease corresponds to adjustments for Advanced Scientific Computing, the unspecified Congressional Appropriation reduction, the Congressionally directed Automation initiative, International Cooperative Research programs, Program Development and Management funds, and the Distributed programs.

The Congressionally directed Automation Research initiative of $2,000,000 was added to the estimate for the Intelligent Systems program element.

FY 1986 Budget Highlights and Explanation of Increases, Decreases, and Continuing Emphases

Obligations

FY1984 Actual	$33,720,312
FY1985 Current Plan	$39,092,000
FY1986 Request	$41,730,000
Difference FY1986/FY1985	$ 2,638,000

The FY1986 Budget Request for Computer Research is $41,730,000. This is an increase of $2,638,000, or 6.8 percent, above the FY 1985 Current Plan. This budget plan allows no expansion of the Coordinated Experimental Research (CER) program but does provide funds to maintain the activity at its FY1985 level with allowance for inflation of operating costs. It also provides limited real growth in instrumentation for academic computer research and some relief for the core science research project programs that have been held down for five years to allow more rapid expansion of the (CER) program. This relief is provided mostly to the more theoretical computer research areas for which NSF has unique responsibility.

- Support for coordinated experimental research facilities will be increased by $900,000, or 5.84 percent, to a total of $16,300,000. This will cover inflation of the costs of performing research but allow no increase in the number of active CER awards. The total number will remain at about 22, with new or renewal awards replacing those terminating in FY1986. Support for the Computer Science Network (CSNET), which was $300,000 in FY1985, will be terminated in FY1986, reflecting the shift of that project to a completely self-supporting status.
- The research equipment program will be increased by $290,000, or 19.3 percent, to a total of $1,790,000. This increase will strengthen the research instrumentation on which much of academic computer research depends.
- Research project support will be increased by $1,750,000, or 8.0 percent, to a total of $23,640,000. This will allow limited expansion of support for more theoretical computer research projects and for graduate students in all research areas. These items have highest priority in academic computer research at this time.

The increases for the eight program elements for FY1986 over FY1985 are:

	Change, FY 1985 to FY 1986	
	$Millions	Percent
Theoretical Computer Science	$0.65	15.8%
Software Systems Science	0.4	10.0
Software Engineering	0.35	10.0
Intelligent Systems	0.0	0.0
Computer Systems Design	0.38	10.0
Coordinated Experimental Research	0.6	3.82
Special Projects	0.0	0.0
Computer Research Equipment	0.29	19.3
Total Computer Research	$2.64	6.8%

The following text is excerpted from a report prepared by the staff of the Science and Engineering Directorate of NSF and submitted to Congress as a part of the material which accompanied the Administration's Budget Request for the Fiscal Year 1986.

Science and Engineering Education Program Activity Summary
$82,000,000

(Millions of dollars)

Activity	Actual FY1984	Request FY1985	Plan FY1985	Request FY1986
Research Career Development	$20.3	$21.0	$27.3	$27.3
College Science Instrumentation	0.0	0.0	5.0	5.0
Materials Development and Research	23.4	27.7	22.7	22.7
Teacher Enhancement and Informal Science Education	11.9	25.0	25.0	25.0
Studies and Program Assessment	1.8	2.0	2.0	2.0
Total	$57.4	$75.7	$82.0	$82.0

The goals of the Science and Engineering Education (SEE) activity are to provide strong leverage for improving the quality of the Nation's science and engineering education at all levels and help assure tomorrow's citizens an adequate scientific knowledge base for more productive living in a high-technology, information-intensive society. The intention is to develop a continuing national capability to maintain and renew excellent education in mathematics, science and technology.

SEE accomplishes this goal by conducting leadership activities to inform and/or stimulate other sectors and by support of original work and other high-leverage activities that serve as prototypes and models of excellence for the Nation. A major objective is to encourage partnerships and cooperation among concerned groups such as educational agencies, universities and business.

Although NSF supports activities at all levels of science and engineering education from the early years through graduate and postdoctoral training, SEE is currently targeting for special emphasis the science and mathematics taught in the middle and elementary grades of the Nation's schools. Strong evidence suggests not only that these years are crucial to the ultimate outcomes of education, but also that the problems of learning and motivation in mathematics and science are most complex at these levels.

The problems facing the Nation's schools are now well known, due in large part to the wide publicity given to the numerous national commission reports that appeared in the last few years. Many activities directed at solving these problems are now underway throughout the country. However, although there are now many activities underway, there remains a major need for national-level programs, carefully structured to provide support at minimal but critical levels and to catalyze a range of improvement efforts. There also is a severe need for communication networks among the activities now underway and those to be developed in the future. NSF's programs have been designed to satisfy these needs, by capitalizing on NSF's unique position to lead this effort. This unique position is derived from NSF's extensive interactions with practicing mathematicians, scientists and engineers and with educational and professional institutions and societies.

NSF will also continue to support graduate fellowships in the sciences and engineering, significant improvements at the high school level, and limited, but high-leverage, activities at the undergraduate level. To address its goal, SEE will provide merit-based, competitive support for:

- Graduate fellowship activities designed to recognize and support the Nation's most talented graduate students and prepare them to enter the science and engineering work force, with specific attention given to the participation of minorities;
- College science instrumentation to strengthen the laboratories and curricula in undergraduate science instruction at the Nation's predominantly undergraduate colleges;
- Research and development projects to enable scientists and science educators to develop instructional materials for student and teacher preparation, to understand better the processes of teaching and learning, and to study and develop potential applications of advanced technologies;
- Local and regional projects for continuing education and professional development for precollege mathematics and science teachers, programs of informal science education through museums and the media, and dissemination activities to bring teachers information on new programs and materials;
- Studies and analyses of existing educational data bases to provide systematic and current understanding of the condition of science and mathematics education in the United States; and
- Projects at all levels that seek to reduce the barriers to careers in science and engineering for women, minorities, and the physically handicapped.

The building of partnerships and communications networks is a central element in NSF's Science and Engineering Education plan for FY1986 and the future. This and other aspects of the program are consistent with the goals and purposes of P. L. 98-377, the Education for Economic Security Act.

NSF Role

The National Science Foundation Act of 1950, as amended (42 U.S.C. 1861–1875), authorizes the NSF to initiate and support programs to strengthen science and engineering education at all levels in the mathematical, physical, biological, engineering, social, and other sciences and to award graduate fellowships in these fields. NSF science and engineering education activities emanate from this basic authority.

NSF support for science and engineering education activities represents only a small fraction of the total national effort. Therefore, NSF programs are designed to gain maximum leverage from relatively small investments that can lead to significant improvements in the Nation's science and engineering education activities.

NSF staff members are called upon frequently for their expertise in improvement of science and mathematics education by many national organizations. Governors' offices, state legislatures, state and local educational agencies, universities, and other Federal agencies have sought advice from the NSF on ways to improve their programs. In FY1984, the following countries sent representatives or inquiries to NSF to learn about United States precollege mathematics and science education: France, Taiwan, Australia, Italy, United Kingdom, The Netherlands, New Zealand, South Africa, Japan, Belgium, Morocco, Sweden, People's Republic of China, Saudi Arabia, Brazil, Malaysia and Argentina.

The Foundation will continue to work with the Department of Education, the Department of Energy, the National Aeronautics and Space Administration, and other Federal agencies to ensure program coordination and complementary effort.

Research Career Development Subactivity
$27,300,000

The objective of the Research Career Development subactivity is to promote the development of young scientists and engineers, and thereby help to assure a steady flow of high-ability students through the educational and research training systems of the Nation. This objective is addressed through Graduate Research Fellowships, which promote the future strength of the Nation's scientific endeavors by recognizing and supporting the most promising graduate students. Highly talented U.S. citizens who are beginning graduate study are identified in a national competition. Awards for these portable fellowships are made on the basis of merit in all fields of science and engineering. Within this framework, support is also provided for graduate students who are members of ethnic minority groups underrepresented

in science and technology through the award of Minority Graduate Fellowhips.

Fellowship awards provide both stipends and cost-of-education allowances (institutional allowances in lieu of tuition and fees). Up to three years of support is offered to outstanding graduate students for study at institutions of their choice. Full-time study support of this kind has historically accelerated Fellows' progress toward active and distinguished science and engineering careers.

College Science Instrumentation Subactivity
$5,000,000

The objective of the College Science Instrumentation subactivity is to strengthen and support models of excellence in science and engineering instruction at the four-year colleges. This target population is selected because of the great needs for modern instructional instrumentation at these institutions and the particular importance of the four-year colleges in producing outstanding graduates who become scientists and leaders of government, business, and the professions.

The College Science Instrumentation Program (CSIP) provides competitive, merit-based support for the improvement of undergraduate science laboratories and curricula through:

- Introduction of modern instruments to improve the experiences of undergraduate students in science and engineering courses, laboratories, and field work;
- Interfacing of computers with scientific instrumentation and other appropriate uses of current technology in science and engineering instruction;
- Development of new instrumentation that extends instructional capabilities; and
- Establishment of equipment sharing capability via consortia or centers.

The NSF funds are used only for the purchase of scientific equipment and instrumentation needed for these improvements. Institutions must contribute sufficient funds to at least match the NSF grant, thus effectively doubling the impact of the program, and serving, in many cases, to establish partnerships involving the colleges and private industry. This and other aspects of the program are consistent with the goals and purposes of P.L. 98-377, the Education for Economic Security Act.

Materials Development and Research Subactivity
$22,700,000

The objective of the Materials Development and Research subactivity is to strengthen the quality of education in mathematics, science and technology for the Nation's youth by supporting the generation of new knowledge on learning and teaching and the development of instructional materials, improved methods for teacher preparation, and applications of advanced technologies.

This subactivity is responsive to the major recommendations of the report of the National Science Board (NSB) Commission on Precollege Education in Mathematics, Science and Technology, *Educating Americans for the 21st Century*, September 1983. These recommendations state that "the National Science Foundation should take a leadership role in promoting and supporting" these areas in a manner that will point the direction for widespread change and improvement over the next ten years. The NSB Commission argued for the importance of the Federal investment in research and development, since other sectors of the Nation will benefit from the Foundation's experience in conducting programs of the highest quality. For FY1985 and FY1986, up to 50 percent of the funds available for the Materials Development and Research subactivity will be devoted to projects that target middle and elementary school instruction.

The approaches and materials developed through this effort will help prepare students for productive living in a high-technology, information-intensive society, for enhanced career options, and for pursuing higher education opportunities in mathematics, science, and technology.

This subactivity supports efforts in the following areas:

- *Instructional Materials Development* to enable the most capable scientists and science educators to design, create and develop new or improved science and mathematics instructional materials for students and teachers that have the potential for widespread national use.
- *Materials and Methods for Teacher Preparation* to stimulate the development of innovative methods, national model programs, and related materials for preparing elementary and secondary school teachers of science and mathematics.
- *Applications of Advanced Technologies* to provide for research and development on the creation, design and application of advanced technologies—particularly the computer—as educational and instructional tools for students and their teachers. Products may include prototypes of new hardware, software, systems and languages.
- *Research in Teaching and Learning* to undertake basic and applied research on significant factors essential to the effective teaching and learning of mathematics and science at all levels. This effort is pursued in collaboration with the Biological, Behavioral and Social Sciences activity.

Teacher Enhancement and Informal Science Education Subactivity
$25,000,000

The objective of the Teacher Enhancement and Informal Science Education subactivity is to promote the development of quality educational

programs in mathematics, science, and technology in both formal, school and informal, out-of-school, settings. The objective is accomplished by supporting activities that prepare, motivate and provide continuing assistance for teachers, who are central to the motivation and learning of students, and that provide appropriate, parallel out-of-school reinforcement and continuing exposure to what has been learned. The elements supported under this subactivity address several of the recommendations contained in the many national studies of mathematics, science and technology education.

Support for this subactivity will help teachers provide all students with basic mathematics and science education in grades kindergarten through twelve; this is all the formal exposure to mathematics and science that some citizens will ever get. This early development is intended for all students, not only for prospective mathematicians, scientists, engineers and science educators. Opportunities for out-of-school reinforcement through electronic and print media, museums and nature centers, and local continuing education possibilities build upon, review and consolidate these formal exposures to mathematics, science and technology. For FY1985 and FY 1986, up to 50 percent of the funds available for teacher enhancement/development programs will be allocated for projects that target elementary and middle school teachers.

This subactivity will consist of the following:

- *Presidential Awards for Excellence in Science and Mathematics Teaching* provide for annual recognition of outstanding secondary school teachers in science and mathematics. Increased professional status and awards to their schools provide strong incentives for high-quality teachers to enter and remain in their field. Publicity and information about the methods that these teachers find successful help other teachers develop their own, more effective approaches.
- *Leadership Activities for Precollege Teachers* (formerly "Honors Workshops") involves activities that:

  –Establish a cadre of well-trained and highly-skilled elementary school and secondary school master teachers.

  –Provide an incentive to establish cooperative and collaborative efforts to use and build upon the human resources developed. The leadership programs will serve as a magnet for attracting the most talented individuals into the educational enterprise.
- *Local and Regional Teacher Development* involves activities that:

  –Assist local and regional communities to provide appropriate continuing education opportunities to improve the mathematics and science knowledge base of elementary school teachers and of ill-prepared secondary school teachers.

  –Will involve school administrators, school boards, local community leaders, and other educational policy-makers and draw upon the master teacher resources available in the region.
- *Informal Science Education* involves activities that:

  –Provide greater opportunities for the public to make use of the rich resources for mathematical, scientific and technological learning that exist outside the formal educational systems.

  –Encourage communications media to take a more intense and greater interest in imparting knowledge about the interesting processes involved in mathematical, scientific and technological concepts to both the public at large and selected groups and to develop techniques designed to enhance classroom use, especially at the elementary and middle school level, of materials originally designed for broadcast.

  –Support the efforts of local groups, such as boys' and girls' clubs, service clubs, etc., to provide active engagement in out-of-school mathematics and science activities for their members of for groups served by them.
- *Information in Science and Mathematics Education* involves activities designed to:

  –Support the development and activities of substantial networks and collaborations designed to meet the needs and take advantage of the opportunities in mathematics, science and technology education in a well-defined region of the country. Collaborations are encouraged that take advantage of the curricula and materials, methods and human resources and expertise identified and developed in other mathematics and science education projects, especially those supported by the NSF. An information brokering role is assumed by the NSF in helping them develop.

  –Provide opportunities for elementary and secondary school teaching and administrative personnel, locally and through the networks, to learn about new and alternative instructional materials, teaching techniques and recent research findings applicable to the classroom as well as strategies for making choices among them.

  –Build bridges between educational product developers and distributors and users, including teachers and agencies responsible for product selection, to help producers better meet the needs for effective mathematics and science instructional materials.

Studies and Program Assessment Subactivity
$2,000,000

The objectives of the Studies and Program Assessment subactivity are to serve a major role

in policy formulation to improve and strengthen science and engineering education in the U.S. and to provide support for leadership efforts of the Foundation in science and engineering education activities. The efforts supported under this subactivity address recommendations in the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology that require monitoring of educational progress by developing and tracking indicators of the condition of precollege mathematics and science education. Other efforts encourage private sector liaison to strengthen science and mathematics education.

This subactivity consists of several major activities that:

- Support the collection, analysis, evaluation and dissemination of information on the status and condition of education in mathematics, science and technology in the U.S. by means of a program of external grants and contracts and internal analysis and publications of major indicators;
- Establish and maintain data systems designed to monitor the status and progress of education in the U.S.;
- Determine through the design and implementation of systematic program evaluation the impact and outcomes of past and present NSF support for science and engineering education;
- Are designed to develop and encourage cooperative partnerships and other interactions with the private sector, especially industry, to strengthen science and engineering education.

Report to the Members of the Society

Report of the Acting Executive Editor[1]

Mathematical Reviews—MR—*the quarto-sized (9 × 12 inches) basic bibliographic reference tool in mathematics; one of the very few places where mathematicians critique each other's work for the record; the orange giant which consumes yard after yard of office or library bookshelves; the authoritative record of the literature in research mathematics.*

This major publication of the American Mathematical Society—constituting roughly one-third of the Society's budget and employing one-third of the Society's staff—is concluding a period of substantial change, and facing important challenges. This report will bring readers up to date on these changes, and highlight the challenges. It can be read in parallel with the report of the Executive Director, which appeared in the *Notices* (March 1985, pages 164–167).

A Time of Change

Two momentous changes in the way *Mathematical Reviews* operates occurred in 1984:

The editorial offices of MR moved from rented space at 611 Church Street in Ann Arbor to another Ann Arbor building—416 Fourth Street—which was purchased by the Society and renovated and expanded to fit MR's needs.

MR has changed to a new typesetting system, TEX, designed especially for the presentation of mathematics.

A New Home

In 1965, MR moved from Providence, Rhode Island, to Ann Arbor, Michigan, on the occasion of the appointment of W. J. LeVeque (now Executive Director of the Society) as Executive Editor. By coincidence, the first Ann Arbor location of MR was part of the building recently bought and improved for MR by the Society. Later moves to a house on Hill Street and to the Campus Arcade building were all to rental property. The newly acquired and renovated facility at 416 Fourth Street was built as a brewery in the early 1900s, and served as an ice cream factory during Prohibition, an Argus camera factory during the 30s, 40s and early 50s, and a University of Michigan office building until purchased by the AMS.

Purchase of the building was completed in April 1984; occupancy was in November. In the interval, major renovation took place: demolishing outbuildings, adding floors, stairs and elevators, and providing offices, barrier-free ramps, improved heating and cooling, new windows, carpet, and paint, and an improved parking area. Also provided were a local area network for computer connections, and a new telephone system. These steps represent a commitment by the Society to provide for MR a permanent and efficient facility in which to edit and produce the most authoritative and comprehensive bibliographic data base of mathematical research publications available anywhere in the world.

A New Language

The 1985 issue year of MR and *Current Mathematical Publications* (CMP) marks the change to a new typesetting language: TEX, developed by D. E. Knuth of Stanford University, represents a major development in the effort to provide an efficient and effective way for authors, publishers, and on-line vendors to provide to users an easily readable and attractive presentation of mathematical information in familiar formats. TEX has the capability of providing, from one initial input file, output for a long list of services to users:

CMP, produced in less than four weeks production time, listing all bibliographic items recently added to the MR data base in subject classification order, with an author and key index;

Cumulative author and key indexes for CMP;

Monthly issues of MR, including an author index;

Individual sections of MR, tailored to the interests of individual subscribers, including monthly and annual author indexes;

Annual indexes of MR (author and subject);

Cumulative indexes (author and subject);

Review volumes drawn from MR, in such fields as number theory, ring theory, graph theory, etc.;

MathSci, the newly expanded and more timely on-line version of CMP and MR;

Special tapes formatted to respond to specific interests.

All of these outputs can be provided from the single, original TEX input file, which adjusts for various type fonts, line lengths, page sizes, and printing or viewing devices.

MR has been typeset by many vendors; all the early ones (through June 1979) utilized hot lead type, so that each index or special purpose volume

[1] *The Executive Editor of* MR, *Dr. J. L. Selfridge, is on study leave for the academic year 1984-1985 at Northern Illinois University. He returns to* MR *on July 1, 1985.*

had to be completely rekeyboarded and reset. In 1978, bibliographic information was being keyboarded between eight and eleven times for each item, with attendant opportunities for added error (not to mention added expense) at each stage. Since the introduction of computerized typesetting, the number of keyboardings has been reduced to one. The first computerized typesetting language was STI (Science Typographers, Inc.), a proprietary language which required that output be obtained from a typesetting machine utilizing STI's output program. By contrast, TEX is in the public domain and includes routines which will drive many familiar typesetting devices, such as Imagen, Florida Data, Xerox 9700, QMS, Varian, Alphatype, APSMicro5, etc.

Electronic "On-line" Access

MR and CMP are now available on a number of vendor systems for information retrieval in MathSci, the premier "on-line" file of bibliographic information and evaluative reviews for the fields of mathematics, statistics, computer science and applied mathematics. The shift to TEX as the typesetting language for MR and CMP means that before too long the information in these files will be viewable on screens or in "off-line" printouts in its original full typeset sophistication, with all symbols and displays faithfully reproduced.

A Time of Challenge

The last seven years have been a time of unusual challenge for MR:

- Conversion to computerized typesetting required a substantial change in procedure.
- Conversion to computerized storage and maintenance of bibliographic and reviewer information required substantial fiscal and personnel resources; reconversion to a second system required even greater resources.
- A significant backlog of unreviewed material which had developed in the early and mid 1970s required the publication in 1979 of almost twice as many reviews as in any previous year; this unprecedented bulge in volume size led to a delay in publication which required that, in 1980 and 1981, 18 "monthly" issues be produced in 12 months.
- The rapid inflation of the late 1970s caught the Society (and most nonprofit organizations) unawares; they failed to raise prices to match the inflationary increases and found themselves faced with substantial budget deficits. Resulting heavy price increases, required to cover those deficits and re-establish break-even fiscal operations, came as libraries and individuals were feeling the restrictions of the recession of the early 1980s. The resulting reduction in numbers of subscribers added to the pressure on subscription prices.
- The unexpected rise in the strength of the U.S. dollar against almost all foreign currencies meant that the increase in the price of MR to foreign subscribers was markedly more serious than the already heavy increase to domestic subscribers. This dramatic increase in the strength of the dollar also meant that American subscribers to the only other western-language reviewing journal in mathematics, *Zentralblatt für Mathematik* (Zbl), could suddenly buy it for noticeably less than MR. Some libraries whose need for reviewing journals in mathematics was marginal chose to subscribe only to Zbl, further increasing the squeeze on income to MR, and thus the pressure on the Society to raise prices to the remaining subscribers.

These challenges have been faced squarely by the Trustees and the staff of MR, and most have been overcome. The journal is now published in timely fashion, with an extremely timely early-awareness journal—*Current Mathematical Publications* (CMP)—arriving in libraries before many of the journals covered therein. Efforts continue to find new ways to reduce costs and subscription prices of MR.

In addition, efforts also continue to find an accommodation with the editors and publishers of Zbl.

W. B. WOOLF

AMS Postdoctoral Research Fellowship

The Society has awarded one Postdoctoral Research Fellowship for 1985-1986. The recipient is R. MICHAEL BEALS, who received his Ph.D. from Princeton University in June 1980. He is currently an Assistant Professor at Rutgers University.

The AMS Research Fellowship fund was established in 1973 in response to the need for funds for postdoctoral research. The fellowships are awarded on the basis of mathematical merit to persons who are five to ten years past the Ph.D., but below the academic rank of professor (regardless of their age), who are citizens or permanent residents of a country in North America. The awards are intended to support research fellows for a period of one year and, at present, carry a stipend of $30,000 each, with an expense allowance of $1,000. The competition was under the supervision of the Society's Committee on Postdoctoral Fellowships, consisting of George E. Andrews (chairman), J. William Helton, Peter J. Kahn, H. Jerome Keisler, Neil I. Koblitz, Ivar Stakgold, and Alan D. Weinstein.

There were many strong candidates among the thirty-one applicants. The fellowship is financed by the generous contributions of supporters of mathematical research, supplemented with Society funds appropriated according to a matching formula. The continuation of the AMS Research Fellowship program depends on contributions the Society receives. Every member of the Society is urged to contribute to the Fund. Contributions are, of course, tax deductible. Checks should be made payable to the American Mathematical Society, clearly marked "AMS Research Fellowship Fund" and sent to the American Mathematical Society, Post Office Box 1571, Annex Station, Providence, Rhode Island 02901.

Unpublished Lecture Notes

The *Notices* will institute a column containing lists of unpublished lecture notes available from departments in the mathematical sciences, research institutes, and other organizations in the nonprofit sector.

Readers are invited to submit material for this column; items submitted for inclusion in this section of the *Notices* should be accompanied by the following information:

Name of author(s), title, year, number of pages, price;

Address for orders and information about payment (postal surcharge, if any, or whether postpaid, to whom checks should be made).

Items should be sent to the Providence office (*Notices* Lecture Notes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940).

Herman H. Goldstine and I. M. Singer Awarded National Medal of Science

At ceremonies in the East Room of the White House on February 27, 1985, President Reagan awarded the National Medal of Science to nineteen American scientists who "have made outstanding contributions to our way of life and to our future". Included in this group were two mathematicians, Herman H. Goldstine and I. M. Singer.

Eighteen other mathematicians have received the National Medal of Science since the award was established by Congress in 1959. The medal is given to individuals who are "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical or engineering sciences."

Goldstine was honored "for his fundamental contributions to the development of the digital computer, computer programming, and numerical analysis". Professor Singer was honored "for his inspired revival of differential geometry and its connection to analysis".

Herman H. Goldstine was born on September 13, 1913 in Chicago, Illinois. He received his Ph.D. (1936) from the University of Chicago and held an assistantship in mathematics there from 1936 to 1939. He then went to the University of Michigan as an instructor and was promoted to Assistant Professor in 1945, a position he held until 1948. He also served as Assistant Project Director, Electronic Computer Project, Institute for Advanced Study (1946–1958). In 1946, he became a member of the Institute and, in 1950, he was elected as a long-term member. In 1958 Goldstine joined the T. J. Watson Research Center of the IBM Corporation. He was made an IBM fellow in 1969. Goldstine is a member of the National Academy of Science, and is currently the Executive Officer of the American Philosophical Society.

Shmuel Winograd of the T. J. Watson Research Center, IBM, was asked by the Editors of the *Notices* to comment on Goldstine's contributions. He responded with the following:

> Herman J. Goldstine is one of a small group of pioneers whose contributions in the 40s and early 50s created the digital computer as we know it today. Recognizing the revolutionary potential of electronic speed in computation, Goldstine began a long collaboration with

News from the Mathematical Sciences Research Institute

Berkeley

This is being written on April 1, 1985, the day that MSRI began operations in its new building at 1000 Centennial Drive, 1000 feet above the main Berkeley campus. It happens to be a clear day, and there is a sweeping view of the Bay, the Oakland and San Francisco skylines, and the bridges.

The 1984-1985 year is winding up with a blitz of three nearly consecutive workshops, one for each of the programs: *4-Manifolds* (May 20–25), *Differential Geometry* (May 28–June 1) and *K-Theory of Operator Algebras* (June 5–12).

The programs planned for 1985-1986 and 1986-1987 appeared in the MSRI column in the November 1984 *Notices*, page 776. For the year 1987-1988 (the first year of the pending five-year renewal) the plans call for classical analysis (program committee: C. Fefferman, E. Stein, G. Weiss) and representations of Lie groups (W. Schmid, D. Vogan, J. Wolf).

Three "microprograms" (i.e. programs much shorter than the usual ones) are in the works.

(1) Nonlinear diffusion equations and their equilibrium states (W.-M. Ni, L. Peletier, J. Serrin), August 25–September 13, 1986.

(2) Commutative algebra (C. Huneke, M. Hochster, J. Sally), June 15–July 3, 1987.

(3) Structure of Banach spaces (J. Bourgain, W. Johnson, Y. Lindenstrauss, G. Pisier, H. Rosenthal), some time during 1987-1988.

MSRI has announced that between six and ten "midcareer" sabbatical type awards will be made for 1986-1987. These will provide up to a half of the applicant's salary. No connection with the main program (number theory with connections to algebraic geometry) is expected. The deadline for applications is **October 1, 1985** with announcements of awards about a month later. For further details see the advertisement in the March 1985 *Notices*. Posters have been widely distributed.

The mathematical community is warmly invited to submit suggestions concerning programs, microprograms, the midcareer sabbatical awards, or any aspect of the operations. Write to the Director, Irving Kaplansky, or the Deputy Director, Calvin Moore, at the Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720.

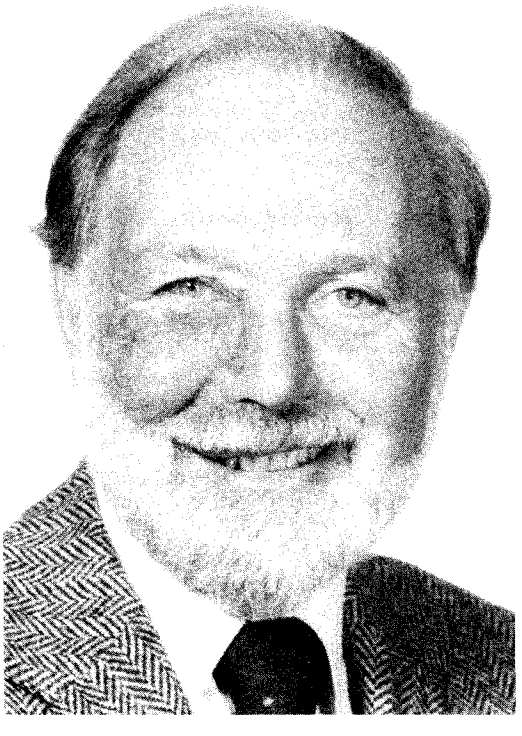
von Neumann which laid the intellectual foundation for the computer age. In a series of reports they defined the computer organization that is still dominant today—the set of instructions, arithmetic organs, the memory management, the input-output, and control. The machine envisioned in these reports was built at the Institute for Advanced Study in 1946–1950 and served as the prototype for almost all the computers that have been built since. In the same period, Goldstine and von Neumann made fundamental contributions to the creation of the art of programming and, by the first theoretical analysis of computer round-off error and by actual large-scale computation, showed the feasibility of very large scale calculations.

I. M. Singer was born on May 4, 1924, in Detroit, Michigan. He received his Ph.D. (1950) from the University of Chicago. He was an instructor in mathematics at M.I.T. (1950–1952), assistant professor at the University of Calfornia, Los Angeles (1952–1954), visiting assistant professor at Columbia University (1954-1955), and member, Institute for Advanced Study (1955-1956). From 1957 until his early retirement in 1979, he was a member of the faculty at M.I.T. In 1979 he became a Professor of Mathematics at the University of California, Berkeley. He returned to M.I.T. this year as the John D. MacArthur Professor of Mathematics and is on leave from the University of California, Berkeley. In addition, Singer has

been an Alfred P. Sloan Foundation Fellow (1959–1962) and a Guggenheim Foundation Fellow (1968-1969, 1975-1976). He is a member of the National Academy of Sciences and the White House Science Council. In 1969 he received the Bôcher Prize. Singer has served on many AMS committees and as Vice President (1970-1971), Member-at-Large of the Council (1978) and on the Executive Committee (1975, 1978).

S. S. Chern of the University of California, Berkeley, was asked by the Editors of the *Notices* to comment on Singer's contributions. He responded with the following:

> I. M. Singer is a mathematician of great versatility and depth. He is best known for the Atiyah-Singer index theorem, one of the great mathematical achievements of the century. His other works on differential geometry include: holonomy groups (with W. Ambrose), infinite pseudo-groups (with S. Sternberg), spectrum of the Laplacian (with H. McKean), and the Reidemeister torsion (with D. B. Ray), each of which is a topic of major importance. He came to geometry from analysis. Earlier in his career he made contributions to functional analysis, such as function algebras, operator algebras, and representations of Lie groups. In recent years he has devoted his research on relations between mathematics and theoretical physics. He has a tremendous influence on young mathematicians. He is a mathematician with a clear view of its future.



News from the Institute for Mathematics and its Applications

Minneapolis

Stochastic Differential Equations and Stochastic Analysis are the themes for the year August 1985–July 1986 at the Institute for Mathematics and its Applications. The theory of stochastic differential equations was originated by K. Ito, who will be in residence for the entire year. During August–December 1985, there will be three periods of concentration.

The first period, *Stochastic Integrals*, opens with a workshop (August 21–30) organized by D. Stroock. It will provide a "preview of coming attractions." Lecturers will give expository talks summarizing topics to be covered in greater detail later in the year. The session should appeal to nonspecialists as well as to experts.

The session in September and October is devoted to *Random Media.* A workshop will be held September 18–24.

The subject deals with a collection of problems which emerge when certain processes take place in a medium described by a random field or some other collection of random variables. For example, acoustic wave propagation in a medium whose index of refraction is a random function, motion of an electron in a random potential, diffusion in a region where the diffusivity is a random function, etc. The session will be devoted to theoretical and applied problems in these areas, including the problem of localization. Localization is a term which describes how a random medium can trap a wave or particle in a finite region of space for a long time.

During November and December the topic for discussion will be *Large Deviations.* A workshop organized by S. Orey (November 4–15) will open this period of concentration. *Large Deviations* has wide applicability to mathematical areas such as Gaussian processes, singular perturbation problems, sums of independent and dependent random variables, dynamical systems and local time. It has also been applied to other areas—including infinite particle systems, statistics, statistical mechanics and quantum theory.

Workshops to be held later in the program include (a) Regularity of PDE, Harmonic Analysis, Malliavin Calculus; (b) Disordered Systems, Percolation and Self-Avoiding Random Walks; (c) Hydrodynamic Behavior of Interacting Particle Systems and (d) Stochastic Differential Systems with Applications to Control Theory, Electrical/Computer Engineering, and Operations Research.

The organizing commitee for the year 1985-1986 consists of W. Fleming, P. L. Lions, S. Orey, G. Papanicolaou and D. Stroock (chairman). For a detailed list of speakers please refer to the Special Meetings column.

For additional information contact: H. Weinberger, Director 612-373-0355.

Sloan Fellowships Awarded

The Alfred P. Sloan Foundation has announced the award of ninety Sloan Research Fellowships for 1985-1986, including twenty awards to mathematicians. Awards were also made to physicists, chemists, economists, and neuroscientists. Each award is for $25,000 per year.

The Sloan Research Fellowships program is over thirty years old, making it one of the oldest such programs in the United States. During this period a total of $42 million dollars has been spent on this program.

This year's winners were selected from over 400 nominees by a committee consisting of fifteen members, three representing each of the five areas in which the awards were made. The mathematicians on the committee this year were Peter D. Lax, Courant Institute of Mathematical Sciences, New York University; John W. Milnor, Institute for Advanced Study; and David Mumford, Harvard University.

The awards for mathematicians were made to CHARLES J. AMICK, University of Chicago; DAVID E. BARRETT, Princeton University; R. MICHAEL BEALS, Rutgers University; RUSSEL E. CAFLISCH, New York University; TED C. K. CHINBERG, University of Pennsylvania; ROBERT F. COLEMAN, University of California, Berkeley; JACK F. CONN, California Institute of Technology; DENNIS M. DETURCK, University of Pennsylvania; STEVEN E. HURDER, University of Illinois, Chicago; DAVID JERISON, Massachusetts Institute of Technology; NICHOLAS J. KUHN, Princeton University; TERRY R. MCCONNELL, Syracuse University; KARL RUBIN, Ohio State University; JOHN SMILLIE, CUNY, Lehman College; DENNIS W. STANTON, University of Minnesota, Minneapolis; ROBERT W. THOMASON, Johns Hopkins University; ANDREJS TREIBERGS, University of Chicago; MICHAEL S. VOGELIUS, University of Maryland; BRIAN WHITE, Stanford University; LAI-SANG YOUNG, Michigan State University.

Guggenheim Fellowships

The John Simon Guggenheim Memorial Foundation has announced the award of 270 Guggenheim Fellowships in its sixty-first annual competition. This year's list includes thirteen in the mathematical sciences and related disciplines.

Names of the recipients, their positions, institutional affiliation, and proposed topics of study are: LUIS A. CAFFARELLI, Professor of Mathematics, University of Chicago (Nonlinear partial differential equations in geometry and mechanics); DANIEL Z. FREEDMAN, Professor of Applied Mathematics, Massachusetts Institute of Technology (Studies in supersymmetric quantum field theory and supergravity); JOSEPH L. GASTWIRTH, Professor of Statistics and Economics, George Washington University (Statistical problems in law and public policy); J. WILLIAM HELTON, JR., Professor of Mathematics, University of California, San Diego (Functional analysis in electrical engineering); RICHARD E. LADNER, Professor of Computer Science, University of Washington (The theory of distributed computing, and computer science education for the deaf); ANDREU MAS-COLELL, Professor of Economics, Harvard University (The complexity of economic decision rules); HERBERT E. SCARF, Sterling Professor of Economics, Yale University (Studies in mathematical economics and complexity theory); YUM-TONG SIU, Professor of Mathematics, Harvard University (Studies in complex differential geometry); GERARD J. TOOMER, Professor of the History of Mathematics, Brown University (An edition and translation of the *Conics* of Apollonius, books 5–7); KA-KIT TUNG, Associate Professor of Applied Mathematics, Massachusetts Institute of Technology (Studies of atmospheric waves); LESLIE G. VALIANT, Gordon McKay Professor of Computer Science and Applied Mathematics, Harvard University (The complexity of machine learning); ALAN D. WEINSTEIN, Professor of Mathematics, University of California, Berkeley (Hamiltonian systems and nonlinear wave equations); ANDREW J. WILES, Professor of Mathematics, Princeton University (Studies in number theory).

New Members Elected to the Academy of Engineering

The following mathematical scientists were elected to the National Academy of Engineering in March 1985: GEORGE B. DANTZIG (Stanford University); RONALD S. RIVLIN (Lehigh University); CLAUDE E. SHANNON (Massachusetts Institute of Technology); JOSEPH F. TRAUB (Columbia University).

Fulbright Scholar Awards 1986-1987

The Council for International Exchange of Scholars (CIES) has announced that applications are now being accepted for Fulbright Scholar Awards in research and university lecturing abroad during 1986-1987. This year's offerings include 300 grants in research and 700 grants in university lecturing for periods ranging from three months to a full academic year. There are openings in over 100 countries and, in a few cases, the opportunity for multi-country research is available.

Benefits include round-trip travel for the grantee and, for full academic year awards, one dependent; maintenance allowance to cover living costs of grantee and family; tuition allowance, in many countries, for school-age children; and book and baggage allowances. The basic eligibility requirements for a Fulbright

Award are U.S. citizenship; Ph.D. or comparable professional qualifications; university or college teaching experience; and, for selected assignments, proficiency in a foreign language.

Application deadlines for 1986-1987 are **June 15, 1985** (for Australasia, India, Latin America and the Caribbean); **September 15, 1985** (for Africa, Asia, Europe, and the Middle East); **November 1, 1985** (for Junior Lectureships to France, Germany, Italy, and Spain); **December 1, 1985** (for Administrators' Awards in Germany, Japan, and the United Kingdom); **December 31, 1985** (for NATO Research Fellowships); and **February 1, 1986** (for Spain Research Fellowships, and France and Germany Travel-Only Awards).

Information and applications may be obtained from CIES, 11 Dupont Circle N.W., Washington, DC 20036-1257; 202-939-5401.

–CIES News Release

Conference on New Directions in Applied and Computational Mathematics

This conference, in honor of Gail S. Young on his 70th birthday, focuses on the mutual interaction among pure mathematics, applied mathematics, and computer science that is rapidly and dramatically changing the nature of all three disciplines. It is being held at the University of Wyoming, Laramie, Wyoming, August 8–10, 1985 and is being sponsored by the Sloan Foundation, the National Science Foundation (NSF) and the Air Force Office of Scientific Research (AFOSR). The lectures will address applications of quite pure mathematics that have arisen in recent years; for example, the role of combinatorics, algebra, and recursive function theory in computer science, application of algebraic geometry to control theory, the use of number theory in coding problems, the role of algbebraic topology in applied mathematics, and others. The conference will also emphasize the far-ranging effects of computing, for example, in the areas of numerical analysis and nonlinear partial differential equations which, in turn, have pervasive scientific and engineering applications. The following is a partial list of speakers who have tentatively agreed to attend: Henry Pollak (AT&T Communications), Anil Nerode (Cornell University), Daniel Kleitman (Massachusetts Institute of Technology), Christopher Byrnes (Arizona State University), Shmuel Winograd (IBM), Richard Ewing (University of Wyoming), Peter Hilton (State University of New York, Binghamton), and Clyde Martin (Texas Tech University). The complete program will be announced in the next issue of the *Notices*, in *Focus*, and in the *SIAM Newsletter*. The conference will conclude with a panel discussion dealing with the implications of graduate and undergraduate education in mathematics. It is anticipated that the proceedings of this conference will be published.

With the conference timed for the three days prior to the start of the Annual Summer Meetings, those planning to attend the annual meetings should consider arriving early to attend this conference. A limited amount of funding will be available to partially defray expenses. Address inquiries to Kenneth I. Gross, Director, Conference on Applied and Computational Mathematics, Department of Mathematics, University of Wyoming, Box 3036, University Station, Laramie, Wyoming 82071.

Trust Fund Established

Professor Paul R. Burcham of the University of Missouri, Columbia, died on March 13, 1985. He was a member of the Society for over forty years. His family has set up a trust fund in his memory at the university. Contributions to this fund should be sent to the Department of Mathematics, 202 Mathematical Science Building, University of Missouri, Columbia, MO 65211.

Tome Centennial Symposium

On September 26–28, 1985 Dickinson College will celebrate the 100th anniversary of the Tome Scientific Building.

A two-day interdisciplinary symposium entitled "Science in the Liberal Arts" will not only celebrate the heritage of science teaching in the liberal arts institution, but will also critically examine recent and future trends influencing the role of science in our culture. As part of this symposium, Lynn A. Steen, President of the Mathematical Association of America (MAA), will speak on Friday, September 27, 1985 on *Mathematics: Our invisible culture.*

Further information is available from Susan Wolf, Coordinator, Tome Centennial Symposium, Department of Physics and Astronomy, Dickinson College, Carlisle, PA 17013.

IUTAM Symposia 1988-1989

The United States National Committee for Theoretical and Applied Mechanics (USNC/TAM) is seeking invitations to host IUTAM Symposia any time during the calendar years 1988-1989.

The aim of an IUTAM symposium is to assemble a group of active scientists within a well-defined field for the development of science within that field. In order to achieve effective communication with the group, the number of active participants is necessarily limited. All IUTAM symposia are therefore reserved for invited participants. Invitations to participate are made by the Scientific Committee solely on the basis of scientific merit. Typical symposia invite approximately sixty scientists of whom about twenty-five present prepared lectures.

Invitations to host a symposium should be made on a prepared form which may be obtained from the Secretary of the USNC/TAM. The completed application should be sent to the Secretary not later than **December 1, 1985**. Applications will be competitively screened by the USNC/TAM. A maximum of five for the two-year period will be forwarded to IUTAM where they will compete with those from other countries. Final decisions will be made at the meeting of the General Assembly of IUTAM in August 1986. Approximately twelve to twenty symposia will be scheduled for 1988-1989.

For each proposal accepted IUTAM will appoint a Scientific Committee. The chairman will normally be the submitter of the invitation, but the other members will be chosen from the international scientific community. The proposal may indicate a preference for 1988 or 1989, but actual scheduling within the year will be worked out jointly by the Scientific Committee and IUTAM.

IUTAM provides a small amount of financial support to pay some travel expenses, primarily for young scientists and for scientists from developing countries. Organizers of symposia are encouraged to seek additional financial support from other sources. Upon request the Secretary of USNC/TAM will send a symposium-invitation kit consisting of an application form, some examples of previously approved applications, and a list of recent symposia. Please address all inquiries to Philip G. Hodge, Jr., Secretary, USNC/TAM, 107 Akerman Hall, University of Minnesota, Minneapolis, MN 55455.

1986-1987 Advanced Research Fellowships in India

The Indo-U.S. Subcommission on Education and Culture of the Council for International Exchange of Scholars (CIES) is offering twelve long-term (six to ten months) and nine short-term (two to three months) awards, without restriction as to field, for 1986-1987 research in India. Applicants must be U.S. citizens at the postdoctoral or equivalent professional level. The fellowship program seeks to open new channels of communication between academic and professional groups in the United States and India and to encourage a wider range of research activity between the two countries than now exists. Therefore, scholars and professionals with limited or no prior experience in India are especially encouraged to apply.

This program is sponsored by the Indo-U.S. Subcommission on Education and Culture and is funded by the United States Information Agency, the National Science Foundation, the Smithsonian Institution, and the Government of India.

The application deadline is June 15, 1985. Application forms and further information are available from CIES, Attn: Indo-American Fellowship Program, Eleven Dupont Circle, Suite 300, Washington, DC 20036-1257; 202-939-5472.

–CIES News Release

John Simon Guggenheim Memorial Foundation

Joel Conarroe will succeed Gordon N. Ray as President of the John Simon Guggenheim Memorial Foundation when Ray retires in September 1985 at the age of seventy.

–Guggenheim Foundation Release

Fulbright and Other Grants for Graduate Study Abroad

The United States Information Agency (USIA) and the Institute of International Education (IIE) has announced that applications are now being accepted for 1986-1987 grants for graduate study or research abroad in academic fields.

Applicants must be U.S. citizens at the time of application, who will generally hold a bachelor's degree or its equivalent before the beginning date of the grant and, in most cases, will be proficient in the language of the host country.

Selection is based on the academic, professional, and/or artistic excellence of the applicant, the validity and feasibility of the proposed study plan, the applicant's language preparation and personal qualifications. Preference is given to candidates who have not had prior opportunity for extended study or residence abroad.

The deadline date for receipt of completed applications is **October 31, 1985.** Application forms and further information may be obtained from the Institute of International Education, 809 United Nations Plaza, New York, New York 10017.

–IIE News Release

NSF Announces Mathematical Sciences Postdoctoral Research Fellowships

Thirty recent recipients of doctoral degrees in the mathematical sciences have been offered fellowship awards under the National Science Foundation's (NSF) Mathematical Sciences Postdoctoral Research Fellowship program. These awards will permit recipients to choose research environments that will have maximal benefit to their scientific development.

The awards are made to U.S. citizens or nationals. Selections are made on the basis of ability of the applicant and the likely improvement of her or his future in science. A panel of mathematical scientists, chosen by the American Mathematical Society (AMS), the Institute for Mathematical Statistics (IMS), and the Society for Industrial and Applied Mathematics (SIAM), evaluated ninety-six applications. Final selections were made by the NSF. Each awardee will receive a stipend of $57,600 for study and research over a three-year period.

The recipients in the mathematical sciences are listed below (institutions in parentheses are the current institution, those outside the parentheses are those at which the fellowship will be held): JEFFERY D. ADAMS (University of California, Berkeley), University of California, Berkeley; DAVID A. BAYER (Columbia University), Columbia University; STEVEN A. BUECHLER (University of Wisconsin, Milwaukee), University of California, Berkeley; SAMUEL R. BUSS (Princeton University), University of California, Berkeley; THOMAS D. COCHRAN (Indiana University), Indiana University; DAVID H. COLLINGWOOD (Rutgers University, New Brunswick), University of Utah; JAMES F. DAVIS (Notre Dame University), Notre Dame University; RANDALL L. DOUGHERTY (University of California, Berkeley), California Institute of Technology; PAUL G. DUPUIS (Brown University), University of Minnesota; LESLIE J. FEDERER (University of Michigan, Ann Arbor), University of Maryland; DANIEL S. FREED (Massachusetts Institute of Technology), Massachusetts Institute of Technology; CLAUDE A. GREENGARD (Courant Institute of Mathematical Sciences, New York University), Courant Institute of Mathematical Sciences, New York University; ROBERT L. GROSSMAN (University of California, Berkeley), University of California, Berkeley; NATHAN B. HABEGGER (Yale University), University of California at San Diego, La Jolla; EDUARD HARABETIAN (Courant Institute of Mathematical Sciences, New York University), University of California, Los Angeles; JEE HEUB KOH (Purdue University, West Lafayette), Brandeis University; NICHOLAS J. KOREVAAR (University of Kentucky, Lexington), University of California at San Diego, La Jolla; MICHAEL T. LACEY (University of Illinois, Urbana-Champaign), University of Minnesota; DAVID C. MANDERSCHEID (University of Utah), University of Iowa; NORMAN C. PHILLIPS (University of California, Berkeley), University of California, Los Angeles; JAMES M. RENEGAR, JR., (Colorado State University), Stanford University; THOMAS C. SIDERIS (University of California, Santa Barbara), Courant Institute of Mathematical Sciences, New York University; CHRISTOPHER D. SOGGE (Princeton University), University of Chicago; BRUCE SOLOMON (Indiana University, Bloomington), University of California at San Diego, La Jolla; TIM J. STEGER (Washington University), Yale University; GLENN H. STEVENS (Boston University), Massachusetts Institute of Technology; MICHAEL E. STILLMAN (University of Chicago), Brandeis University; LAURETTE S. TUCKERMAN (Centre d'Etudes Nuclearies de Saclay), University of Texas, Austin; DAVID S. WITTE (University of Chicago), University of California, Berkeley; STEVEN M. ZELDITCH (Columbia University), Massachusetts Institute of Technology. –NSF News Release

1985 Presidential Young Investigators Named

The National Science Foundation recently announced the selection of 200 engineers and scientists to receive the Presidential Young Investigator Awards for 1985. This is the second year in a program begun in 1984. It is expected that 100 new investigators will be selected to receive the five year awards in future years. The awards, which fund research by faculty near the beginning of their academic careers, are intended to help universities attract and retain outstanding young Ph.D.'s who might otherwise pursue non-teaching careers. The awards carry an annual base grant from NSF of $25,000. In addition, NSF will provide up to $37,500 per year to match contributions from nonuniversity sources, bringing the possible total support to $100,000 per year and $500,000 for the five-year term of the award.

The FY 1986 competition has a tentative deadline for receipt of completed applications of **July 1, 1985**. Highlights and key changes in the program guidelines for 1986 are listed below. Further details on the FY 1986 competition and application forms may be found in NSF Brochure #85-24 which was sent to all department chairs in May. Copies of the brochure may be obtained

by calling the Division of Mathematical Sciences at NSF; 202-357-9764.

1. The Ph.D. cutoff date for FY 1986 competition will be January 1, 1982. Assuming a closing date of July 1, 1985, this yields 3 1/2 years as maximum time as holder of a Ph.D. in the areas considered. The provision of last year for a two-year grace period for industrial employment will continue.

2. Matching funds are now also acceptable from private, nonprofit foundations (excluding those associated with particular universities or university systems) in addition to the usual industrial sources.

3. Donations of permanent research equipment are now also eligible for matching NSF funds in addition to cash donations. The equipment must be of a type and quality necessary to carry out the research program of the awardee and would be valued on the basis of its fair market value.

4. Holders of postdoctoral positions at universities or Ph.D. candidates are considered eligible for nomination for PYI's under the "candidate award" category. Subsequent to receipt of a candidate award, the recipient must accept a tenure track position.

Names of 1985 recipients of Presidential Young Investigator Awards in the mathematical sciences, their institutional affiliations and research interest follow: DAVID L. DONOHO (University of California, Berkeley), *Robust and Nonparametric Techniques of Statistical Inference, Deconvolution Methodology and Data Analysis*; DAVID JERISON (Massachusetts Institute of Technology), *Fourier Analysis and Partial Differential Equations*; IAIN M. JOHNSTONE (Stanford University), *Decision Theory, Multivariate Analysis, Robust Methods and Monte Carlo Methods*; WILLIAM L. KATH (Northwestern University), *Asymptotic and Singular Perturbation Techniques and their Classical Applications*; ROBERT K. LAZARSFELD (University of California, Los Angeles), *Algebraic Geometry*; NGAIMING MOK (Columbia University), *Algebraic and Complex Differential Geometry*; MICHAEL RENARDY (University of Wisconsin), *Nonlinear Partial Differential Equations, Rheology and Bifurcation Theory*; PETER SARNAK (Stanford University), *Analysis, Number Theory and Geometry*; THEODORE A. SLAMAN (University of Chicago), *Definability and Computability*; W. HUGH WOODIN (California Institute of Technology), *Set Theory and Foundations*.

–NSF News Release

NATO Postdoctoral Fellowships Awarded

The National Science Foundation (NSF) and the Department of State today announced the award of fifty North Atlantic Treaty Organization (NATO) Postdoctoral Fellowships in Science. These fellowships are awarded to young scientists for full-time postgraduate study abroad at institutions and laboratories in NATO countries or in neighboring countries that cooperate with NATO.

The three recipients in the mathematical sciences are listed below (institutions in parentheses are the current institution, those outside the parentheses are those at which the fellowship will be held): SOLOMON FRIEDBERG (Harvard University), Institut des Hautes Etudes Scientifique, France; ERIC L. GRINBERG (University of Michigan, Ann Arbor), Institut des Hautes Etudes Scientifique, France; and RANEE K. GUPTA (Brown University), University of Paris, France.

–NSF News Release

NSF Awards Minority Graduate Fellowships

The National Science Foundation (NSF) announced in March the award of sixty fellowships to minority students of outstanding ability for graduate study in the sciences, mathematics and engineering. Five of the awards are in the mathematical sciences or computer science.

Over 610 students who are American Indian, Black, Pacific Islander or Hispanic submitted applications in a nationwide competition for these fellowships, which are awarded on the basis of merit.

Panels of scientists, assembled by the National Research Council of the National Academy of Sciences, reviewed and evaluated applications, with final selections made by the Foundation. In addition to the fellowships awarded, NSF accorded Honorable Mention to 194 applicants.

Each fellowship provides a stipend of $11,100 per year for full-time graduate study. NSF Minority Graduate Fellows may attend any appropriate non-profit U.S. institution of higher education. An annual education allowance of $6,000 is provided to the institution by NSF in lieu of all tuition and fees. Three years of graduate study are supported by each fellowship. The fellowships may be used over a five-year period, so students can incorporate teaching or research assistantships into their education during periods when they are not receiving fellowship support.

In addition to the awards announced today, 118 individuals who previously received minority fellowhips may continue their study during the 1985-1986 fellowship year.

The 1985 recipients in the mathematical sciences or computer science follow (the institutions in parentheses are those at which graduate study is to be pursued): ROBERTO ARMANDO RIBAS (University of California, Berkeley), Central Missouri State University; ERNEST SCHIMMERLING (University of California, Berkeley), University of California, Berkeley; ALAN CLINTON SHAW (University of California, Berkeley), Harvard University; DONNA PATRICIA SMITH (University of Virginia), University of Virginia; GEORGE

WOLBERG (Columbia University), Cooper Union.
–NSF News Release

NSF Awards for Small Business Innovation Research

One hundred and two awards totaling $4.0 million have been made by the National Science Foundation (NSF) to small science- and technology-based firms in a program designed to increase technological innovation and the economic return on investment from Federally funded research.

The awards, administered through the NSF's Small Business Innovation Research (SBIR) program, were made to firms in thirty-one states and the District of Columbia. A total of 975 proposals were received in this year's program from forty-six states and the District of Columbia. Firms receiving awards ranged from a one-person company to one with 450 employees.

Objectives of the SBIR program are to increase the opportunity for small science and high technology firms to participate in NSF-funded research and to support high-risk, cutting-edge research of interest to the NSF in areas that have potential industrial applications.

A list of companies and their project titles which are receiving NSF awards in the fields of mathematics and computer science follows: A. J. Devaney Associates, Ridgefield, CT, *Mathematical Topics in Diffraction Tomography*; Cambridge Hydrodynamics, Inc., Princeton, NJ, *Renormalization Group Formulation of Turbulent Transport in Complex Media*; Reservoir Simulation Research Corp., Tulsa, OK, *Numerical Simulation of Miscible Flooding*; Speech Response Systems, Inc., Pittsburgh, PA, *Research on Feature-Based Systems for Speech Recognition*; Technology Development of California, Inc., Santa Clara, CA, *Mini-Supercomputer*; and William V. Stoecher, Rolla, MO, *Skin Cancer Recognition by Computer Vision.* –NSF News Release

NSF Establishes Six Major Engineering Research Centers

The selection of six universities and two affiliates to receive up to $94.5 million over the next five years to establish and operate six Engineering Research Centers has been announced by the National Science Foundation (NSF).

The eight institutions will operate six centers, selected from 142 proposals submitted by 106 institutions. They are the University of California, Santa Barbara, Columbia University, University of Delaware, in collaboration with Rutgers University, University of Maryland, in collaboration with Harvard University, Massachusetts Institute of Technology and Purdue University.

Agency officials expect the new program to grow to include more engineering research centers in future years. The program is an effort by the foundation to increase its support of basic engineering research relevant to U.S. industry and to promote greater collaboration between academic and industrial researchers.

The director of NSF, Erich Bloch, a former engineer at IBM, said the centers would not only give industry "a solid knowledge base and foundation for its development and manufacturing efforts," but should also give graduate and undergraduate students more experience with industry-related research. –NSF News Release

National Advanced Scientific Computing Centers

The National Science Foundation (NSF) has announced the selection of four institutions to receive approximately $200 million over the next five years to establish and operate National Advanced Scientific Computing Centers. Selection of the institutions was approved by the National Science Board (NSB), the policymaking body of the NSF. Awards will range from $7 million to $13 million per year over the grant period. Each award will have a cost-sharing provision in which the states, industries and institutions will contribute an amount that will approximately double the NSF award.

As a result of a nationwide competition, the four national supercomputer facilities will be started this year at the University of California at San Diego, La Jolla; the University of Illinois, Urbana-Champaign; Cornell University; and the John von Neumann Center near Princeton.

Plans call for the four supercomputing centers to be the nucleus of a national academic network for use by scientists and engineers from throughout the country. –NSF News Release

Science and Engineering Education Activities

The National Science Foundation (NSF) has in the past three years renewed its commitment to science education by re-establishing the Science and Engineering Education Directorate and by budgeting a significant level of funding for the support of science, mathematics and engineering education activities. The Foundation is encouraging the research community to join with the education community in efforts to strengthen science, mathematics, and technology education at all levels. This will involve such activities as research in teaching and learning, research and development on the application of advanced technologies to science and mathematics education, developing materials and model programs for the preparation and continuing education of teachers, developing new and improved instructional materials, increasing the ability and effectiveness of teachers, disseminating effective

teaching materials and strategies, and using non-school settings to increase understanding of the principles and issues in science, mathematics, and technology. The Foundation currently supports projects relating to all levels of precollege science and mathematics education. Proposals that focus on the elementary and middle school/junior high school levels are especially encouraged.

The precollege education activities at NSF are the responsibility of two major divisions within the Directorate of Science and Engineering Education. The Division of Materials Development and Research supports the generation of new knowledge and the development of materials, technologies, and model programs. The Division of Teacher Enhancement and Informal Science Education supports enrichment and leadership activities for teachers, dissemination activities, and activities that use non-school settings for science and mathematics education. The various programs within these two divisions are described briefly below.

Division of Materials Development and Research

Research in Teaching and Learning. This program supports basic and applied research on significant factors that underlie effective teaching and learning of precollege mathematics, science, and technology. Anticipated outcomes include knowledge of how students learn complex concepts in science and mathematics, of how they learn to apply these concepts effectively in real problem solving situations, and of those factors that are most influential in governing their participation and performance in school science and mathematics courses.

Applications of Advanced Technologies. This program supports research and development on the application of advanced technologies—particularly the computer—to science and mathematics education. Support is provided for the exploration, development, and proof-of-concept demonstration of advanced computer and telecommunication technologies in education. Projects may focus on technology as a tool, a medium, or an object of study. Among the anticipated products are innovative educational systems, authoring languages, problem solving tools, courseware, microworlds, tutors, and expert systems that increase the efficiency and effectiveness of instruction in science and mathematics.

Materials and Methods for Teacher Preparation. This program supports the development of creative new materials and model programs that are designed to improve the preservice preparation or the continuing education of teachers of mathematics, science and technology. Materials and model programs designed to enable professionals of high ability in mathematics, science, and engineering to enter teaching at the precollege levels are also supported.

Instructional Materials Development. This program provides support for the development of new or improved instructional materials in science, mathematics, and technology for precollege students and their teachers. The program encourages the development of materials that fill content gaps in previously developed curricula, present new approaches to the study of traditional subjects, introduce recent discoveries, or demonstrate applications of scientific or mathematical concepts. The materials developed may be printed materials or they may be materials that use alternative methods of delivering instruction, such as computer software, computer simulation, television, film, videocassette, or videodisc.

Division of Teacher Enhancement and Informal Science Education

Local and Regional Teacher Development. This program supports part-time and full-time courses, seminars, workshops, and other activities for teachers dealing with (i) content in mathematics, science and technology, (ii) applications of technology to the teaching and learning process, (iii) new or improved instructional activities, delivery systems, or teaching practices, and (iv) procedures to increase teacher effectiveness.

Leadership Activities for Precollege Teachers. This program supports seminars, conferences, research participation opportunities, workshops, and other activities designed to expand the scientific and/or mathematical knowledge base of teachers who already have a solid foundation in these areas. Projects in this program will provide teachers with new information in the sciences and mathematics and with training to enable participant teachers to take leadership roles in the inservice training of their peers in their home schools and communities. Participants in projects supported by this program will collect improved materials and methods and adapt them for use in their classes and in presentations in their home schools.

Science and Mathematics Education Networks. This program encourages the development of substantial local and regional resource-sharing networks for the purpose of disseminating information on successful curricula, methods, materials, and human resources that are available in well-defined geographic regions of the country. The planning, execution, and support of these networking activities will involve collaboration and cooperation among many people and institutions. Cooperative efforts will be based on sharing and using identified strengths found in the region to improve mathematics and science education throughout the region.

Informal Science Education. This program supports activities in a variety of media, such as broadcasting, museums, zoos, and clubs, that provide rich and stimulating environments for informal learning about science and mathematics. Representative activities include those that encourage personal interactive learning, offer out-of-school programs for students and parents,

train teachers to use museum and zoo resources effectively, or design innovative ways to take the museum to the schools and the public rather than the reverse. This program also supports large-scale communications activities such as science series via radio or television.

Other NSF programs in science education are Studies and Program Assessment, which supports data collection, analysis, evaluation, and information dissemination on the condition of precollege education in mathematics, science and technology, College Science Instrumentation, which provides matching support for the purchase of laboratory and instructional equipment in predominantly undergraduate colleges, and the programs in the Division of Research Career Development: Graduate and Minority Graduate Fellowships, NATO Postdoctoral Fellowships in Science, Advanced Institute Travel Awards, and Presidential Young Investigator Awards.

Further information on the above programs can be obtained by writing to the Directorate for Science and Engineering Education, National Science Foundation, Washington, DC 20550.

Bypassing of Merit-Based Review System

The National Science Board (NSB), the policymaking body of the National Science Foundation (NSF), has urged that a conference be held to discuss "politically feasible solutions" to problems caused by colleges and universities that try to get funding for facilities by appealing directly to Congress and bypassing the merit-based review system.

In the past two years, the NSB said in a statement, a number of universities have bypassed the review system and obtained more than $100 million for facilities construction by appealing directly to Congress. In several cases the funds were diverted from scientific activities that had been selected on the basis of their merit. Bypassing normal standards of scientific excellence through merit review procedures jeopardizes the nation's science and engineering strength, the NSB said. —NSF News Release

EDITOR'S NOTE: At its August 7, 1983, meeting the Council of the AMS passed the following resolution regarding this matter:

> The Council of the American Mathematical Society deplores the intervention of political processes in scientific decisions that should be made on the basis of scientific judgements through the peer review process. In particular, we view with dismay that funding for certain scientific projects has been incorporated in legislation that was passed by the House of Representatives although these projects have not been subjected to the review processes that have in the past guided federal funding. Such action opens the prospect that in the future federal support of science may be determined more by political considerations than by scientific merit. We believe that this prospect constitutes a grave threat to the health of science in the U.S.

Positions Open in NSF

Applicants for the following positions should submit résumés including current salary to NSF, Personnel Administration Branch, Room 212, 1800 G Street, N.W., Washington, DC 20550; Attn: Catherine Handle, 202-357-7840. Hearing impaired individuals should use TDD 202-357-7492.

Specific years of successful scientific research experience beyond the Ph.D. are required for the following positions in all fields: Program Director, six to eight years; Associate Program Director, four to six years; Assistant Program Director, three to four years.

NSF's Division of Computer Research is seeking qualified applicants for the positions of assistant program director, associate program director and program director for Theoretical Computer Science and for Intelligent Systems. The positions will be filled on a permanent, temporary or rotational basis. Salaries range from $35,000 to $50,000 for assistant program director; $40,000 to $60,000 for associate program director; and $45,000 to $68,700 for program director.

The incumbent will be responsible for/or assisting in the planning, coordination, and management of basic research facilities and other scientific activities primarily through Federal grants and contracts to academic institutions and nonprofit, nonacademic research institutions. A broad, general knowledge of computer research and some administrative experience are also required. For technical information about the positions contact Kent Curtis, Director, Division of Computer Research, 202-357-9747.

NSF's Division of Mathematical Sciences is seeking qualified applicants for positions which periodically become available. These positions will be filled on a one- or two-year rotational or temporary basis. Incumbents will be responsible for the planning, coordination, and management of basic research activities primarily through Federal grants and contracts to academic institutions and nonprofit, nonacademic research institutions. A broad, general knowledge of the field and some administrative experience are required. For technical information about the position contact John Polking, Director, Division of Mathematical Sciences, 202-357-9669. —*NSF Bulletin*

Letters to the Editor

Electronic Addresses

Many of our colleagues from the AMS and other societies already take advantage of various academic computing networks and dial-up facilities for communicating with each other, querying MATHFILE[1] and running programs on host computers at other universities. Other colleagues are not interested at all in bothering with computer mail on a daily basis, but occasionally might like to send a report or receive an important message with the speed of electronic mail.

Personally, my editorial work for the journal *Discrete Mathematics* has been facilitated by the use of electronic mail via networks such as ARPANET, BITNET and CSNET. I have been able to receive referee reports as well as communicate with various authors quickly, and this savings of time is resulting in earlier publication of articles. I have also found electronic mail useful in communicating with Ph.D. candidates seeking employment.

The purpose of this letter is to make a suggestion concerning the wider use of electronic mail.

1. Those mathematicians who use the computer and check their electronic mail frequently should list their electronic mailing address in the *Combined Membership List* of the Society along with their other particulars. The Society itself might encourage this by providing a place for this information on the form sent to its members.

2. Individual mathematics departments should designate a departmental user ID on a computer accessible by the major academic computer networks for the purpose of receiving and sending the occasional messages for faculty members who are not regular users. This computer address should be listed in the institutional membership portion of the *Combined Membership List*, and could also be included on the departmental stationery. The regular departmental staff would be responsible for checking the computer mailbox on a daily basis. (A number of institutions have already set up such a facility.)

Even this letter might have been printed in the *Notices* earlier had I known the electronic mailing address of the AMS.

Martin Charles Golumbic
IBM Israel Scientific Center
(Received December 17, 1984)

EDITOR'S NOTE: As a result of Dr. Golumbic's letter, the question of adding electronic addresses to the *Combined Membership List* was raised at the May meeting of the Executive Committee and Board of Trustees.

[1]MATHFILE became MathSci as of January 1985.

Financing *Mathematical Reviews*

A good portion of the June 1984 issue of the *Notices* was devoted to the financial plight of the Society and some proposed measures to remedy the situation. There is one action, I believe, the Society (and the mathematical community at large) should take and that is to try to persuade in the strongest possible terms the National Science Foundation to take over the financing of the *Mathematical Reviews*. (Correct me if I am wrong, but I understand that it costs AMS about $100,000 per year to subsidize the Reviews.) The Reviews is not just another journal, it is a national resource. It is clearly an indispensible tool in any serious research in mathematics. If the NSF is at all serious about supporting mathematics in this country, this is obviously the place to start. It is really not fair to expect individual members to finance the service that is absolutely essential to any mathematician, whether here or abroad. I realize that AMS does not make the decisions for NSF but the Society should urge its members to write letters to NSF and the Congress, if necessary, to try to persuade the appropriate authorities that it is extremely important for the *Mathematical Reviews* to be federally funded. NSF has in the past, and is right now, supporting some pretty esoteric and specialized projects. Maybe it is time to go back to basics and do things that would benefit all of mathematics.

Vladimir Drobot
University of Santa Clara
(Received January 10, 1985)

COMMENT FROM THE SECRETARY OF THE AMS: At one time, the National Science Foundation (NSF) supplied some support to *Mathematical Reviews* (MR) but it has not done so since 1967. One way in which the NSF supports journals is through page charges rather than by direct subsidies. Insofar as authors honor the request, through grants, to pay the reviewing charge, NSF money is coming to the Society for the support of MR. The amount collected is on the order of $5000 per year, against an annual MR budget approaching $4 million.

When the NSF was supporting abstracting journals, it did so through the Office of Science Information Service. This office has long since been abolished, and its functions were explicitly made the responsibility of the individual discipline divisions, such as the Mathematical Sciences Division. The Society has made tentative approaches to the NSF for support in recent years, but the Advisory Panel to the Division

representing the mathematical community has never supported the idea, obviously, at least in part, because of the shortage of funds for research grants, from which such MR support would have to be subtracted. Moreover, the price to be paid in possible loss of complete editorial and financial control has loomed large enough that the matter has not been pressed to conclusion.

E. Pitcher

Accepting/Rejecting a Paper for Publication

What follows is a slightly shortened version of a letter that I wrote recently as one of the editors of the *Proceedings*. I had rejected a paper; the referee had said (in essence) that it was a fairly interesting result but not a substantial advance on results that the author had already derived by similar methods in earlier work. The author maintained that it was a significant improvement, and asked me if I would be willing to obtain a second opinion. After some thought, I wrote the following answer. I think the author's question is one that must arise frequently, even if few people put it into words, and I hope having one answer written out will clarify the matter (or perhaps provoke discussion).

Dear Professor...:

...The *Proceedings* has room to print less than half of the papers submitted to it. Some papers of course can be rejected because they have mistakes, or because they duplicate material already published; but the majority of those not accepted are valid mathematics (and my impression is that many of them do get published elsewhere). The decision which to accept then must be one of weighing the strengths of the different papers. There is no precise way to do this, because different referees have different standards and find different things interesting. Some papers seem to be clearly significant enough to be accepted, but there are a number of others on which I suspect I could get divergent opinions if I sent each one to a variety of different referees. I do try to judge the general attitude of a referee, and I sometimes take that attitude into account in borderline decisions, but generally I think I ought to rely on the opinion I get. If I were to request a second opinion on every paper that a referee considers borderline, it would mean a great deal of extra refereeing (and further delay); and of course if the two opinions differed, I would then want yet a third recommendation before accepting the paper. In practice, I think, authors get second opinions on papers by submitting them to different journals.

Sometimes, needless to say, referees really do make mistakes. I had a case a while ago where a referee misread a theorem and thought that it said something much weaker than it actually did; when the author pointed this out, I sent the paper out for another report. But I feel I should do this only if there has been a *gross* misjudgement. I have now read your paper fairly carefully myself, together with your previous paper in..., and I think that the referee was not *grossly* unjust, even if the specific decision may have been wrong. After all, ... [Here followed my brief discussion of ways in which the later paper seemed to me to be similar to the preceding one]... Of course, I do not mean these comments to be a balanced judgement on your paper; they merely mean that I think the referee had *some* grounds for the decision, and therefore I will not override it... I do think the result should be published somewhere.

I know quite well myself how unpleasant it is to have a journal reject a valid paper; getting the paper published elsewhere does not fully make up for it. I doubt that this letter can do much to console you. But I hope you can see at least that I considered your letter carefully, and that the problem is one inherent in the practice of editing a journal.

William C. Waterhouse
Pennsylvania State
University, University Park
(Received December 6, 1984)

State of the Profession

I have been reading with interest the letters on the "State of the Profession" in the November 1984 *Notices*. I would like to express my own view.

I intentionally work in an area of mathematics which I do not think will have immediate practical applications. I would never dare to do physics. If one does physics and if one has (as surely everybody hopes to have) a really good idea, then one runs the risk of unwittingly unleashing

Policy on Letters to the Editor

Letters submitted for publication in the *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of the *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made.

The committee reserves the right to edit letters.

The *Notices* does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in the *Bulletin of the American Mathematical Society* will be considered for publication.

Letters should be mailed to the Editor of the *Notices*, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, and will be acknowledged on receipt.

something really destructive on the world. The armies and industries of the world use science for many destructive purposes. Who would willingly contribute to this?

I think that mathematics will never be really "healthy" so long as mathematicians must fear that their work will be used to contribute to the destruction of the world.

It is partly for this reason that I do not like to regard mathematics as "science"; but also I personally value mathematics not for its contributions to other fields but for itself. Mathematics has value in the way that poetry or music have value; and this is why I want to do mathematics. (I am sure that I am not alone in this.) I do not require a high salary to do work that is play (i.e., mathematical research or teaching under relaxed circumstances); it would be a privilege to have such work. Unfortunately (as is also, sadly, the case for poets, musicians, painters, etc.) such work is not easy to come by. I like to teach if I may teach small classes and have some freedom with the curriculum. But teaching calculus and differential equations (in a simplified and unsatisfying form, and in a hurry) to a class of one hundred engineering students is not my idea of an exciting job.

I hope to finish a Ph.D. in mathematics soon. I love mathematics. But the job prospects are not exciting. I think that there are mathematical jobs which admit some degree of peace and freedom, but they are few. I have an M.A. in Latin and it may be that I will end up earning my living by teaching Latin, rather than mathematics. It is far more exciting to teach a language (where one may vary the vocabulary and the readings and hence the entire curriculum) than to teach a set curriculum out of a preassigned book to too many students who are forced to be in too much of a hurry. I had one of these (calculus) courses in high school and it drove me from mathematics for ten years. I hate to teach mathematical results without full explanation. It is painful to me.

These are what I see as some "unhealthy" trends in American mathematics today. I also agree with the views expressed by Douglass Muder and Hassler Whitney in the November 1984 *Notices*.

Amy Babich
University of Texas, Austin
(Received February 20, 1985)

Mathematics and the Defense Department

The report of the committee of the National Academy of Sciences on mathematics and the Defense Department (published in *Notices*, October 1984, pages 609–616) recommends an increased militarization of mathematics. The assumptions and conclusions of the report should be rejected by the mathematics community.

The report incorrectly implies that "defense" (pages 609 and 614) is the major activity of the Pentagon. While the U.S. military has been used several times since World War II (Korea, Vietnam, the Dominican Republic, Cambodia, Lebanon, Grenada), none of these uses was to defend American soil from a foreign attack. Today the Rapid Deployment Force does not train to repel an aggressor from American beaches; it practices landing on other countries' territory. The report favorably mentions the contribution of mathematics to the MX missile program (page 612), without recognizing that the MX is potentially a first strike weapon that makes us all less secure.

Instead of calling for the Department of Defense to have a "close relationship with the mathematical sciences community" (page 616), the committee should have pointed to the bloated military spending that is diverting real resources from all other sectors of our society, including the universities. We will be better off if the mathematics community does not sell more of itself to the Pentagon. Rather than letting the military influence our research efforts and buy our goodwill (what the committee calls "further improving the relationship between the mathematical sciences community and the DOD," page 610), we should insist that our society stop devoting so much of our scientific resources to weapons development. A realistic assessment of our genuine self-defense needs will allow a greater effort to be made in pursuing other important social goals, including education.

Sheldon Axler
Michigan State University
Donald Sarason
University of California, Berkeley
(Received December 5, 1984)

Queries

Edited by Hans Samelson

QUESTIONS ARE WELCOMED from AMS members regarding mathematical matters such as details of, or references to, vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures. This is not intended as a problem corner, except for occasional lists of problems collected at mathematical meetings.

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

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

Queries

324. Francis D. Lonergan (Department of Mathematics, Catholic University of America, Washington, D.C. 20064). Some link groups have quite natural presentations such that the set of relations is unchanged if one replaces the generators $a, b, \ldots$ by their inverse $\bar{a}, \bar{b}, \ldots$. Example: $\langle a, x, y; \bar{a}ya\bar{y}a\bar{y}a = xyx\bar{y}x\bar{a}y\bar{x}\bar{y}\bar{x}, a\bar{y}ayay\bar{a} = \bar{x}\bar{y}\bar{x}yxa\bar{y}xyx\rangle$. Does this have any algebraic or geometric significance? Note that the question refers to given presentations; changes of generators, and adding or deleting unnecessary relations may change the situation.

325. Bertram Ross (Mathematics Department, University of New Haven, West Haven, Connecticut 06516). In the calculus of finite differences one deals with the difference $\Delta f(x)$ and higher order differences $\Delta^2 f(x), \Delta^3 f(x), \ldots$. Suppose one can define a difference of arbitrary order $\Delta^\nu f(x)$, where ν can be any number, for example $\Delta^{1/2} f(x)$. Does anyone know of any possible use of a difference to an arbitrary order, that is, any use for interpolating between integral orders of a difference, or any references?

326. Aldo Peretti (Murillo 1121, 9°, "D", (1414) Buenos Aires, Argentina).

A. Can one evaluate

$$\int_2^\infty \frac{dx}{x(x^2-1)\log x}$$

in closed form?

B. Is there a book on series solutions of algebraic and transcendental equations?

C. Is there an (approximate) formula for the number of palindromic numbers $\leq x$?

327. Robert Vinograd (Division of Mathematical Sciences, North Dakota State University, Fargo, North Dakota 58105).

A. The projections P_i and Q_j in a Banach space with

$$P_1 + \cdots + P_n = I, \quad P_i P_j = 0 \text{ for } i \neq j$$
$$Q_1 + \cdots + Q_n = I, \quad Q_i Q_j = 0 \text{ for } i \neq j$$

are said to be similar if there is a linear operator S such that

$$SP_iS^{-1} = Q_i, \quad i = 1, \ldots, n.$$

A known sufficient condition for the existence of S is

$$\Sigma ||P_i|| \cdot ||Q_i - P_i|| < 1$$

(e.g. see Daleckii and Krein, *Stability of Solutions of Differential Equations in Banach Space*, AMS, Providence, R.I., 1974, p. 150).

Is it known that a much weaker condition

$$||P_i - Q_i|| < 1, \quad i = 1, \ldots, n$$

is also sufficient?

B. Let X and Y be subspaces of $\mathbf{R}^n$ or $\mathbf{C}^n$ with $\dim X = l \leq m = \dim Y$. Then it is known that l angles $\alpha_1 \leq \cdots \leq \alpha_l$ between X and Y can be naturally defined. Next let $G_{u_1 \cdots u_r}$ denote the Gram determinant of vectors $u_1, \ldots, u_r$. The Hadamard inequality states that $G_{x_1 \cdots x_l, y_1 \cdots y_m} \leq G_{x_1 \cdots x_l} \cdot G_{y_1 \cdots y_m}$.

Is it known that it can be replaced by the equality

$$G_{x_1 \cdots x_l, y_1 \cdots y_m} = G_{x_1 \cdots x_l} \cdot G_{y_1 \cdots y_m} \cdot \sin^2 \alpha_1 \cdots \sin^2 \alpha_l$$

where α_i are the above angles between $X = \operatorname{span}\{x_1, \ldots, x_l\}$ and $Y = \operatorname{span}\{y_1, \ldots, y_m\}$?

C. Let $A \oplus B = \mathbf{R}^n$ or $\mathbf{C}^n$ be a direct decomposition and $a_0 \in A$, $b_0 \in B$ be vectors for which the angle between A and B takes on its minimum (assumed unique up to scalar factors).

A cone K is defined as a set of all vectors $x = a + b$, $a \in A$, $b \in B$ such that $|b| = k|a|$, where k is a given constant. Is it true that the angle between $x = a + b \in K$ and $x' = a' + b' \in K'$ is minimal when all four vectors a, b, a', b' lie in the 2-plane spanned by a_0 and b_0?

328. Badih Ghusayni (Department of Mathematics, Auburn University, Auburn, Alabama 36849). What is known about the following problem: Let V be a subspace of $L_2(\mathbf{R})$, $\neq \{0\}$, such that (1) $f \in V$, $g \in L_2(\mathbf{R})$, $|g| \leq |f|$ a.e. $\Rightarrow g \in V$, (2) $f \in V \Rightarrow$ the Fourier transform $\hat{f} \in V$. Is $V = L_2(\mathbf{R})$? Comment: The author proved in 1982 that $\overline{V} = L_2(\mathbf{R})$.

329. Ludvik Janos (Claremont Graduate School, Claremont, California 91711). Call a metric d on a space X maximal if the isometry group $G(d')$ of any equivalent metric d' does not contain $G(d)$ properly. Is the usual metric on Euclidean space

maximal? (True for $n = 1$.) Are any other facts known?

330. Vladik Ya. Kreĭnovich (P.O. Box 21, Leningrad 22, 197022 USSR). For given $p_{ij} = p_{ji}$, $1 \le i, j \le n$, consider the surface (in the plane $\Sigma x_i = 0$ in $\mathbf{R}^n$), given by $x_i = \Sigma p_{ij} \sin(\delta_i - \delta_j)$, where the δ_i are real variables. For $n = 3$ this is an ellipse. Are there simple formulae $\phi(x_1, \ldots, x_n) = 0$ for this surface, or can one at least describe simple good approximations to the surface, say for $n \le 12$? This is related to energy nets (the δ_i are phases). (N. Gorenstein).

Responses

The editor would like to thank all those who sent in replies.

126. (vol. 24, no. 6, p. 386, October 1977, J. D. Finley and Stanley Steinberg) On the solvability of $f_{xx} \cdot f_{yy} - f_{xy}^2 + f_{xp} + f_{yq} = 0$, $f = f(x, y, p, q)$, everything complex. **Reply:** A "general solution" can be given via R. Penrose's curved twistor construction; it is related to E. T. Whittaker's general solution of the 3-dimensional Laplace equation. See the recent paper by J. F. Plebanski and C. P. Boyer, J. Math. Phys. **26** (1985), 231–234, and references there. (Contributed by Charles P. Boyer.)

321. (vol. 32, p. 9, January 1985, Robert E. Vinograd) Formula for angle between kernel and range of a projection. **Reply:** The formula appears in Massera-Schäffer (*Linear Differential Equations and Function Space*, 1966), Thm. 14.B, p. 28, and in T. Kato, *Estimation of Iterated Matrices...*, Numer. Math. **2** (1960), p. 29. The origin of the formula is uncertain. (Contributed by O. Hájek, W. Luxemburg, J. J. Schäffer.)

322. (vol. 32, p. 198, March 1985, Dennis Spellman) Existence of non-Abelian groups of order n^2, if n is composite and prime to $\varphi(n)$. **Reply:** Such a groups exists iff, with $n = p_1 \cdot p_2 \cdot \cdots p_t$, some p_i divides some $p_j + 1$, or, equivalently, if n is prime to $\sigma(n)$. This follows from a theorem of L. E. Dickson (Trans. Amer. Math. Soc. **6** (1905), p. 201); see also theorem 9.2.7 in W. R. Scott, *Group Theory*, 1964. (Contributed by G. Bachman, W. R. Scott, P. Venzke.)

323, part B. (vol. 32, p. 198, March 1985, Vladik Ya. Kreĭnovich) Abnormal likelihood of primality of the numbers obtained by reversing the binary digits of primes. **Reply:** The correlation is definitely there up to $n = 1000$, also in base 10. It seems to be due, however, to relatively simple reasons like the fact that primes tend to be "small". Details and a program available through the AMS office. (Contributed by S. Sawyer.)

Problem

Stochastic Differential Geometry

The following problem arose at the Special Session on Stochastic Differential Geometry, AMS meeting, Anaheim, January 1985.

1. (Mark Pinsky, Northwestern University). Let (M, g) be an n-dimensional Riemannian manifold with Laplacian Δ_g and exponential map $\exp_m : M_m \to M$. Let the solution of the Dirichlet problem $\Delta_g u = 0$ in the ball $B_m(\epsilon)$ with $u|_{\partial B_m(\epsilon)} = f \circ \exp_m^{-1}$ be written in the form $u(m) = \int_{S^{n-1}} h_m^\epsilon(d\theta) f(\theta)$ where $h_m^\epsilon(\cdot)$ is the harmonic measure induced on the unit sphere S^{n-1}. The problem is to prove (or disprove) the following: if $\forall m \in M$, $\forall \epsilon > 0$, $h_m^\epsilon(\cdot)$ is normalized Lebesgue measure, then g has constant scalar curvature.

1985 AMS Elections

Council Nominations for Vice-Presidents and Members-at-Large

Two vice-presidents and five members-at-large of the Council will be elected by the Society in a contested election in the fall of 1985.

The vice-presidents will serve for a term of two years effective January 1, 1986. The Council has nominated four candidates for the two positions. They are:

Richard A. Askey	Linda Keen
Daniel Gorenstein	Olga Taussky-Todd

Nominations by petition are acceptable. Refer to the previous issue of the *Notices* (March 1985, pages 202-203) for the rules and the form of the petition.

The five members-at-large will serve for a term of three years. The Council nominated eight candidates. They are:

James G. Arthur	Philip C. Kutzko
Charles Herbert Clemens	Boris Mityagin
Jane P. Gilman	Chuu-Lian Terng
Vadim Komkov	William A. Veech

Nominations by petition are acceptable. See the reference above. If the total number of nominees is less than ten, it will be brought to ten by the Council before the ballot is circulated.

Everett Pitcher
Bethlehem, Pennsylvania — Secretary

Amendments to the Bylaws
for Presentation at the Business Meeting of 14 August 1985 in Laramie

There are two amendments to the bylaws recommended by the Council to come before the Laramie Business Meeting. The first revises the wording of Articles III and IV to reduce the size of the Council. As a secondary effect, the complexity that has been inherent in a roll call vote is eliminated. The second is a modification of Article IX, Section 8. There are also editorial changes to make the wording in other places consistent with these changes.

~~Overscored material~~ is to be deleted; **boldface material** is to be inserted.

Article III

~~Publications and Communications~~ Committees

Section 1. ~~There shall be eight publications committees, which shall be the eight editorial committees specified in Section 2 of this Article.~~

~~Section 2.~~ There shall be eight editorial committees as follows: committees for the *Bulletin*, for the *Proceedings*, for the *Colloquium Publications*, for *Mathematical Surveys and Monographs*, for *Mathematical Reviews*; a joint committee for the *Transactions* and the *Memoirs*; a committee consisting of the representatives of the Society on the Board of Editors of the *American Journal of Mathematics*; and a committee for *Mathematics of Computation*.

Section 2. There shall be a Science Policy Committee.

Section 3. There shall be a communications committee called the Committee to Monitor Problems in Communication.

Section 4. The size of each ~~publications committee and communications~~ committee shall be determined by the Council.

Article IV

Council

Section 1. The Council shall consist of fifteen members-at-large and the following *ex officio* members: the officers of the Society specified in Article I, **except that it shall include only one associate secretary,** the ~~members~~ **chairman of each** of the ~~publications~~ **editorial** committees and ~~the chairman~~ of the communications committee **and of the Science Policy Committee** ~~specified in Article III~~, any former secretary for a period of two years following his terms of office, and members of the Executive Committee (Article V) who remain on the Council by the operation of Article VII, Section 4.

The chairman of any committee designated as a Council member may name a deputy from the committee as substitute. The associate secretary shall be the one charged with the scientific program of the meeting at which the Council meets except that at a meeting associated with no scientific meeting of the Society the secretary may designate the associate secretary.

There is one exception. Council members by virtue of membership on an editorial committee or as associate secretary on January 1, 1986 shall remain members of the Council through their elected terms. This paragraph is no longer effective after December 31, 1989 and shall then be deleted.

Section 2. The Council shall formulate and administer the scientific policies of the Society and shall act in an advisory capacity to the Board of Trustees.

Section 3. In the absence of the secretary from any meeting of the Council, ~~one of the associate secretaries present~~ **a member** may be designated as acting secretary for the meeting, either by written authorization of the secretary, or, failing that, by ~~majority agreement among the associate secretaries present~~ **the presiding officer**.

Section 4. All members of the Council shall be voting members. **Each member, including deputies and the designated associate secretary, shall have one vote.** The method for settling matters before the Council at any meeting shall be by majority vote of the members present. If the result of a vote is challenged, it shall be the duty of the presiding officer to determine the true vote by a roll call. In a roll call vote, each Council member shall vote only once (although he may be a member of the Council in several capacities)~~,~~. ~~and he shall state before the vote in which capacity he votes. The group consisting of the four associate secretaries shall have one vote, and it shall be divided equally among those who vote as associate secretaries. Each of the eight publications committees shall have one vote, and it~~

~~shall be divided equally among those who vote as members of the respective publications committees. All other members of the Council shall have one vote each. Fractional votes shall be counted.~~

Section 5. Any ~~group of~~ five members of the Council ~~who have a total of five votes as defined in Section 4 of this Article for a vote by roll call~~ shall constitute a quorum for the transaction of business at any meeting of the Council.

Section 6. Between meetings of the Council, business may be transacted by a mail vote. Votes shall be counted ~~as in the case of a roll call~~ as specified in Section 4 of this Article, "members present" being replaced by "members voting." An affirmative vote by mail on any proposal shall be declared if, and only if, (a) more than half of the total number of possible votes is received by the time announced for the closing of the polls, and (b) at least three-quarters of the votes received by then are affirmative. If **five or more** members ~~who have a total of five or more votes~~ request postponement at the time of voting, action on the matter at issue shall be postponed until the next meeting of the Council, unless either (1) at the discretion of the secretary, the question is made the subject of a second vote by mail, in connection with which brief statements of reason, for and against, are circulated; or (2) the Council places the matter at issue before the Executive Committee for action.

Section 7. The Council may delegate to the Executive Committee certain of its duties and powers. Between meetings of the Council, the Executive Committee shall act for the Council on such matters and in such ways as the Council may specify. Nothing herein contained shall be construed as empowering the Council to divest itself of responsibility for formulating and administering the scientific policies of the Society.

Section 8. The Council shall also have power to speak in the name of the Society with respect to matters affecting the status of mathematics or mathematicians, such as proposed or enacted federal or state legislation; conditions of employment in universities, colleges, or business, research or industrial organizations; regulations, policies, or acts of governmental agencies or instrumentalities; and other items which tend to affect the dignity and effective position of mathematics.

With the exception noted in the next paragraph, a favorable vote of two-thirds of the entire membership of the Council~~, taken in accordance with the provisions of a vote by roll call as specified in Section 4 of this Article,~~ shall be necessary to authorize any statement in the name of the Society with respect to such matters. With the exception noted in the next paragraph, such a vote may be taken only if written notice shall have been given to the secretary by the proposer of any such resolution not later than one month prior to the Council meeting at which the matter is to be presented; and the vote shall be taken not earlier than one month after the resolution has been discussed by the Council.

If, at a meeting of the Council, there are present **twelve** members, ~~having a total of twelve votes, as specified for a vote by roll call in Section 4 of this Article,~~ then the prior notification to the secretary may be waived by unanimous consent. In such a case, a unanimous favorable vote by those present shall empower the Council to speak in the name of the Society.

The Council may also refer the matter to a referendum by mail of the entire membership of the Society, and shall make such reference if a referendum is requested, prior to final action by the Council, by two hundred or more members. The taking of a referendum shall act as a stay upon Council action until the votes have been canvassed, and thereafter no action may be taken by the Council except in accordance with a plurality of the votes cast in the referendum.

Article IX

Dues and Privileges of Members

Section 8. After retirement from active service on account of age **or on account of long term disability**, any ordinary or contributing member who is not in arrears of dues and with membership extending over at least twenty years may, by giving proper notification to the secretary, have his dues remitted, on the understanding that he will thereafter receive the *Notices* but not the *Bulletin*.

1985 Summer Seminar In Applied Mathematics, June 30–July 13

Reacting Flows: Combustion and Chemical Reactors

The seventeenth AMS-SIAM Summer Seminar in Applied Mathematics will be held June 30–July 13, 1985, at Cornell University, Ithaca, New York. The seminar will be sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics. It is anticipated that it will be supported by grants from federal agencies. The proceedings of the seminar will be published by the Society in the series *Lectures in Applied Mathematics.*

The seminar is the culmination of the Special Year 1984–85 on the same subject held at the Center for Applied Mathematics of Cornell University. The theory of reacting flows has finally blossomed as a mathematical science in the last decade, and an attempt will be made to synthesize it into a firm foundation for future large-scale computing. The seminar will not, however, be aimed at computational fluid mechanics as a whole, but only those parts peculiar to reacting flows.

A series of five introductory lectures each will be given by Rutherford Aris (University of Minnesota, Minneapolis), G. S. S. Ludford (Cornell University), and Andrew Majda (University of California, Berkeley); shorter series will be presented by Harry Dwyer (University of California, Davis), and A. F. Ghoniem (Massachusetts Institute of Technology). There will also be lectures by R. Alexander (Iowa State University), M. R. Baer (Sandia National Laboratories, Albuquerque), T. A. Bak (Copenhagen), V. Balakotaiah (University of Houston–University Park), J. Bebernes (University of Colorado, Boulder), J. D. Buckmaster (University of Illinois, Urbana), J. F. Clarke (Cranfield Institute of Technology), D. S. Cohen (California Institute of Technology), P. F. Embid (University of New Mexico), P. Fife (University of Arizona), J. Guckenheimer (Cornell University), V. Hlavacek (SUNY at Buffalo), R. D. Janssen (Los Alamos National Laboratory), K. Jensen (University of Minnesota), A. Kapila (Rensselaer Polytech Institute), B. Keyfitz (University of Houston–University Park), S. H. Lam (Princeton University), B. Larrouturou (INRIA–Sophia Antipolis), M. Marek (Prague Institute), S. Margolis (Sandia National Laboratories, Livermore), M. Marion (University of Paris, Orsay), A. C. McIntosh (Luton College of Higher Education), D. Mikolaitis (University of Florida), I. Müller (Technical University of Berlin), B. Nicolaenko (Los Alamos National Laboratory), N. Peters (RWTH–Aachen), L. M. Pismen (Technion), H. Rabitz (Princeton University), V. Roytburd (Rensselaer Polytech Institute), M. Sermange (INRIA–Le Chesnay), M. Smooke (Yale University), A. Varma (University of Notre Dame), D. H. Wagner (University of Houston–University Park), G. C. Wake (Victoria University, Wellington), and F. A. Williams (Princeton University). Together, these lectures will summarize the Cornell Special Year and sharpen the focus onto computational questions.

A brochure is available from the AMS office which includes a description of the scientific program, information on the residence and dining hall facilities, firm room and board rates, local information, and a reservation form to be used to obtain accommodations on campus. Each participant will pay a $20 social fee to cover the cost of refreshments served at breaks and for social events. There will also be a meeting registration fee of $73 (reduced to $53 for students and unemployed). A copy of the proceedings will be available to registered participants as a privilege of participation in the seminar.

Application blanks for admission and/or financial assistance can be obtained from the Meetings Department, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940. An applicant should have completed at least one year of graduate school and will be asked to indicate his or her scientific background and interest. A graduate student's application must be accompanied by a letter from his or her faculty advisor concerning the applicant's ability and promise. Those who wish to apply for a grant-in-aid should so indicate; however, funds available for the seminar are very limited and individuals who can obtain support from other sources should do so.

Laramie Meetings, August 10–15, 1985

Supplement to Announcement in March Notices

Please refer to the Preliminary Announcement for this meeting which appears on pages 239–259 of the March 1985 issue of the *Notices*. The Table of Contents for the preliminary announcement is reproduced below for convenience.

In addition to AMS, MAA, and Pi Mu Epsilon, the Association for Women in Mathematics will also be meeting in Laramie.

IMPORTANT DEADLINES

AMS Abstracts,	
For consideration for special sessions	**Expired**
Of contributed papers	**May 28**
MAA Abstracts,	
Of contributed papers	**May 28**
Joint Meeting Preregistration and Housing	**June 14**
MAA Minicourse Preregistration	**June 14**
Summer List of Applicants	**June 14**
Motions for AMS Business Meeting	**July 15**
Housing Cancellations (100% refund)	**July 25**
MAA Banquet (50% refund)	**July 25**
Preregistration cancellations (50% refund)	**August 9**
Dues credit for nonmembers/students	**September 15**

Prizes

It was erroneously announced in the March issue of the *Notices* that the Norbert Wiener Prize in Applied Mathematics will be awarded during the Laramie meeting. This prize will be awarded at the meeting of the Society for Industrial and Applied Mathematics in Tempe, Arizona, on October 28–30. We apologize for any inconvenience this may have caused.

AMS Special Sessions

An additional special session and updated lists of speakers are now available for some of the special sessions.

Combinatorics and special functions, RICHARD A. ASKEY, University of Wisconsin, Madison. Eiichi Bannai, Ira Gessel, Yiming Hong, Mourad E. H. Ismail, Jacques Labelle, Judith Q. Longyear, Aaron Meyerowitz, Stephen Milne, Mizanur Rahman, Donald St. P. Richards, and Paul Terwillinger.

Dynamical systems and ergodic theory, MARCY BARGE, University of Wyoming and ROBERT F. WILLIAMS, Northwestern University.

Commutative algebra and algebraic geometry, FRANK R. DE MEYER, Colorado State University and RICK MIRANDA, Bedford, Massachusetts. David Cox, Bruce Crauder, Robert Fossum, Robert Gilmer, Craig Huneke, Elliot Jacobson, William Lang, Pablo Lejarrage, Andy Magid, David Morrison, David Saltman, Loring Tu, Roger Wiegand, and Sylvia Wiegand.

Gauge theories and 4-manifolds, RONALD A. FINTUSHEL, Tulane University. Nicholas Buchadahl, Dan Burns, Andrej Derdzinski, Martin Guest, Claude Le Brun, Gordana Matic, and Pankaj Topiwala.

The geometry of configurations, GEORGE B. PURDY, Texas A&M University. J. Beck, Fan Chung, L. Danzer, S. Fejes-toth, J. E. Goodman, B. Grunbaum, H. Harborth, L. M. Kelley, W.O.J. Moserd, Richard Pollack, and Joel Spencer.

Numerical approximation theory and applications, V. M. SEGAL, University of Wyoming and S. P. SINGH, Memorial University of Newfoundland. J. C. Dunn, P. M. Gauthier, C. A. Micchelli, G. M. Phillips, B. E. Rhoades, V. M. Sehgal, K. L. Singh, S. P. Singh, P. W. Smith, G. D. Taylor, and John Todd.

Mechanics and bifurcation theory, SCOTT J. SPECTOR, Southern Illinois University, Carbondale. Philip Holmes, J. H. Maddocks, and H. C. Simpson.

Analysis of one complex variable, CHUNG-CHUN YANG, Naval Research Laboratory, Washington, DC. D. W. Brownawell, A. H. Cayford, Kuan-Heo Chang,

W. H. Chen, Chi-Tai Chang, Albert Edrei, Chonggi Dai, G. H. Fricke, Paul M. Gauthier, Fred Gross, Simon Hellerstein, Jue Huang, Peter Lappan, Guoping Lee, B. Lepson, R. F. Li, K. Niino, S. Mori, Charles F. Osgood, Carl L. Prather, S. M. Shah, Daniel Shea, Bernard Shiffman

MAA Hedrick Lectures

The 34th Earle Raymond Hedrick Lectures to be given by ARTHUR M. JAFFE are titled *Towards the reunification of theoretical physics with mathematics.*

MAA Invited Addresses

A complete list of titles, an additional speaker, and times and dates for MAA invited addresses follow:

Interactive computer graphics in elementary differential geometry, THOMAS F. BANCHOFF, Brown University, 2:15 p.m. Wednesday.

Truth and meaning in mathematics, REUBEN HERSH, University of New Mexico, 8:40 a.m. Thursday.

The nervous system: Some recent work in mathematical biology, FRANK C. HOPPENSTEADT, University of Utah, 8:40 a.m. Tuesday.

Women in the American mathematical community: The pre-1940 Ph.D.'s, JEANNE LADUKE, DePaul University, 1:00 p.m. Wednesday.

Integration: Why you can and why you can't, HENRY P. MIRANDA, Colorado State University, 3:20 p.m. Wednesday.

The place of the Riemann hypothesis in modern prime number theory, HUGH L. MONTGOMERY, University of Michigan, 2:15 p.m., Tuesday.

Karmarkar's algorithm and other recent developments in linear programming, MICHAEL SAKS, Bell Communications Research, 2:15 p.m., Monday.

MAA Minicourses

Five Minicourses are being offered by MAA. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: *Geometry for college teachers* is being organized by BRANKO GRÜNBAUM, University of Washington. Part A is scheduled from 8:30 a.m. to 10:30 a.m. and Part B from 7:30 p.m. to 9:30 p.m. on Monday, August 12. Total enrollment for this Minicourse is limited to 45 persons. Geometry instruction at the college level has practically disappeared. Many people find this an intolerable loss, which imposes heavy and unnecessary handicaps on future professionals of all kinds. The Minicourse will attempt to present a practising geometer's views on what should be the philosophical and educational underpinnings of college level geometry courses, what should be the aims of such courses, what kinds of topics can be presented with chances of success, and what difficulties will have to be overcome if the feeling for spatial relations is not to atrophy completely in the next few generations.

Minicourse #2: *Applied mathematics via classroom experiments* is being organized by HERBERT R. BAILEY, Rose-Hulman Institute of Technology. Part A is scheduled for 8:30 a.m. to 10:30 a.m. and Part B from 7:30 p.m. to 9:30 p.m. on Wednesday, August 14. Total enrollment for this Minicourse is limited to 80 persons. This Minicourse is based on a junior level applied mathematics course which has been developed to encourage students to combine their knowledge of physics, calculus, and differential equations. Students are asked to derive and solve the equations that model simple classroom experiments. For example, the first experiment is to let a ball bounce until it stops. The problem is to relate "percent rebound" and "time to stop bouncing." The student must combine the concepts of time of fall and summation of geometric series. The full course includes five units: I–The Chain, II–Rotation, III–Fluid Flow, IV–Heat Flow, and V–Calculus of Variations. The Minicourse will begin with a brief description of each unit including demonstrations of most of the experiments. Participants will then be asked to work through some of the units either individually or in small groups. Each participant will be given a writeup and a solution manual for each of the units. The writeups include review sections covering the necessary mathematics and physics.

Minicourse #3: *Teaching experiential applied mathematics,* (TEAM) is being organized by JAMES R. CHOIKE, Oklahoma State University. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Monday, August 12 and Part B from 2:15 p.m. to 4:15 p.m. on Tuesday, August 13. Total enrollment for this Minicourse is limited to 80 persons. This Minicourse will feature applied mathematics multi-media learning modules for use in college classrooms which were produced by a project called TEAM, funded by a grant to the MAA from the Fund for the Improvement of Postsecondary Education (FIPSE). TEAM learning modules consist of video cassettes, written materials, and (for some modules) microcomputer software. In these real-world industrial problems, solutions are presented by industrial representatives who have actually encountered these problems in their work. The Minicourse will introduce participants to the six TEAM learning modules produced during the first two years of this project. Of special interest to those already familiar with TEAM modules, this Minicourse will mark the first official release of three new TEAM learning modules. Each participant will receive a complete set of TEAM written materials. Participants will be shown how these modules can be used (i) to prevent a course in applied mathematics at the upper division level or at the lower division level; (ii) to offer students independent study projects, or (iii) to provide a lecture presentation of an application in industry.

Minicourse #4: *Computing in undergraduate linear algebra* is being organized by EUGENE A. HERMAN, Grinnell College. Part A is scheduled from

8:30 a.m. to 10:30 a.m. on Tuesday, August 13 and Part B from 8:30 a.m. to 10:30 a.m. on Wednesday, August 14. Total enrollment for this Minicourse is limited to 30 persons. A major reason that linear algebra is now taught to so many students so early in their education is that the computer has made linear algebra much more useful to scientists than it was 35 years ago. Yet computing has not had a significant effect on how undergraduate linear algebra is usually taught. This Minicourse explores the possibilities and consequences of putting powerful matrix computation packages in the hands of beginning linear algebra students. We will demonstrate and give participants experience using one such package. We will discuss the mathematical algorithms incorporated in the software, the importance of the user interface, the probable changes needed in the course, the kinds of application problems that can be assigned to students, the demands such a course puts on instructors and students, and the possible effects of the course. The capabilities possessed by the packages include: LU-factoring, QR-factoring, finding least square solutions, finding complete sets of eigenvectors and associated eigenvalues, orthonomalizing vectors, and finding Jordan and rational canonical forms.

Minicourse #5: *Microcomputer software in mathematics instruction* is being organized by ROY E. MYERS, Pennsylvania State University, Kensington. Part A is scheduled from 2:15 p.m. to 4:15 p.m. on Monday, August 12 and Part B from 2:15 p.m. to 4:15 p.m. on Tuesday, August 13. Total enrollment for this Minicourse is limited to 30 persons, but a second session will be offered if demand warrants. A wide variety of instructional software is becoming available for use with microcomputers. It varies in nature, including drill and practice, tutorial, and materials for use as lecture aids. Software is available for use in courses from introductory algebra through calculus, statistics, differential equations, and linear algebra. In this Minicourse, various types of software will be demonstrated, and issues relating to their uses will be discussed. It is planned that a large variety of software will be available and that Minicourse participants will have the opportunity to work with the software on microcomputers.

MAA Contributed Papers

The days on which the sessions for contributed papers will meet are as follows:

- The role of the history of mathematics in the undergraduate curriculum (Duane D. Blumberg, University of Southwestern Louisiana), Tuesday morning, August 13.
- What's happening in college geometry courses? What should? (Lester H. Lange, San Jose State University), Wednesday morning, August 14.
- Experience with innovation in solving the discrete/continuous mathematics dilemma (Michael G. Murphy and Nancy T. Rich, University of Houston–Downtown), Monday morning, August 12.
- What's new in teaching statistics? (Ann E. Watkins, Los Angeles Pierce College), Monday afternoon, August 12.

Other MAA Sessions

The Committee on Computers in Mathematics Education will sponsor a panel on the *Use of computing in the teaching of linear algebra.* This panel, being organized by EUGENE A. HERMAN, Grinnell College, will take place on Monday, August 12 at 9:00 a.m.

MAA Banquet for 25-year Members

The MAA is planning its tenth annual banquet for individuals who have been members of the Association for twenty-five years or more for Wednesday, August 14. Dinner will be served at 7:00 p.m. The menu includes fresh fruit cup, Western cut of prime rib of beef, salad, vegetable, potato, rolls, dessert, coffee, tea, Sanka, iced tea. Dinner will be preceded by a reception; no alcohol will be served.

Please note that all tickets for this banquet must be purchased through preregistration, since a guarantee must be given to the caterer. Tickets (which include gratuities) are $17.25 each. For those who are residing in the residence halls and are subject to the three-meal plan, the price of the banquet ticket is $12.75 since a credit of $4.50 will be allowed. Interested participants should complete the appropriate section of the preregistration form. In the event of cancellations, a full refund of the amount paid for the ticket will be refunded if notification is received in Providence prior to July 25. After that date, only a 50 percent refund will be given.

Joint AMS-MAA Sessions

Further information on the Joint AMS-MAA sessions follows:

RICHARD A. ASKEY, University of Wisconsin, title to be announced, 9:45 a.m. Wednesday.

SAUNDERS MAC LANE, University of Chicago, *The 20th century revolutions in geometry and topology*, 9:45 a.m. Monday.

BENOIT B. MANDELBROT, IBM and Harvard University, *Fractal geometry: Setting, birth and growth*, 9:45 a.m. Tuesday.

Activities of Other Organizations

The Association for Women in Mathematics will sponsor a panel discussion at 8:30 a.m. on Tuesday, August 13, on *Ethical problems in mathematical life.* The moderator is LINDA KEEN. Speakers include SUSAN MONTGOMERY, JEAN TAYLOR, and AUDREY TERRAS.

The Pi Mu Epsilon J. Sutherland Frame Lecture to take place at 8:30 p.m., on Wednesday, August 14, will be given by ERNST SNAPPER, Dartmouth College.

The Division of Mathematical Sciences of the National Science Foundation will sponsor a presentation at 4:30 p.m. on Monday, August 12. Speakers will include JOHN C. POLKING, Division Director and JOHN THORPE, Science and Engineering Education.

Participants interested in the conference on *New directions in applied and computational mathematics* to be held at the University of Wyoming, August 8–10, in honor of GAIL S. YOUNG's 70th birthday, should refer to the news item in the News and Announcements section of this issue of the *Notices*.

Accommodations

A change in rates for the Holiday Inn which appeared in the March issue of the *Notices* are as follows:

Single	$42–king bed
Double	$44–2 beds
Double	$46–king bed

Miscellaneous Information

Barbecue

A beef barbecue, prepared by the Albany County Cowbelles, will be held on Tuesday, August 13, 1985, from 5:30 p.m. to 7:30 p.m. in Washington Park, approximately 8 blocks from the campus of the University of Wyoming. The Cowbelles are famous in the Laramie area for their barbecues and serve only beef raised on their own ranches.

The menu includes barbecued beef on buns, baked beans, cole slaw, potato chips, cake or brownies, beer, lemonade, and coffee. Tickets are $8 per person.

It is anticipated that a form of entertainment, typical of their lifestyle as ranchers, will be provided by the Cowbelles.

Those planning to attend the barbecue should purchase their tickets as much in advance as possible so that a guarantee may be given. Please check at the Transparencies section of the registration desk for further details regarding the location on campus from which an organized departure is being planned to made the guided walk to Washington Park enjoyable for all.

Travel

The shortest and most scenic route is I-25 north to Fort Collins, then Colorado 14 west to Route 287, which runs north alongside the Rockies into Laramie. Driving time is approximately two-and-one-half hours. Colorado 14 was given as Colorado 24 in the first announcement.

The Preregistration/Housing Form, Employment Register Applicant Résumé Form, and instructions to complete the résumé form can be found at the back of this issue.

Robert M. Fossum
Urbana, Illinois — Associate Secretary

Amherst, October 26–27, University of Massachusetts

First Announcement of the 822nd Meeting

The eight hundred and twenty-second meeting of the American Mathematical Society will be held at the University of Massachusetts, Amherst, on Saturday and Sunday, October 26–27, 1985. All scientific sessions will be held in the Lederle Graduate Research Tower and the adjacent East Engineering Building. The meeting will be followed by a symposium at Harvard University to commemorate the accomplishments of Sonia Kovalevskaia, organized by the Association for Women in Mathematics in cooperation with the Mary Ingraham Bunting Institute of Radcliffe College.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Eastern Sectional Meetings, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the times of presentation, are as follows:

VAUGHAN F. R. JONES, University of Pennsylvania and Mathematical Sciences Research Institute, Berkeley, *A connection between von Neumann algebras and knot theory*, 1:30 p.m. Sunday.

ANDRÉ JOYAL, Université du Quebec, Montreal, *Witt vectors from a categorical standpoint*, 11:00 a.m. Saturday.

NGAIMING MOK, Princeton University, *Metric rigidity theorems on Hermitian locally symmetric spaces*, 11:00 a.m. Sunday.

ROBERT T. SEELEY, University of Massachusetts, Boston, *Asymptotics of the heat equation at conic singularities*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be eleven special sessions of selected twenty-minute papers. The topics of these special sessions and names of the organizers are as follows:

An introduction to quasi-crystals, JEAN TAYLOR, Rutgers University.

Nonlinear problems arising in physics and geometry, LESLEY M. SIBNER, Polytechnic Institute of New York.

Sonia Kovalevskaia: Major currents in 19th century mathematics, JANE CRONIN SCANLON, Rutgers University.

The above three special sessions are coordinated with the AWM Symposium on the legacy of Sonia Kovalevskaia.

Lattice theory, geometry and combinatorics, M. K. BENNETT, University of Massachusetts, Amherst, and GARRETT BIRKHOFF, Harvard University.

The mathematical science of Hermann Weyl: A centenary tribute, MELVYN S. BERGER, University of Massachusetts, Amherst, and DONAL O'SHEA, Mount Holyoke College. The tentative speakers include M. Berger, H. Fischer, A. Jaffe, H. McKean, I. Segal, M. Senechal, and S. Sternberg.

Transcendental algebraic geometry, DAVID COX, Amherst College, and ALAN DURFEE, Mount Holyoke College.

Braids, links and operator algebras, RICHARD H. HERMAN, Pennsylvania State University, and VAUGHAN F.R. JONES.

**-fields, Hermitian forms, and *-valuations*, SAMUEL S. HOLLAND, JR., University of Massachusetts, Amherst, and MAURICE CHACRON, Carleton University.

Representations of reductive Lie groups, JAMES E. HUMPHREYS, University of Massachusetts, Amherst, and Rutgers University.

Categorical methods in homotopy theory, ANDRÉ JOYAL.

Functional equations and iteration, BERTHOLD SCHWEIZER, University of Massachusetts, Amherst.

Most of the papers to be presented at these special sessions will be by invitation. However, anyone submitting an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract form and submit it by **July 29, 1985**, three weeks before the deadline for contributed papers, in order that it may be considered for inclusion. All abstracts must be accompanied by payment of $15 to cover a portion of the processing costs. Participants are reminded that a charge of $12 is also imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Providence, Rhode Island 02940, so as to arrive before the **August 19, 1985**, abstract deadline. All abstracts must be accompanied by payment of the $15 processing charge. Participants are reminded that charge of $12 is also imposed for retyping abstracts that are not in camera-ready form. It appears unlikely that late papers can be accommodated.

Association for Women in Mathematics

A symposium in honor of Sonia Kovalevskaia will be held at Harvard University, Cambridge, Massachusetts, on Sunday evening, October 27, and Monday, October 28, following the meeting of the American Mathematical Society in Amherst. The symposium has been organized by the AWM in cooperation with the Mary Ingraham Bunting Institute of Radcliffe College. The academic year

1985–1986 marks the fifteenth anniversary of the AWM and the twenty-fifth anniversary of the Bunting Institute. This dual occasion provides an apt framework in which to celebrate the mathematical accomplishments of Sonia Kovalevskaia, who did some of her most important work just about a century ago, and to present the work of mathematicians who are today working in related fields.

The lectures in the symposium will focus on a broad selection of topics to Kovalevskaia's work. These include the following: reaction-diffusion equations, theory of vibrations, Hamiltonian systems, dynamical systems and turbulences, Backlund transformations, singularities in Yan-Mills fields, topological entropy, theory of solitons, minimal immersions and submanifolds, geometric measure theory, geometric invariant theory, and boundary problems.

Details of the program will appear in a subsequent issue of the *Notices*.

Registration

The meeting registration desk will be located in the 16th floor lobby of the Lederle Graduate Research Tower. The desk will be open from 7:00 p.m. to 9:00 p.m. on Friday, from 8:00 a.m. to 2:00 p.m. on Saturday, and from 8:00 a.m. to noon on Sunday. The registration fees for the AMS meeting only are $10 for members, $16 for nonmembers, and $5 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box in the Laramie meeting announcement on page 246 in the March issue of the *Notices*.

Accommodations

Rooms have been blocked for participants at the following hotels or motels in the area. Individuals should make their own reservations directly and identify themselves as participants in the AMS meeting at Amherst. The rates listed are subject to change and, with the exception of Motel 6, do not include applicable tax.

Lincoln Campus Center Hotel (on campus)
University of Massachusetts, Amherst 01003
Deadline for reservations: October 11
Telephone: 413-549-6000
Single $38 Double $48
Triple $54

Motel 6 (10 miles from campus)
Routes 5 & 10, South Deerfield 01373
Deadline for reservations: October 4
Telephone: 413-665-2681
Single $18.97 Double $23.20
Quadruple $27.43

University Motor Lodge (1/4 mile from campus)
345 North Pleasant Street, Amherst 01002
Deadline for reservations: September 25
Telephone: 413-256-8111
Single $39 Double $48
Third person $5

Food Service

Meals will be available at the following campus locations: Top of the Campus Restaurant (located in Lincoln Campus Center) will serve dinner from 5:00 p.m. to 9:00 p.m. Friday and Saturday; Hatch Cafeteria in the Student Union is open from 8:00 a.m. to 4:00 p.m. Saturday and Sunday; and the Newman Center Cafeteria will be open from 8:30 a.m. to 4:00 p.m. on Saturday, and from 8:30 a.m. to 10:00 p.m. on Sunday.

Social Event

A wine and cheese party is scheduled to take place at 5:00 p.m. Saturday in the Mathematics Lounge on the 16th floor of the Lederle Graduate Research Tower.

Parking

Parking will be permitted in any of the parking lots on campus from 6:00 p.m. on Friday until 7:00 a.m. Monday. There is no charge for parking in these campus lots. The only restrictions apply to spaces reserved for the handicapped or areas that are marked towing zone. Additional parking is available for a fee in the parking garage adjacent to the Lincoln Campus Center.

Travel

The University of Massachusetts, Amherst is accessible by air, bus, and automobile. In the town of Amherst there is no taxi service, but it is expected that Pioneer Valley Transit Authority (PVTA) will provide free bus service between the campus and several points within the Amherst city limits.

Amherst is a 50-minute drive from Bradley International Airport in Windsor Locks, Connecticut, which is served by such major airlines as American, Delta, Eastern, People Express, TWA, United, and USAir. Participants are advised to fly in and out of Bradley, since it is closer and more convenient than Logan International Airport in Boston. Peter Pan Bus Line provides frequent service between the terminal at Bradley International Airport and the Springfield bus terminal, where passengers then transfer to another Peter Pan bus which will take them to the Lincoln Campus Center. The present hours of operation from Bradley International Airport is from 8:40 a.m. to 9:15 p.m., and from the Lincoln Campus Center back to Bradley between 4:45 a.m. and 7:50 p.m. The bus trip takes approximately 90 minutes and the fare is $8.50 each way.

Several major car rental agencies, including Avis, Budget, Hertz, National, and Thrifty, are located at Bradley International Airport.

W. Wistar Comfort
Middletown, Connecticut Associate Secretary

Columbia, November 1–2, 1985, University of Missouri

First Announcement of the 823rd meeting

The eight hundred and twenty-third meeting of the American Mathematical Society will be held at the University of Missouri, Columbia, on Friday and Saturday, November 1 and 2, 1985.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there will be four invited one-hour addresses. The speakers are as follows:

ERIK FRIEDLANDER, Northwestern University, Title to be announced.

CARLOS KENIG, University of Minnesota, Minneapolis, Title to be announced.

ANDREW SOMMESE, University of Notre Dame, *A survey on hyperplane sections of projective varieties.*

MICHAEL TALAGRAND, Ohio State University, *Empirical processes and measure theory.*

Special Sessions

By invitation of the same committee, there will be six special sessions of selected twenty-minute papers. The topics of these special sessions, the names and affiliations of the organizers, and partial lists of speakers, are as follows:

Ordinary differential equations, CALVIN D. AHLBRANDT, University of Missouri, Columbia.

Differential geometry, JOHN KELLEY BEEM and PAUL EHRLICH, University of Missouri, Columbia. The tentative speakers include Stephanie Alexander, Dean Allison, Richard Bishop, Robert Blumenthal, Lawrence Conlon, Gregory Galloway, Samuel Goldberg, Carolyn Gordon, Steven Harris, James Hebda, Gary Jensen, Franz Kamber, Marek Kossowski, Ravi Kulkarni, Kishore Marathe, Bahram Mashhoon, Phillip Parker, Thomas Powell, Brian Smyth, Abraham Taub, and Philippe Tondeur.

Inverse scattering theory, BRIAN DE FACIO, University of Missouri, Columbia. The tentative speakers include Mark Ashbaugh, Margaret Cheney, James P. Corones, Gerhard Kristensson, R. J. Krueger, D. A. Lee, Roger G. Newton, and Vaughn H. Weston.

Commutative algebra, RICHARD FEDDER, JAMES A. HUCKABA, and IRA J. PAPICK, University of Missouri, Columbia. The tentative list of speakers includes Kaan Akin, Daniel Anderson, David Anderson, James Brewer, Al Dixon, David Dobbs, Eloise Hamann, William Heinzer, Melvin Hochster, Sam Huckaba, Craig Huneke, Jon Johnson, Bernie Johnson, Daniel Katz, David Lantz, Andy Magid, Bruce Magurn, Mary Martin, Bernd Ulrich, Roger Weigand, and Sylvia Weigand.

Maximal functions in harmonic analysis, BJORN JAWERTH, Washington University, and ALBERTO TORCHINSKY, Indiana University.

Banach spaces and related topics, ELIAS SAAB, University of Missouri, Columbia. The tentative speakers include Kevin Andrews, Donald Burkholder, William Davis, Joe Diestel, G. A. Edgar, William Johnson, Dan Lewis, Nassif Ghoussoub, E. Odell, Larry Riddle, Richard Rochberg, Haskell Rosenthal, Joel Shapiro, N. Tomczak-Jaegermann, Jerry Uhl, Guido Weiss, and Robert F. Wheeler.

Most of the papers to be presented at these special sessions will be by invitation. However, anyone submitting an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract form and submit it by **July 31, 1985**, three weeks before the deadline for contributed papers, in order that it may be considered for inclusion. All abstracts must be accompanied by payment of $15 to cover a portion of the processing costs. Participants are reminded that a charge of $12 is also imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, so as to arrive before the **August 21, 1985**, abstract deadline. All abstracts must be accompanied by payment of the $15 processing charge. Participants are reminded that a charge of $12 is also imposed for retyping abstracts that are not in camera-ready form.

Midwest Differential Equations Conference

The fourteenth annual Midwest Differential Equations Conference will be held in Columbia, Missouri, on Thursday, October 31, 1985. Principal speakers will be TOM HALLAM of the University of Tennessee, Knoxville; MORRIS HIRSCH of the University of California, Berkeley; and PAUL WALTMAN of Emory University. This conference is being held in honor of W. R. UTZ on the occasion of his retirement from the University of Missouri, Columbia. A retirement dinner for Professor Utz will be held on the evening of October 31. Contact Calvin D. Ahlbrandt at the University of Missouri, Columbia, for further details.

Registration and Local Information

Information concerning registration, travel, food services, and accomodations will be included in the August issue of the *Notices*.

Robert M. Fossum
Associate Secretary

Urbana, Illinois

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

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

Laramie, August 1985

Stuart S. Antman	Ronald J. Stern
Richard E. Block	Jerrold Tunnell
Robert L. Bryant	Karen K. Uhlenbeck
David B. MacQueen	(Colloquium Lecturer)
Dennis Stanton	Lai-Sang Young

Amherst, October 1985

Vaughan F. R. Jones	Ngaiming Mok
Andre Joyal	Robert T. Seeley

Columbia, November 1985

Eric Friedlander	Andrew Sommese
Carlos Kenig	Michael Talagrand

Claremont, November 1985

Bruce Blackadar	James Carrell

New Orleans, January 1986

Joseph N. Bernstein	Sergiu Klainerman
Lennart A. E. Carleson	Naynes R. Miller
Alexander S. Kechris	Jane Cronin Scanlon

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of the *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

August 1985 Meeting in Laramie

Associate Secretary: Robert M. Fossum

Deadline for organizers: Expired
Deadline for consideration: Expired

Richard A. Askey, *Combinatorics and special functions*

Marcy Barge and Robert F. Williams, *Dynamical systems and ergodic theory*

Frank R. DeMeyer and Rick Miranda, *Commutative algebra and algebraic geometry*

Ronald A. Fintushel, *Gauge theories and 4-manifolds*

George B. Purdy, *The geometry of configurations*

V. M. Segal and S. P. Singh, *Numerical approximation theory and applications*

Scott J. Spector, *Mechanics and bifurcation theory*

Chung-Chun Yang, *Analysis of one complex variable*

October 1985 Meeting in Amherst

Eastern Section

Deadline for organizers: Expired
Deadline for consideration: July 29, 1985

M. K. Bennett and Garrett Birkhoff, *Lattice theory, geometry and combinatorics*

Melvyn S. Berger and Donal O'Shea, *The mathematical science of Hermann Weyl: A centenary tribute*

David Cox and Alan Durfee, *Transcendental algebraic geometry*

Richard H. Herman and Vaughan F.R. Jones, *Braids, links and operator algebras*

Samuel S. Holland, Jr. and Maurice Chacron, **-fields, Hermitian forms, and *-valuations*

James E. Humphreys, *Representations of reductive Lie groups*

André Joyal, *Categorical methods in homotopy theory*

Jane Cronin Scanlon, *Sonia Kovalevskaia: Major currents in 19th century mathematics*

Berthold Schweizer, *Functional equations and iteration*

Lesley M. Sibner, *Nonlinear problems arising in physics and geometry*

Jean Taylor, *An introduction to quasi-crystals*

November 1985 Meeting in Columbia

Central Section

Deadline for organizers: Expired
Deadline for consideration: July 31, 1985

Calvin D. Ahlbrandt, *Ordinary differential equations*

John Kelley Beem and Paul Ehrlich, *Differential geometry*

Brian de Facio, *Inverse scattering theory*

Richard Fedder, James A. Huckaba, and Ira J. Papick, *Commutative algebra*

Bjorn Jawerth and Alberto Torchinsky, *Maximal functions in harmonic analysis*

Elias Saab, *Banach spaces and related topics*

November 1985 Meeting in Claremont

Far Western Section

Deadline for organizers: Expired
Deadline for consideration: August 5, 1985

Gerald Beer and Richard Vitale, *Multifunctions, hyperspaces, and their application*

Christopher I. Byrnes, *Algebraic geometry and control theory*

Bernard Russo, *Operator algebra theory*

Fall 1985 Meeting

Southeastern Section

No meeting will be held

January 1986 Meeting in New Orleans

Associate Secretary: Frank T. Birtel

Deadline for organizers: Expired
Deadline for consideration: September 25, 1985

Gary Bloom and D. F. Hsu, *Labeled graphs*

Richard Bronson, *Mathematical modeling and computer simulation*

Peter Duren, *Complex analysis*

Robert Gardner, *Equivalence problems and applications*

Eric Grinberg and Eric Todd Quinto, *Radon transforms and tomography*

Alexander S. Kechris and Hugh Woodin, *Terminacy and large cardinals*

Sung Lee, *Operator method of optimal control problems*

Erwin Lutwak, *Convexity*

Jorge Martinez, *Ordered algebras*

Peter McCoy, *Classical partial differential equations*

Steven Mitchell, *Homotopy theory*

Paul Muhly, *Complex variables and operator theory*

Paul Sally and Rebecca Herb, *Harmonic analysis on reductive groups*

Jane Cronin Scanlon, *Mathematical biology*

Claude Schochet and Kenneth Millett, *Operator algebra perspectives*

Jalal Shatah and Sergiu Klainerman, *Recent advances in nonlinear hyperbolic equations*

Lutz Weis, *Positive operators and their applications*

Spring 1986 Meeting

Eastern Section

Deadline for organizers: October 15, 1986
Deadline for consideration: To be announced

April 1986 Meeting in Indianapolis

Central Section

Deadline for organizers: October 15, 1986
Deadline for consideration: To be announced

Spring 1986 Meeting

Far Western Section

No meeting will be held

Spring 1986 Meeting

Southeastern Section

Deadline for organizers: October 15, 1986
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer meetings are held under the general supervision of the Program Committee. They are administered by the Associate Secretary in charge of the meeting with staff assistance from the Society office in Providence.

Some Special Sessions arise from an invitation to a proposed organizer issued through the Associate Secretary. Others are spontaneously proposed by interested organizers or participants. Such proposals are welcomed by the Associate Secretaries.

The number of Special Sessions at a Summer or Annual Meeting is limited to twelve. Proposals, invited or offered, which are received at least nine months prior to the meeting are screened for suitability of the topic and of the proposed list of speakers, and for possible overlap or conflict with other proposals (specific deadlines for requesting approval for Special Sessions at national meetings are given above). If necessary, the numerical limitation is enforced.

Proposals for Special Sessions should be submitted directly to the Associate Secretary in charge of the meeting (at the address given in the accompanying box). If such proposals are sent to the Providence office, addressed to the *Notices*, or directed to anyone other than the Associate Secretary, they will have to be forwarded and may not be received before the quota is filled.

In accordance with an action of the Executive Committee of the Council, no Special Session may be arranged so late that it may not be announced in the *Notices* early enough to allow any member of the Society, who wishes to do so, to submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration.

Special Sessions are effective at Sectional Meetings and can usually be accommodated. They are arranged by the Associate Secretary under the supervision of the Committee to Select Hour Speakers for the section. The limitation on the number of sessions depends on the space and time available. The same restriction as for national meetings applies to the deadline for announcing Special Sessions at sectional meetings: no Special Session may be approved too late for its announcement to appear in time to allow a reasonable interval for members to prepare and submit their abstracts prior to the special early deadline set for consideration of papers for Special Sessions.

The Society reserves the right of first refusal for the publication of proceedings of any special session. These proceedings appear in the book series *Contemporary Mathematics*.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)
Hugo Rossi, Associate Secretary
Department of Mathematics
University of Utah
Salt Lake City, UT 84112
(Telephone 801-581-8159)

Central Section
Robert M. Fossum, Associate Secretary
Department of Mathematics
University of Illinois
1409 West Green Street
Urbana, IL 61801
(Telephone 217-333-3975)

Eastern Section
W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203-347-9411)

Southeastern Section
Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504-865-5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Call For Topics For 1987 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1987. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences are outlined below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, or telephoning 401-272-9500, extension 296.

Individuals willing to serve as organizers should be aware that the professional meeting staff in the Society's Providence office will provide full support and assistance, before, during, and after each of these conferences. Organizers should also note that for all conferences except Summer Research Conferences, it is required that the proceedings be published by the Society, and that SRC's are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and chairman of the Organizing Committee; (2) a two- or three-page detailed outline of the subject(s) to be covered, including the importance, timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; (5) a list of likely candidates who would be invited to participate and their current affiliations; and (6) any other observations which may affect the size of the conference and the amount of support required. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. By action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference, and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

Refer to the box titled **Topics of Current and Recent Conferences** in this announcement for lists of topics.

Topics of Current and Recent Conferences

AMS-SIAM Symposium in Applied Mathematics

1980–*Mathematical psychology and psychophysiology,* organized by STEPHEN GROSSBERG of Boston University.

1983–*Inverse problems,* organized by D. W. MCLAUGHLIN of the University of Arizona.

AMS Summer Institute

1983–*Nonlinear functional analysis and applications,* organized by FELIX BROWDER of the University of Chicago.

1984–*Geometric measure theory and the calculus of variations,* organized by WILLIAM K. ALLARD of Duke University and FREDERICK J. ALMGREN, JR. of Princeton University.

1985–*Algebraic geometry,* organized by DAVID EISENBUD of Brandeis University.

1986–*Representations of finite groups and related topics,* organized by JONATHAN L. ALPERIN of the University of Chicago.

AMS-SIAM Summer Seminar

1983–*Large scale computations in fluid mechanics,* organized by RICHARD C. J. SOMERVILLE, Scripps Institution of Oceanography

1984–*Nonlinear systems of PDE in applied mathematics,* organized by BASIL NICOLAENKO of Los Alamos National Laboratories.

1985–*Reacting flows: Combustion and chemical reactors,* organized by G.S.S. LUDFORD of Cornell University.

1987 AMS-SIAM Symposium In Applied Mathematics

This two-day symposium in applied mathematics will henceforth take place in every odd-numbered year, alternating with a symposium in pure mathematics in even-numbered years. The next regularly scheduled symposium is scheduled to be held during the two days preceding the 1987 spring AMS sectional meeting at a site that has not yet been selected. Proceedings are published by the Society as volumes in the series *SIAM-AMS Proceedings.*

Deadline For Suggestions: August 15, 1985

1987 AMS Summer Institute

Summer institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics, and usually extend over a three-week period. Dates for a summer institute must not overlap those of the Society's summer meeting (not known at this printing, but some time in August) and, there should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics.*

Deadline For Suggestions: August 15, 1985

1987 AMS-SIAM Summer Seminar

The goal of the summer seminar is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the Society as volumes in the series *Lectures in Applied Mathematics.*

Deadline For Suggestions: August 15, 1985

1987 Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences

These conferences are similar in structure to those held at Oberwolfach, and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the fourth series of one-week conferences, being held in 1985, are *Brown-Gitler spectra and applications, Applications of Lie groups in differential geometry, Numerical simulations of fluid flow, Multiparameter bifurcation theory, Harmonic analysis in* $\mathbf{R}^n$, *Function estimates, Applications of mathematical logic to finite combinatorics, Combinatorics and ordered sets, Current trends in arithmetical algebraic geometry,* and *Computational number theory.* If proceedings are published by the Society, they will appear as volumes in the series *Contemporary Mathematics.*

Deadline For Suggestions: February 1, 1986

Call for Topics for 1987 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions ordinarily extending over a period of one and one-half days immediately prior to the Joint Mathematics Meetings held in January and August each year. Each of the courses is devoted to a specific area of applied mathematics or to areas of mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences. Topics in recent years have been *Fair Allocation* (January 1985), *Environmental and Natural Resource Mathematics* (August 1984), *Mathematics of Information Processing* (January 1984), *Population Biology* (August 1983), and *Computer Communications* (January 1983). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics,* with the approval of the Editorial Committee.

Deadline for Suggestions: July 1, 1985 for January 1987 course, and December 1, 1985 for August 1987 course.

Submit suggestions to: Professor Stefan A. Burr, Chairman, AMS Short Course Subcommittee, Department of Computer Sciences, CUNY, City College, New York, New York 10031.

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), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on special meetings should be sent to the Editor of the *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

1984–1985. **Academic Year Devoted to Nonlinear Differential Equations**, The Mittag-Leffler Institute, Djursholm, Sweden. (February 1984, p. 194)

1984–1985. **Special Year Devoted to Minimal Surfaces and their Applications to Low-Dimensional Topology**, Department of Mathematics, University of California, Santa Barbara, California. (October 1984, p. 690)

1984–1985. **Special Year Devoted to Reacting Flows: Combustion and Chemical Reactors**, Center for Applied Mathematics, Cornell University, Ithaca, New York. (April 1984, p. 333)

1984–1985. **Special Year in Mathematical Logic and Theoretical Computer Science**, University of Maryland, College Park, Maryland. (March 1985, p. 267)

1984–1985. **Special Year in Singularities and Algebraic Geometry**, University of North Carolina, Chapel Hill, North Carolina.

Information: Jonathan Wahl, Department of Mathematics, University of North Carolina, Chapel Hill, North Carolina 27514.

September 1, 1984–August 31, 1985. **Program on Continuum Physics and Partial Differential Equations**, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (August 1984, p. 521)

October 7, 1984–December 14, 1985. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (October 1984, p. 689)

1985. **European Mechanics Colloquia**, Various locations. (October 1984, p. 690)

1985–1986. **Academic Year Devoted to Nonlinear Differential Equations**, Mittag-Leffler Institute, Djursholm, Sweden. (January 1985, p. 89)

August 16, 1985–July 15, 1986. **Program on Stochastic Differential Equations and Their Applications**, University of Minnesota, Minneapolis, Minnesota.

Information: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-373-0355.

October 1985–October 1986. **Material Instabilities in Continuum Mechanics**, Heriot-Watt University, Edinburgh, Scotland.

Topics: Nonlinear elasticity, models of phase transition.

Participants: R. J. DiPerna, Duke University; J. L. Eriksen, University of Minnesota; R. D. James, Brown University; R. V. Kohn, Courant Institute; J. E.Marsden, University of California, Berkeley; O. Penrose, Open University; M. Slemrod, Rensselaer Polytechnic Institute; J. Smoller, University of Michigan; G. Strang, Massachussetts Institute of Technology; L. Tartar, Limeii.

Information: J. M. Ball, Department of Mathematics, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, Scotland.

JUNE 1985

3–7. **CIT-CNNAA Joint Differential Equations Seminar**, Taiwan, Republic of China. (January 1985, p. 91)

3–7. **Program Design and Pascal**, Salisbury State College, Salisbury, Maryland. (January 1985, p. 91)

3–7. **Third Bad Honnef Conference on Stochastic Differential Systems**, Bad Honnef, Federal Republic of Germany. (March 1985, p. 269)

3–7. **Workshop on Dynamical Problems in Continuum Physics**, University of Minnesota, Minneapolis, Minnesota. (March 1985, p. 269)

3–8. **Calcul Formel**, CIRM-Luminy, France.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 route Léon Lachamp, 13288 Marseille Cedex 09, France.

4–6. **7th Symposium on Computer Arithmetic**, University of Illinois, Urbana, Illinois.

Information: Daniel G. Gajski, Department of Computer Science, University of Illinois, Urbana, Illinois 61801.

5–7. **International Conference on Modelling Techniques and Tools for Performance Analysis**, Sophia-Antipolis, France.

Information: AFCET, 156 boul. Péreire, 75017 Paris, France.

Erratum to March 1985 Issue

In the March Special Meetings listing, the Fifth International Conference on Mathematical Modelling was incorrectly listed as being held in Milano, Italy. It is actually being held in Berkeley, California. The person to contact for information is George Leitmann at the University of California, Berkeley.

5–8. **International Conference on Computational Geometry and Computer Aided Design**, New Orleans, Louisiana. (January 1985, p. 91)

5–14. **Conference on Geometry and Operator Algebras**, Berkeley, California. (August 1984, p. 525)

6–8. **Canadian Mathematical Society Annual Summer Meeting**, Université Laval, Québec, Canada. (March 1985, p. 270)

8–9. **Fractals and the Geometry of Nature**, Salisbury State College, Salisbury, Maryland.

Principal Lecturer: B. B. Mandelbrot, Harvard University.

Information: B. A. Fusaro, Department of Mathematical Sciences, Salisbury State College, Salisbury, Maryland 21801, 301-543-6465.

9–19. **Workshop on Stochastic Differential Systems with Applications in Electrical/Computer Engineering, Control Theory, and Operations Research**, University of Minnesota, Minneapolis, Minnesota.

Information: Institute for Mathematics and Its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-373-0355.

10–14. **Computer Solutions to Differential Equations**, Salisbury State College, Salisbury, Maryland. (January 1985, p. 91)

10–14. **Ninth International Conference on Transport Theory**, Montecatini Terme, Italy. (March 1985, p. 270)

10–14. **Seventh International Symposium on the Mathematical Theory of Networks and Systems**, Royal Institute of Technology, Stockholm, Sweden. (October 1984, p. 693)

10–14. **Short Course on Numerical Grid Generation**, Mississippi State University, Mississippi State, Mississippi. (March 1985, p. 270)

10–15. **Conference on Topology**, National University of Singapore. (November 1984, p. 802)

12–15. **Ninth Summer Real Analysis Symposium**, University of Louisville, Louisville, Kentucky.

Information: Real Analysis Symposium, Department of Mathematics, University of Louisville, Louisville, Kentucky 40292.

13–15. **Logic, Logic Machines, and Public Education**, University of Houston-Clear Lake, Houston, Texas. (March 1985, p. 270)

17–21. **Applications of Combinatorics and Graph Theory to Computer Science**, University of Alabama, Huntsville, Alabama.

Program: Ten research-level lectures by C. S. Liu (University of Illinois at Urbana-Champaign), additional speakers, discussion groups, and problem solving sessions.

Support: Limited travel and subsistence funds available.

Information: P. J. Slater, Department of Mathematics and Statistics, University of Alabama, Huntsville, Alabama 35899, 205-895-6470.

17–21. **Lecture Series on Combinatorial Aspects of Matrix Analysis**, Johns Hopkins University, Baltimore, Maryland. (March 1985, p. 270)

17–21. **NSF-CBMS Regional Conference on Group Rings, Crossed Products, and Galois Theory**, Mankato State University, Mankato, Minnesota.

Principal Lecturer: D. Passman.

Supporting Lecturers: D. Farkas, E. Formanek, S. Montgomery, L. Small, R. Warfield.

Information: F. T. Hannick, Department of Mathematics, Mankato State University, Mankato, Minnesota 56001.

17–21. **Operator Algebras and Mathematical Physics**, University of Iowa, Iowa City, Iowa.

Topics: Some aspects of the algebraic approach to statistical mechanics; noncommutative differential geometry; group actions and dynamical systems.

Information: P.E.T. Jorgensen, P. S. Muhly, or R. H. Oehmke, Department of Mathematics, University of Iowa, Iowa City, Iowa 52242.

17–21. **Probability and Banach Spaces**, Zaragoza, Spain.

Speakers: E. Giné, N. Kalton, G. Pisier, J. L. Rubio de Francia.

Information: Jesús Bastero or Miguel San Miguel, Facultad de Ciencias-Matemáticas, Universidad de Zaragoza, 50009 Zaragoza, Spain.

17–22. **Histoire des Mathématiques**, CIRM-Luminy, France.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 Route Léon Lachamp, 13288 Marseille Cedex 09, France.

17–29. **Canadian Mathematical Society Seminar on Number Theory**, Concordia University, Montréal, Québec, Canada. (March 1985, p. 270)

18–21. **Optimisation Mathématique et Applications Spatiales**, Toulouse, France.

Information: B. Trung Van, CNES/DTI/MN, 18 av. E. Belin, 31062 Toulouse Cedex, France.

19–21. **Fourth International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Dublin, Ireland. (June 1984, p. 398)

20–21. **Calcul des Probabilités sur les Espaces de Banach**, Strasbourg, France.

Information: SMF, Comm. Journées, B.P. 126-05, 75226 Paris Cedex 05, France.

20–July 5. **Third Workshop on Nonlinear Evolution Equations and Dynamical Systems**, Lecce, Italy. (October 1984, p. 693)

24–26. **SIAM 1985 Spring Meeting**, Pittsburgh Hyatt House, Pittsburgh, Pennsylvania. (January 1985, p. 91)

24–28. **Analyse sur les Groupes de Lie et les Espaces Symétriques**, CIRM-Luminy, France.

Organizers: J. Carmona, P. Delorme, M. Vergne.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 Route Léon Lachamp, 13288 Marseille Cedex 09, France.

24–28. **Aspects of Positivity in Functional Analysis**, Mathematisches Institut der Universität Tübingen, Federal Republic of Germany. (August 1984, p. 525)

24–28. **Journées Arithmétiques**, Besançon, France.

Information: J. Cougnard, Université de Franche-Comté, Route de Gray, 25030 Besançon Cedex, France.

24–28. **Second International Workshop on Mathematical Aspects of Fluid and Plasma Dynamics**, University of Paris, Orsay, France.

Objective: Analysis of fluid and plasma dynamics systems with emphasis on mathematical methods of applied mathematics and numerical analysis, in view of applications to experimental observations.

Information: Second International Workshop on Mathematical Aspects of Fluid and Plasma Dynamics, BP 38, 91406 Orsay Cedex, France.

24–29. **4th International Vilnius Conference on Probablity Theory and Mathematical Statistics**, Vilnius, U.S.S.R. (March 1985, p. 270)

24–July 12. **Ecole d'Eté d'Informatique**, Clamart, France. (March 1985, p. 270)

25–28. **Dundee Biennial Conference on Numerical Analysis**, Dundee, Scotland.

Information: Organizing Secretaries, Numerical Analysis Conference, Department of Mathematical Sciences, University of Dundee, Dundee DD1 4HN, Scotland.

30–July 3. **Hermann-Weyl-Congress**, Kiel University, Federal Republic of Germany. (March 1985, p. 270)

30–July 6. **3rd Conference on Differential Equations and Applications**, Ruse, Bulgaria. (March 1985, p. 270)

30–July 13. **Summer Seminar in Applied Mathematics: Reaching Flows, Combustion, Chemical Reactors**, Ithaca, New York.

Information: Professor Ludford, Theoretical and Applied Mechanics, Thurston Hall, Cornell University, Ithaca, New York 14853.

JULY 1985

1–4. **Rational Approximation and Its Application**, Kancut, Poland.

Information: M. Pindor, Instytut Fizyki Teoretycznej, Uniwersytet Warszawski, ul. Hora 69,00-681, Warsaw, Poland.

1–5. **International Conference on Classical and Categorical Algebra**, University of Natal, Durban, Republic of South Africa. (October 1984, p. 693)

1–6. **First International Fuzzy Systems Association Congress**, Palma de Mallorca, Balearic Islands, Spain. (October 1984, p. 693)

1–12. **Problèmes Inverses Pour l'Analyse Numérique**, Clamart Cedex, France. (March 1985, p. 270)

2–6. **Fifteenth Conference on Stochastic Processes and their Applications**, Nagoya, Japan. (October 1984, p. 693)

2–19. **XVème Ecole d'Eté de Calcul des Probablités**, Saint-Flour (Cantal), France.

Invited Speakers: Pierre Carier, Persi Diacomis, Srinicasa Varadhan.

Information: P. L. Hennequin, B.P. 45, F63170 Aubiere, France.

5–6. **International Colloquium on Applications of Mathematics**, Hamburg, Federal Republic of Germany. (October 1984, p. 693)

5–9. **Symposium on Transformation Groups**, Mathematics Institute, Adam Mickiewicz University, Poznan, Poland.

Information: S. Jackowski or K. Pawalowski, Instytut Matematyki, UAM, ul. Matejki 48/49, PL-60-769, Poznan, Poland.

6. **Colloquium on Applications of Mathematics**, Hambourg, Federal Republic of Germany.

Information: Institute of Applied Mathematics, University of Hambourg, Bundesstrasse 55, D-2000, Hambourg 13, Federal Republic of Germany.

7–13. **Logic Colloquium 85: European Summer Meeting of the Association for Symbolic Logic**, University of Paris XI, Orsay, France. (October 1984, p. 693)

Fellowships: Limited number available. Applicants should write a detailed letter stating their need.

Information: Before July 1, 1985, use address previously listed. After July 1, 1985, contact Y. Rav, Colloque de Logique, Département de Mathématiques, Bât. 425-Université Paris XI, 91405 Orsay, France.

8–12. **Modern Algebraic Methods-Combinatorial Algebra**, České Budějovice, Czechoslovakia.

Information: L. Bican, Charles University, MFF, Sokolovská 83, 18600 Praha 8, Czechoslovakia.

8–20. **Conference on Logic, Language and Computation**, Stanford University, Stanford, California. (March 1985, p. 271)

9–12. **Fourth International Conference on Numerical Methods in Laminar and Turbulent Flow**, Swansea, United Kingdom. (January 1985, p. 92)

11–13. **Journées Remoises d'Analyse de Problèmes Décisionnels dans un Environnement Incertain et Imprécis**, Reims, France. (March 1985, p. 271)

15–18. **Numerical Methods in Thermal Problems**, Swansea, United Kingdom. (January 1985, p. 92)

15–18. **SIAM Conference on Geometric Modeling and Robotics**, Albany, New York. (March 1985, p. 271)

15–18. **SIAM Conference on Mathematics of CAD/CAM**, Rensselaer Polytechnic Institute, Troy, New York. (January 1985, p. 92)

15–19. **Conference on Algorithms for the Approximation of Function and Data**, Shrivenham, United Kingdom. (January 1985, p. 92)

15–19. **NSF-CBMS Regional Conference on Jordan Algebras in Analysis, Operator Theory, and Quantum Mechanics**, University of California, Irvine, California.

Principal Speaker: Harald Upmeier, University of Kansas.

Participants: J. Dorfmeister, Y. Friedman, W. Kaup, P. Muhly, F. Shultz.

Deadline for Applications: June 1, 1985.

Information: B. Russo, Department of Mathematics, University of California, Irvine, California 92717.

15–19. **Third International Conference on Applied Algebra, Algebraic Algorithms and Symbolic Computation, Error Correcting Codes**, Grenoble, France.

Topics: Error correcting codes, coding/decoding theory, computer algebra, symbolic computation, algebra and algebraic geometry.

Contributed Papers: Deadline by May 5, 1985. Acceptance/rejection notification by June 5. Camera-ready copies by July 15.

Information: Jacques Calmet, Lifia, BP 68, 38402 St-Martin-d'Hères Cedex, France.

15–26. **Ecole d'Eté d'Analyse Numérique**, Clamart, France. (March 1985, p. 271)

15–26. **Problèmes Inverses et Applications**, Bréau-sans-Nappe, France.

Information: Secretariat des Ecoles d'Eté E.D.F., 1 avenue du Général de Gaulle, 92140 Clamart, France, Tel: 1-765-36-44.

15–August 2. **Rocky Mountain Mathematics Consortium**, University of Wyoming, Laramie, Wyoming.

Program: Lectures will cover the foundations of modern control theory from the point of view of both the mathematician and the control engineer.

Speakers: C. I. Byrnes, Arizona State University; C. F. Martin, Texas Tech University.

Cost: $500 plus room and board. Scholarships available to qualified faculty and graduate students.

Information: A. Duane Porter or Melfried Olson, Mathematics Department, University of Wyoming, Laramie, Wyoming 82071.

16–19. **Second International Conference on the Teaching of Mathematical Modelling**, University of Exeter, Exeter, England. (August 1984, p. 525)

21–24. **Conference on Groups and Geometry in Honor of R. H. Bruck**, University of Wisconsin, Madison, Wisconsin.

Principal Speakers: Michael Aschbacher, George Glauberman, Marshall Hall, Graham Higman, D. R. Hughes, William Kantor, T. G. Ostrom, H. J. Ryser, Ernest E. Shult, Stephen D. Smith, Richard Weiss.

Deadline for Papers: June 15, 1985.

Information: D. W. Crowe, Department of Mathematics, 480 Lincoln Drive, University of Wisconsin, Madison, Wisconsin 53706.

21–26. **Workshop on Homotopical Algebra and Its Applications**, University College of North Wales, Bangor, United Kingdom. (March 1985, p. 271)

22–25. **SLU-GTE Conference on Sequence Spaces**, St. Lawrence University, Canton, New York. (January 1985, p. 92)

22–26. **Tenth British Combinatorial Conference**, Glasgow, Scotland, United Kingdom. (October 1984, p. 693)

26–August 5. **Symposium on Homotopy Theory**, Durham University, United Kingdom.

Information: E. G. Ross, Department of Mathematics, University of Edinburgh, King's Buildings, Edinburgh EH9 3JZ, Scotland.

27–August 10. **Groups–St. Andrews 1985**, St. Andrews, Scotland. (January 1985, p. 92)

28–August 10. **Conference on Banach Spaces and Classical Analysis**, Kent State University, Kent, Ohio. (November 1984, p. 802)

29–31. **Fifth International Conference on Mathematical Modelling**, University of California, Berkeley, California.

Information: George Leitmann, Professor of Engineering Science, University of California, Berkeley, California 94720.

29–August 16. **NATO Advanced Study Institute: Nonlinear Dynamical Systems; Integrability and Qualitative Behavior**, Université de Montréal, Montréal, Canada. (January 1985, p. 92)

31–August 8. **Symposium on the Transmission of Mathematical Science**, Berkeley, California. (June 1984, p. 398)

AUGUST 1985

4–10. **Conference on Near-rings and Near-fields**, Tübingen, Federal Republic of Germany. (January 1985, p. 92)

4–10. **Recontre Internationale de la Commission pour l'Etude et l'Amélioration de l'Enseignement des Mathématiques**, Leiden, The Netherlands.

Information: Vakgroep OW-OC, Mme. E. J. Hanepen, 4 Tiberdreef, NL-3561 GG, Utrecht, The Netherlands.

5–9. **Second Seminar on Random Graphs and Probabilistic Methods in Combinatorics**, Poznań, Poland. (October 1984, p. 694)

5–9. **12th International Symposium on Mathematical Programming**, Cambridge, Massachusetts. (March 1985, p. 271)

5–16. **Georgia Topology Conference**, University of Georgia, Athens, Georgia. (October 1984, p. 694)

8–10. **Conference on New Directions in Applied and Computational Mathematics**, University of Wyoming, Laramie, Wyoming.

Program: This conference will explore the interface of pure mathematics, applied mathematics, and computer science.

Tentative Lecturers: H. Pollak, A. Nerode, D. Kleitman, C. Byrnes, S. Winograd, R. Ewing, P. Hilton, and C. Martin.

Information: Kenneth I. Gross, Director, Department of Mathematics, University of Wyoming, Laramie, Wyoming 82071.

11–17. **Haar Memorial Conference**, Budapest, Hungary. (March 1985, p. 271)

11–20. **4th Session of International Institute of Statistics**, Maastricht, The Netherlands. (March 1985, p. 271)

12–16. **Workshop/Conference on Hydrocodes and Other Codes on Parallel Processors**, Michigan Technological University, Houghton, Michigan. (October 1984, p. 694)

16–23. **International Conference on Radicals; Theory and Applications**, Krems/Donau, Austria. (January 1985, p. 93)

18–22. **CRYPTO '85**, Santa Barbara, California. (March 1985, p. 271)

19–23. **NSF-CBMS Regional Conference on Combinatorial Theory and Invariant Theory**, West Chester University, West Chester, Pennsylvania.

Speaker: Gian-Carlo Rota, Massachusetts Institute of Technology.

Support: Funds for travel and subsistence will be available for about 25 participants.

Deadline for Applications: June 15, 1985.

Information: F.D. Grosshans, Department of Mathematical Sciences, West Chester University, West Chester, Pennsylvania 19383.

20–September 13. **Ecole d'Eté du Cimpa, Géometrie Algébrique Réelle**, Nice, France.

Information: Cimpa, 1 avenue Edith Cavell, 06000 Nice, France.

21–30. **Workshop on Stochastic Integrals**, University of Minnesota, Minneapolis, Minnesota.

Organizer: D. Stroock.

Speakers: D. Burkholder, J. Doob, E. B. Dynkin, W. Fleming, L. Gross, K. Ito, S. Kakutani, S. Kotani, P. Malliavin, G. Papanicolaou, J. Pitman, D. Stroock.

Information: Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455, 612-373-0355.

23–27. **Meeting on Mathematical Statistics and Probability**, Maastricht, The Netherlands. (March 1985, p. 271)

25–31. **Second International Symposium on Probability and Information Theory**, Hamilton, Ontario, Canada. (March 1985, p. 271)

26–30. **Colloquium on Ordered Sets**, Szeged, Hungary. (November 1984, p. 803)

26–30. **6th Czechoslovak Conference on Differential Equations and their Applications**, Brno, Czechoslovakia. (March 1985, p. 272)

26–31. **International Symposium on Operator Theory**, Athens, Greece. (January 1985, p. 93)

26–September 5. **Tenth International Conference on Operator Theory**, Timisoara, Romania.

Information: Tenth Operator Theory Conference, Department of Mathematics, INCREST, 220 Bd. Pacii, R-79622 Bucharest, Romania.

26–September 28. **Equations of Fluid Mechanics: Theory and Numerical Calculus**, Ile-Ife, Nigeria.

Information: CIMPA, 1 avenue Edith Cavell, 06000 Nice, France.

27–31. **United States–Netherlands Seminar in Representations of Semisimple Lie Groups**, University of Utrecht, The Netherlands.

Information: J. A. Wolf, Department of Mathematics, University of California, Berkeley, California 94720.

SEPTEMBER 1985

2–7. **Théorie des Nombre**, CIRM-Luminy, France.

Organizer: M. Martinet.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 route Léon Lachamp, 13288 Marseille Cedex 09, France.

2–12. **NATO Advanced Study Institute: Advances in Microlocal Analysis**, Il Ciocco, Castelvecchio-Pascoli, Italy. (August 1984, p. 525)

9–12. **International Symposium on Computational Fluid Dynamics**, Tokyo, Japan. (January 1985, p. 93)

9–12. **Problèmes Spectraux, Approximation, Calculs Numériques, Applications**, Sophia-Antipolis, France. (March 1985, p. 272)

9–13. **International Symposium on Variational Methods for Free Surface Interfaces**, Vallombrosa Center, Menlo Park, California.

Program: Invited speakers and informal presentations.

Organizing Committee: R. Brown, P. Concus, R. Finn (Chairman), S. Hildebrandt, M. Miranda.

Information: R. Finn, Department of Mathematics, Stanford University, Stanford, California 94305.

9–14. **Congrès du Groupement des Mathématiciens d'Expression Latine**, Coimbra, Portugal.

Information: A. Ribeiro Gomes, Department of Mathematics, University of Coimbra, Apartado 300B, P-3000, Coimbra, Portugal.

9–14. **Journées Probabilistes**, CIRM-Luminy, France.

Organizers: J. Azema, M. Yor.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 route Léon Lachamp, 13288 Marseille Cedex 09, France.

12–14. **Mathematics Teaching 1985**, Edinburgh, Great Britain. (March 1985, p. 272)

16–20. **International Colloquium on Group Theory in Memory of Tibor Szele**, University of Debrecen, Bolyai Society, Hungarian Academy of Sciences.

Information: E. Szabó, KLTE Matematikai Intézete, P.O. Box 12, Debrecen 4010, Hungary.

16–20. **Sixth International Meeting on Clinical Biostatistics**, Dusseldorf, West Germany.

Information: R. A. Dixon, University of Sheffield Medical School, Beech Hill Road, Sheffield, S10 2RX, United Kingdom.

16–21. **Eleventh International Congress of the Österreichische Mathematische Gesellschaft**, Graz, Austria. (October 1984, p. 694)

16–21. **Géométrie Algébrique Réelle**, CIRM-Luminy, France.

Organizer: J. J. Risler.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 Route Léon Lachamp, 13288 Marseille Cedex 09, France.

17–19. **Conference on Mathematics and Signal Processing**, University of Bath, United Kingdom. (January 1985, p. 93)

17–19. **International Symposium on Numerical Analysis**, Madrid, Spain. (August 1984, p. 525)

18–24. **Workshop on Random Media**, University of Minnesota, Minneapolis, Minnesota.

Organizer: G. Papanicolaou.

Speakers: L. Arnold, D. Brydges, R. Carmona, J. Cheyes, L. Cheyes, P. Chow, M. Cohen, R. Durrett, E. Economou, D. Fisher, J. Frölich, J. Imbrie, J. B. Keller, W. Kohler, S. Kotani, C. Newman, B. Souillard, T. Spencer, V. Twersky, S. R. S. Varadhan.

Information: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-373-0355.

23–24. **Colloque International: "Approaches non paramétriques en analyse chronologique"**, Brussels, Belgium.

Information: Simone Huyberechts, Institute of Statistics, Free University of Brussels, Campus Plaine, C.P. 210, Boul. du Triomphe, B-1050, Brussels, Belgium.

23–28. **Groupe d'Étude sur les Sommes de Kloosterman**, CIRM-Luminy, France.

Organizer: J. M. Deshouillers.

Information: Anna Zeller-Meier, CIRM, Case 916, 70 route Léon Lachamp, 13288 Marseille Cedex 09, France.

23–28. **International Symposium on Interval Mathematics**, University of Freiburg, Freiburg, Federal Republic of Germany.

Information: K. Nickel, Institut für Angewandte Mathematik, Hermann-Herder-Strasse 10, D-7800 Freiburg, Federal Republic of Germany.

25–27. **Conference on Numerical Methods in Fluid Mechanics**, German Aerospace Research Establishment, Göttingen, West Germany.

Objective: The conference is interested in bringing together scientists who are working on the theory or applications of numerical methods in fluid mechanics. The main objective is to foster exchanges between the various fields of computational fluid dynamics such as aerodynamics, hydrodynamics, propulsion, fluid machinery, nuclear reactor technology, meteorology, biomechanics, and others.

Information: D. Rues, German Aerospace Research Establishment, Conference Chairman, Bunsenstr. 10, D-3400, Göttingen, West Germany.

27–28. **Twelfth Annual Student Conference**, Miami University, Oxford, Ohio.

Call for Abstracts: Undergraduate mathematics and statistics students are invited to contribute papers and should send abstracts by September 16, 1985.

Information: Milton Cox, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056.

27–28. **Thirteenth Annual Mathematics and Statistics Conference**, Miami University, Oxford, Ohio.

Speakers: Myles Hollander, Florida State University; Richard L. Schaffer, University of Florida; Ronald Snee, DuPont Corporation.

Information: Robert L. Schaefer, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056.

30–October 5. **Fourth International Conference on Topology and its Applications**, Dubrovnik, Yogoslavia. (January 1985, p. 93)

OCTOBER 1985

7–12. **Waves and Stability in Continuous Media**, University of Bari, Bari, Italy.

Information: Secretariat of the III Meeting, "Waves and Stability in Continuous Media", M. Maiellaro or L. Palese, Department of Mathematics, University Campus, Bari, Italy.

18–19. **Seventh Midwest Probability Symposium**, Northwestern University, Evanston, Illinois.

Speaker: Ludwig Arnold, University of Bremen.

Information: M. Pinsky, Department of Mathematics, Northwestern University, Evanston, Illinois 60201.

19–20. **Midwest Partial Differential Equations Conference**, University of Illinois, Urbana, Illinois. (March 1985, p. 272)

21–23. **Twenty-Sixth Annual Symposium on Foundations of Computer Science**, Portland Marriot Hotel, Portland, Oregon.

Suggested Topics: Algorithms and data structures; computability and complexity theory; cryptography; theory of data bases; logic of programs; theory of formal languages and automata; theory of logical design, layout, and VLSI; theory of robotics; semantics of programming languages; parallel and distributed computation.

Call for Papers: Submit abstract by April 29, 1985 to Robert E. Tarjan, P.O. Box 347, Oldwick, New Jersey 08858.

Information: Eugene M. Luks, Computer and Information Science, University of Oregon, Eugene, Oregon 97403.

21–24. **Symposium in Honor of J. J. Stoker**, Courant Institute of Mathematical Sciences, New York University, New York, New York. (March 1985, p. 192)

22–24. **Seventeenth National SAMPE Technical Conference**, Kiamesha Lake, New York. (October 1984, p. 694)

25–26. **Fifth Southeastern-Atlantic Regional Conference on Differential Equations**, Georgia Institute of Technology, Atlanta, Georgia.

Program: Lectures will be given by J. A. Goldstein, Tulane University; R. M. Kauffman, University of Alabama at Birmingham; I. Lasiecka, University of Florida. In addition, there will be sessions for twenty-minute talks.

Information: J. V. Herod, School of Mathematics, Georgia Institute of Technology, Atlanta, Georgia 30332, 404-894-5366 or 404-894-2701.

28–30. **International Symposium on Advances in Nonlinear Partial Differential Equations**, Madison, Wisconsin. (March 1985, p. 272)

28–30. **SIAM 1985 Fall Meeting**, Arizona State University, Tempe, Arizona. (January 1985, p. 93)

31. **Fourteenth Annual Midwest Differential Equations Conference**, University of Missouri, Columbia, Missouri. (March 1985, p. 272)

NOVEMBER 1985

4–15. **Workshop on Large Deviation Theory**, University of Minnesota, Minneapolis, Minnesota.

Organizer: S. Orey.

Participants: A. DeAcosta, R. R. Bahadur, T. S. Chiang, M. Day, M. Donsker, R. Ellis, W. Fleming, N. Jain, D. Griffiths, J. Kuelbs, J. Lynch, P. Ney, W. Pruitt, S. Orey, J. Sethuraman, S. J. Sheu, B. Simon, J. Smoller, D. Stroock, S. R. S. Varadhan, S. Zabell.

Information: Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota 55455, 612-373-0355.

18–20. **Second SIAM Conference on Parallel Processing and Scientific Computing**, Norfolk, Virginia. (January 1985, p. 93)

21–22. **Twentieth Actuarial Research Conference**, University of Texas, Austin, Texas.

Sponsors: Casualty Actuarial Society, Society of Actuaries, Actuaries' Club of the Southwest, Graduate School of Business, University of Texas at Austin.

Call for Papers: Presentations of current research in the following fields are being solicited: measurement of surplus, solvency criteria, matching of assets and liabilities, asset selection and fund management. Any paper on financial research of interest to actuaries is welcome.

Information: Samuel A. Cox, Jr., Department of Finance, University of Texas at Austin, Austin, Texas 78712.

DECEMBER 1985

16–21. **Methods of Functional Analysis in Approximation Theory**, Indian Institute of Technology, Bombay, India. (March 1985, p. 272)

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JANUARY 1986

13–17. **Fifth International Symposium on Approximation Theory**, Texas A&M University, College Station, Texas.

Program: Seven survey lectures plus sessions for contributed papers.

Information: C. K. Chui, L. L. Schumaker, or J. Ward, Center for Approximation Theory, Texas A &M University, College Station, Texas 77843.

FEBRUARY 1986

17–21. **Workshop on Disordered Systems, Percolation, and Self-Avoiding Random Walks**, University of Minnesota, Minneapolis, Minnesota.

Organizers: T. Harris, G. Papanicolaou.

Information: Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455, 612-373-0355.

MARCH 1986

17–21. **Workshop on Hydrodynamic Behavior of Interacting Particle Systems**, University of Minnesota, Minneapolis, Minnesota.

Organizers: T. Harris, G. Papanicolaou.

Information: Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455, 612-373-0355.

24–28. **Fourth International Symposium on Numerical Methods in Engineering**, Atlanta, Georgia.

Information: A. Chaudouet, c/o CETIM-B.P. 67-60304 Senlis Cedex, France.

MAY 1986

18–21. **International Symposium on Flood Frequency and Risk Analyses**, Louisiana State University, Baton Rouge, Louisiana. (October 1984, p. 694)

JUNE 1986

9–19. **Stochastic Differential Systems with Applications to Control Theory, Electrical/Computer Engineering, and Operations Research**, University of Minnesota, Minneapolis, Minnesota.

Organizers: W. Fleming, P. L. Lions.

Information: Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455, 612-373-0355.

JULY 1986

27–August 1. **Thirteenth International Biometric Conference**, Seattle, Washington.

Information: Gerald van Belle, Department of Biostatistics, University of Washington, Seattle, Washington 98195.

AUGUST 1986

3–11. **International Congress of Mathematicians**, Berkeley, California. (February 1984, p. 159)

11–16. **Second International Conference on Teaching Statistics**, University of Victoria, Victoria, British Columbia, Canada. (January 1985, p. 93)

25–29. **Sixth Prague Topological Symposium**, Prague, Czechoslovakia.

Information: Zdeněk Frolik, Matematický ústav ČSAV, Žitná 25, 115 67 Praha 1, Czechoslovakia.

LATE ENTRY

August 19–23, 1985. **NSF-CBMS Regional Conference on Optimization in Operator Theory, in Analytic Function Theory, and in Electrical Engineering**, Lincoln, Nebraska.

Principal Speaker: J. W. Helton, University of California at San Diego, La Jolla.

Additional Speakers: S. Y. Chang, University of California, Los Angeles; J. Doyle, California Institute of Technology; C. Foiaş, Indiana University; K. Glover, Cambridge University; I. Gohberg, Tel-Aviv University; P. Muhly, Iowa University.

Information: D. Larson or G. Woodward, Department of Mathematics and Statistics, University of Nebraska, Lincoln, Nebraska 68506.

Reviews in K-theory

Bruce Magurn, Editor

Reviews in K-theory is a collection of all reviews of research papers, surveys and books pertaining to K-theory, which have appeared in *Mathematical Reviews* by the end of 1984. The reviews are organized by subject according to a new subject classification scheme (a version of which is being considered for use by *Mathematical Reviews* beginning in 1986 under a new heading (19 K-theory) in the *Mathematical Reviews–Zentralblatt* subject classification of mathematics). Included are author-, key- and subject-indices. Special features include:

a) Supplement (a bibliography of K-theory papers published by the end of 1984, not yet reviewed by *Mathematical Reviews*)

b) *Zentralblatt* review numbers for nearly all papers mentioned.

The audience is research mathematicians, college and university educators and mathematics graduate students. Specialties touched include linear algebra, algebraic and analytic number theory, algebraic geometry, algebraic and differential topology, category theory, functional analysis and operator algebras, and quadratic forms.

The two most significant contributions are:

a) A subject classification scheme for K-theory based on the advice of sixty-six experts in the field.

b) A complete listing of all K-theory related research, much of which is scattered through the literature in unexpected places.

There is no other collected reviews in K-theory. This differs from other volumes of collected reviews published by the American Mathematical Society because it includes the Supplement and Zentralblatt citations mentioned in the description.

The only necessary background is the ability to read reviews of mathematical papers. Many introductory texts are reviewed in the References section. Readers can expect to gain access to the most current research related to K-theory, and some understanding of the mathematical context which gave rise to and still nurtures the subject. Each section in the subject scheme is represented by papers which form a motivational unit, so the roots and the lines of progress are clear.

1980 *Mathematics Subject Classifications*: 12A62, 12B22, 13D15, 14C35, 14F15, 16A54, 18F25 and others
ISBN 0-8218-0088-4, LC 85-7481
824 estimated pages, August 1985
List price $240, Institutional member $192, Individual member $144
Shipping and handling charges must be added
To order, please specify REVKN

Large-Scale Computations in Fluid Mechanics

Bjorn E. Engquist, Stanley Osher and Richard C. J. Somerville, Editors

(Lectures in Applied Mathematics, Volume 22)

This is the proceedings of an AMS-SIAM Summer Seminar on Applied Mathematics held at Scripps Institution of Oceanography in 1983. The purpose was to bring scientists interested in computational fluid mechanics together with numerical analysts and mathematicians working in large-scale computations.

The numerical modeling included geophysical problems of the atmosphere, ocean, and interior of the earth, and planetary, solar, and stellar atmospheres. Applications ranged from idealized turbulence in laboratory convection models to operational weather prediction. Engineering applications included aerodynamics, combustion, and flow in porous media. Recent advances in numerical analysis which have applications to these problems were stressed. These include shock capturing algorithms, spectral methods, boundary treatments, vortex methods, and parallel computing.

Fifty lectures were given during the two-week seminar. The subject matter of the lectures was equally divided between mathematics and applications. In addition to specialized research lectures, several speakers gave talks surveying important areas of numerical analysis and computational fluid dynamics.

Contents

1980 *Mathematics Subject Classifications*: 35-XX, 65-XX, 76-XX, 86-XX
ISBN 0-8218-1122-3, LC 84-24534
ISSN 0075-8485
xvi + 371 pages (*part 1*), x + 412 pages (*part 2*) (hardcover), July 1985
Set: List price $110, Institutional member $88, Individual member $66
Part 1: List price $66, Institutional member $53, Individual member $40
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Computer Communications

B. Gopinath, Editor

(Proceedings of Symposia in Applied Mathematics, AMS Short Course Lecture Notes, Volume 31)

This is the proceedings of the 1983 American Mathematical Society Short Course given at Denver, Colorado.

Computer communications is characterized by rapid technological advances presenting problems of a theoretical nature that are often very difficult to solve. They range from those that arise on a single chip, where communication among thousands of elements on a chip is influenced by electrical properties, to those that arise when human beings communicate with data bases where the logical aspects of communications play a more important role.

A variety of mathematical methods is needed to attempt to solve such problems; they vary from partial differential equations to temporal or modal logic. A short course cannot give an exhaustive treatment of the role of mathematics in computer communications, however, this book includes a sample of the work that involves mathematics which can give those interested in the area the flavor of the field. All of the articles are of high research value and are self-contained. The article on "Diffusion Approximation" is probably the best review of this field accessible to a mathematician which is available today. The book is unique in having contributors from a variety of different fields of computer communications.

Contents

1980 *Mathematics Subject Classifications*: 60Fxx, 60Gxx, 60Jxx, 68Exx, 90Bxx, 94Axx
ISBN 0-8218-0082-5, LC 84-24556
ISSN 0160-7634
x + 124 pages, June 1985
Hardcover: List price $27, Institutional member $22, Individual member $16
Softcover: List price $21, Institutional member $17, Individual member $13
Shipping and handling charges must be added
To order, please specify PSAPM/31N (hardcover), PSAPMS/31N (softcover)

Environmental and Natural Resources Mathematics

Robert McKelvey, Editor

(Proceedings of Symposia in Applied Mathematics, AMS Short Course Lecture Notes, Volume 32)

This volume contains lecture notes, mildly revised from those originally prepared for the American Mathematical Society's 1984 Summer Short Course, held in Eugene, Oregon on August 14-15. It also contains an expanded version of a panel discussion at the Short Course, on the role played by mathematicians in natural resource modeling.

The term "natural resources" is to be interpreted broadly, encompassing air and water resources, land and soil, minerals and oil, energy resources, and such biological resources as fisheries, agricultural crops, forests, and wildlife. The objective of the Short Course, and of this volume, is to demonstrate that, despite the great diversity of kinds of natural resources, there has developed a coherent theory concerning the efficient and conservative management of resources, and that this theory has a substantial mathematical component.

Contents

1980 *Mathematics Subject Classification*: 49–06, 90–06
ISBN 0-8218-0087-6, LC 85-3917
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xii + 143 pages, July 1985
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Integral Bases for Affine Lie Algebras and their Universal Enveloping Algebras

David Mitzman

(Contemporary Mathematics, Volume 40)

This work is a revised version of the author's Ph.D. thesis written under the supervision of J. Lepowsky at Rutgers University in 1983.

Contents

1980 *Mathematics Subject Classifications*: 17B05, 17B20, 17B35, 17B65
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Deformations of Nilpotent Matrices Over Rings and Reduction of Analytic Families of Meromorphic Differential Equations

Donald G. Babbitt and V. S. Varadarajan

(Memoirs of the AMS, Number 325)

This memoir is devoted to the reduction theory of systems of linear meromorphic differential equations in the neighborhood of an irregular singularity, when the coefficients of the equations depend analytically on one or more complex parameters. The goal of the reduction process is to transform (formally) the equations to canonical forms that were first discovered by Hukuhara and Turrittin in the 1940s and '50s.

The basic idea of this paper is to view this problem as that of the formal reduction of a system of linear differential equations whose coefficients lie in a local ring. The implementation of this idea rests on the availability of a good structure and deformation theory of similarity classes of nilpotent matrices over the local ring, and in the first part of the memoir the authors develop such a theory. This can be done in much detail over a discrete valuation ring, so that the reduction of the differential equations becomes essentially constructive for one parameter families.

The results established in this memoir may be regarded as the basis for constructing a theory of local moduli for linear systems of meromorphic differential equations (in the neighborhood of an irregular singularity), when all the formal invariants of the equations are fixed.

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Perfect C^*-Algebras

Charles A. Akemann and Frederic W. Shultz

(Memoirs of the AMS, Number 326)

Abstract

For any C^*-algebra A the authors construct a kind of completion A_c of A consisting of certain operators in A^{**} which are continuous on the pure states of A. The authors show that both A and A_c can be viewed as algebras of continuous functions from the set of irreducible representations of A (*a la* Takesaki), and in this way they show that A_c is a C^*-algebra. They say that A is perfect if $A = A_c$, and it follows from the Stone-Weierstrass Theorem and the Gelfand Representation Theorem that every abelian C^*-algebra is perfect. Indeed, perfect C^*-algebras form a new class of C^*-algebras for which the general Stone-Weierstrass conjecture is true, and this class cuts across previous classifications. For example, type I C^*-algebras with Hausdorff spectrum are perfect (as are all type I von Neumann algebras), but many type I C^*-algebras are not. (The authors give a complete description of the separable, perfect, type I C^*-algebras). The algebra A_c is always perfect, and its structure is quite close to that of A. For example, A_c is simple iff A is simple; furthermore, the centers of A and A_c coincide. Finally, "perfection" of A is preserved under stable isomorphism.

1980 *Mathematics Subject Classification*: 46LXX
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Eleven Papers on Differential Equations

(American Mathematical Society Translations, Series 2, Volume 126)

These papers have been selected by the Translation Committee of the AMS from various Soviet journals.

Contents

1980 *Mathematics Subject Classifications*: 28C20, 34-XX, 47-XX, 49C15, 65L05, 73C02, 81C10

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Theory and Applications of Differentiable Functions of Several Variables. IX

S. M. Nikol'skiĭ

(Proceedings of the Steklov Institute of Mathematics, Volume 161)

The papers herein 1) establish imbedding theorems and the boundedness of certain operators in new function spaces, 2) obtain coercive estimates and separability theorems for elliptic operators, 3) find a connection between operator norms in periodic and nonperiodic function spaces, 4) study questions of the denseness of compactly supported functions in weighted spaces, 5) investigate properties of polynomial traces, 6) establish estimates of the capacity of sets in function spaces, 7) study singular integral operators and multipliers in weighted spaces.

Contents

G. A. Kalyabin, *Correction to the paper "Descriptions of functions from classes of Besov-Lizorkin-Triebel type*

1980 *Mathematics Subject Classifications*: 26-XX, 30-XX, 35-XX, 41-XX, 42-XX, and others
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Géométrie des Surfaces *K*3: Modules et Périodes

(Astérisque, Number 126)

Ce texte est issu des notes du Séminaire de Géométrie du Centre de Mathématiques de l'Ecole Polytechnique qui s'est tenu d'Octobre 1981 à Janvier 1982, et qui était organisé par A. Beauville, J.-P. Bourguignon et M. Demazure. Son thème "Application des périodes des surfaces *K*3" avait été choisi à cause de la possibilité qu'il offrait d'utiliser des techniques venant de la géométrie algébrique et de la géométrie différentielle. Ce sujet a connu des développements tout à fait intéressants avant, pendant ou juste après la tenue du séminaire. Ce livre se propose de rendre compte de ce sujet de façon aussi autonome qu'il est possible de le faire en un seul volume. Il devrait donc être accessible à des étudiants ou à des mathématiciens ayant seulement des connaissances de base en géométrie algébrique et en géométrie différentielle.

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Séminaire sur les Pinceaux Arithmétiques: La Conjecture de Mordell

L. Szpiro, Editor

(Astérisque, Number 127)

Ce séminaire est centré sur la démonstration par G. Faltings de la conjecture de Mordell: une courbe lisse, géométriquement connexe, de genre au moins deux sur un corps de nombres n'a qu'un nombre fini de points rationnels sur ce corps. Il contient notamment une démonstration complète du théorème de finitude pour la "hauteur modulaire" (exposé IV de L. Moret-Bailly et exposé V de P. Deligne), le calcul effectif de M. Raynaud (exposé VII) pour la variation de la "hauteur modulaire" dans une classe d'isogénie, le décompte de N. Parshin du nombre de points rationnels (exposé XI de L. Szpiro). A part les trois points ci-dessus qui n'ont pas été publiés précédemment, le séminaire traite en détail les hauteurs et intersections d'Arakelov, les démonstrations des conjectures de Tate et Shafarévich et la construction de Kodaira-Parshin. Lintroduction et le leitfaden qui la suit peuvent servir à se faire une première idée de la démonstration de Faltings et de ses développements.

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Proceedings of the conference on integration, topology, and geometry in linear spaces, by Cecilia H. Brook, James K. Brooks, Heron S. Collins, Joe Diestel, Nicolae Dinculeanu, Nelson Dunford, William H. Graves, Denis Higgs, R. E. Huff, N. J. Kalton, Igor Kluvanek, Ka-Sing Lau, F. E. J. Linton, Wolfgang Ruess, Dennis Sentilles, J. J. Uhl, Jr., edited by William H. Graves (University of North Carolina, Chapel Hill, North Carolina, May 17-19, 1979), 1980, 269 pp. (LC 80-25417; ISBN 0-8218-5002-4) Softcover	CONM/2	6	19	11
Problems of elastic stability and vibrations, by K. K. Choi, E. J. Haug, G. H. Knightly, V. Komkov, E. Miersemann, J. Moseley, L. E. Payne, R. H. Plaut, D. Sather, edited by Vadim Komkov (AMS Special Session, Duquesne University, Pittsburgh, Pennsylvania, May 1981), 1981, 137 pp. (LC 81-12833; ISBN 0-8218-5005-9) Softcover	CONM/4	3	10	6
Rational constructions of modules for simple Lie algebras, by George B. Seligman, 1981, 185 pp. (LC 81-12781; ISBN 0-8218-5008-3) Softcover	CONM/5	4	13	8
Plane ellipticity and related problems, by A. K. Aziz, H. Begehr, John C. Bruch, Jr., J. L. Buchanan, R. Delanghe, M. R. Dorr, R. P. Gilbert, Gerald N. Hile, George C. Hsiao, Robert A. Hummel, R. B. Kellogg, Pertti Lounesto, Peter A. McCoy, M. H. Protter, James M. Sloss, F. Sommen, Herbert H. Snyder, edited by Robert P. Gilbert (AMS Special Session, San Francisco, California, January 1981), 1982, 256 pp. (LC 82-11562; ISBN 0-8218-5012-1) Softcover	CONM/11	7	22	13

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How to Write Mathematics, by N. E. Steenrod, P. R. Halmos, M. M. Schiffer and J. A. Dieudonné. This little book contains four essays on expository writing of books and papers at the research level and at the level of graduate texts. The authors were the four members of the AMS Committee on Expository Writing. N. E. Steenrod, who died in 1971, was the chairman, and the book is dedicated to him. 1973; reprinted with corrections 1981; reprinted 1983, 64 pp. (LC 72-13840; ISBN 0-8218-0055-8) Softcover	HWM	$ 3	$10	$ 6
Lectures in Applied Mathematics				
Probability and related topics in physical sciences, by M. Kac, with special lectures by G. E. Uhlenbeck, A. R. Hibbs, and B. Van Der Pol (University of Colorado, Boulder, Colorado, June 23-July 19, 1957), 1959; reprinted 1980, 1984, 266 pp. (LC 59-10443; ISBN 0-8218-0047-7) Softcover	LAM/1.1	10	32	19
Modern modeling of continuum phenomena, edited by R. C. DiPrima (Rensselaer Polytechnic Institute, Troy, New York, July 1975), 1977; reprinted 1982, 251 pp. (LC 77-9041; ISBN 0-8218-1116-9) Softcover	LAM/16	15	50	30
Algebraic and geometric methods in linear systems theory, edited by Christopher I. Byrnes and Clyde F. Martin (Harvard University, Cambridge, Massachusetts, June 19-30, 1979), 1980, 327 pp. (LC 80-27354; ISBN 0-8218-1118-5) Hardcover	LAM/18	10	32	19
Mathematical aspects of physiology, edited by Frank C. Hoppensteadt (University of Utah, Salt Lake City, June 1980), 1981, 394 pp. (LC 81-1315; ISBN 0-8218-1119-3) Hardcover	LAM/19	13	44	26
Lectures on Mathematics in the Life Sciences				
Some mathematical questions in biology, edited by George F. Oster (San Francisco, January 1980), 1980, 274 pp. (LC 77-25086; ISBN 0-8218-1163-0) Softcover	LLSCI/13	8	26	16
Some mathematical questions in biology, edited by Stephen Childress (Toronto, January 1981), 1981, 214 pp. (LC 77-25086; ISBN 0-8218-1164-9) Softcover	LLSCI/14	7	22	13
Translations of Mathematical Monographs				
Distribution of zeros of entire functions, by B. Ja. Levin; translated by R. P. Boas, J. M. Danskin, F. M. Goodspeed, J. Korevaar, A. L. Shields, H. P. Thielman, 1964; revised edition 1980, 524 pp. (LC 80-36891; ISBN 0-8218-4505-5) Softcover	MMONO/5	15	50	30
Introduction to the theory of linear nonselfadjoint operators, by I. C. Gohberg and M. G. Kreĭn; translated by A. Feinstein, 1969; reprinted 1978, 1983, 378 pp. (LC 67-22348; ISBN 0-8218-1568-7) Softcover	MMONO/18	11	36	22
Compact Lie groups and their representations, by D. P. Želobenko; translated by Israel Program for Scientific Translations, 1973; reprinted 1983, 448 pp. (LC 73-17185; ISBN 0-8218-1590-3) Softcover	MMONO/40	14	45	27
Statistical decision rules and optimal inference, by N. N. Čencov; translated by Israel Program for Scientific Translations, 1981, 500 pp. (LC 81-15039; ISBN 0-8218-4502-0) Hardcover	MMONO/53	26	88	53
Systems of quasilinear equations and their applications to gas dynamics, by B. L. Roždestvenskiĭ and N. N. Janenko; translated by J. R. Schulenberger, 1983, 676 pp. (LC 82-24488; ISBN 0-8218-4509-8) Hardcover	MMONO/55	44	147	88

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Proceedings of Symposia in Pure Mathematics				
Algebraic geometry–Arcata 1974, edited by R. Hartshorne (Humboldt State University, Arcata, California, July 29–August 16, 1974), 1975; reprinted with corrections 1979; reprinted 1982, 642 pp. (LC 75-9530; ISBN 0-8218-1429-X) Softcover	PSPUM/29	14	46	28
Automorphic forms, representations and L-functions, Parts 1 and 2 as a set, edited by A. Borel and W. Casselman (Oregon State University, July 11–August 5, 1977), 1979; reprinted 1980, 704 pp. (LC 78-21184; ISBN 0-8218-1435-4 (vol. 1), 0-8218-1437-0 (vol. 2)) Softcover	PSPUM/33	13	44	26
Relations between combinatorics and other parts of mathematics, edited by Dijen K. Ray-Chaudhuri (Ohio State University, March 20–23, 1978), 1979; reprinted 1980, 378 pp. (LC 78-25979; ISBN 0-8218-1434-6) Softcover	PSPUM/34	10	32	19
Geometry of the Laplace operator, edited by Robert Osserman and Alan Weinstein (University of Hawaii, March 27–30, 1979), 1980; reprinted 1982, 323 pp. (LC 79-26934; ISBN 0-8218-1439-7) Softcover	PSPUM/36	9	30	18
The Santa Cruz conference on finite groups, edited by Bruce Cooperstein and Geoffrey Mason (Summer Research Institute, University of California, Santa Cruz, June 25–July 20, 1979), 1981, 634 pp. (LC 80-26879; ISBN 0-8218-1440-0) Hardcover	PSPUM/37	14	46	28
The mathematical heritage of Henri Poincaré, Parts 1 and 2 as a set, edited by Felix E. Browder (Indiana University, Bloomington, April 1980), 1983; reprinted with corrections to Part 1, 1984, 905 pp. (LC 83-2774; ISBN 0-8218-1442-7) Softcover	PSPUM/39	24	79	47
SIAM—AMS Proceedings				
Computers in algebra and number theory, edited by G. Birkhoff and M. Hall, Jr. (New York City, March 1970), 1971; reprinted 1980, 200 pp. (LC 76-167685; ISBN 0-8218-1323-4) Softcover	SIAMS/4	6	19	11
Mathematical psychology and psychophysiology, edited by Stephen Grossberg (Philadelphia, April 1980), 1981, 318 pp. (LC 81-3500; ISBN 0-8218-1333-1) Hardcover	SIAMS/13	11	35	21
Selected Translations in Mathematical Statistics and Probability				
Eighteen papers on statistics and probability, by G. P. Čistjakov, Endre Csáki, I. I. Ežov, P. M. Flekser, A. E. Fryntov, B. N. Ginzburg, A. A. Gol′dberg, B. I. Grigelionis, A. I. Il′inskiĭ, V. S. Koroljuk, L. S. Kudina, L. Z. Livšic, L. D. Mešalkin, A. D. Milka, I. V. Ostrovskiĭ, B. A. Rogozin, I. N. Volodin, V. M. Zolotarev, 1981, 317 pp. (LC 61-9803; ISBN 0-8218-1465-6) Hardcover	STAPRO/15	17	58	35
Proceedings of the Steklov Institute of Mathematics				
Spectral theory of automorphic functions (1981), by A. B. Venkov, 1983, 164 pp. (LC 83-2694; ISBN 0-8218-3078-3) Softcover	STEKLO/153	20	67	40
Theory and applications of differentiable functions of several variables. VIII (1980), edited by S. M. Nikol′skiĭ, 1983, 285 pp. (LC 68-1677; ISBN 0-8218-3017-1) Softcover	STEKLO/156	26	86	52

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Analytic number theory, mathematical analysis and their applications (1981). Dedicated to Academician I. M. Vinogradov on his ninetieth birthday, edited by N. N. Bogolyubov, K. K. Mardzhanishvili, A. A. Karacuba, K. I. Oskolkov and V. I. Blagodatskih, 1984, 248 pp. (LC 84-265; ISBN 0-8218-3077-5) Softcover	STEKLO/158	22	74	44

Mathematical Surveys and Monographs

The theory of valuations, by O. F. G. Schilling, 1950; third printing 1978; reprinted 1982, 253 pp. (LC 50-12178; ISBN 0-8218-1504-0) Softcover	SURV/4	11	35	21
Symplectic groups, by O. Timothy O'Meara, 1978; reprinted with corrections 1982, 122 pp. (LC 78-19101; ISBN 0-8218-1516-4) Softcover	SURV/16	11	35	21

Selected Tables in Mathematical Statistics

The distribution of the size of the maximum cluster of points on a line, by Norman D. Neff and Joseph I. Naus, 1980, 207 pp. (LC 74-6283; ISBN 0-8218-1906-2) Hardcover	TABLES/6	6	19	11
The product of two normally distributed random variables, by William Q. Meeker, Jr., Larry W. Cornwell and Leo A. Aroian, 1981, 256 pp. (LC 74-6283; ISBN 0-8218-1907-0) Hardcover	TABLES/7	7	23	14

AMS Translations—Series 2

Sixteen papers on differential equations, by Ju. V. Egorov, A. V. Fursikov, D. M. Galin, Ju. S. Il'jašenko, T. F. Kalugina, V. Ju. Kiselev, A. I. Komeč, A. A. Lokšin, N. O. Maksimova, O. A. Oleĭnik, V. M. Petkov, P. R. Popivanov, E. V. Radkevič, C. V. Rangelov, D. A. Silaev, A. N. Šošitaĭšvili, M. A. Šubin, A. I. Suslov, M. I. Višik, 1982, 340 pp. (LC 82-20595; ISBN 0-8218-3072-2) Hardcover	TRANS2/118	22	74	44
Twelve papers in algebra, by V. A. Dem'janenko, A. I. Mal'cev, A. Ju. Ol'šanskiĭ, S. A. Ovsienko, B. I. Plotkin, A. V. Roĭter, Boris M. Schein, Hsieh Seng-kang, A. I. Širšov, I. Š. Slavutskiĭ, A. A. Šmelev, Wang Yuan, 1983, 139 pp. (LC 82-24434; ISBN 0-8218-3074-0) Hardcover	TRANS2/119	10	33	20
Four papers on ordinary differential equations, by M. G. Kreĭn and V. A. Jakubovič, 1983, 168 pp. (LC 83-2825; ISBN 0-8218-3075-9) Hardcover	TRANS2/120	11	35	21

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Personal Items

Ruth Silverman has accepted the position of Senior Computer Scientist at Computer Sciences Corporation, Silver Spring, Maryland.

Donald Z. Spicer, associate professor of mathematics and former associate dean at Vassar College, has been named director of academic computing at Dartmouth College.

Olga Taussky-Todd has been elected a corresponding member of the Bayerische Akademie der Wissenschaften, Federal Republic of Germany.

Deaths

Joseph W. Andrushkiw of South Orange, New Jersey, died on December 17, 1984, at the age of 78. He was a member of the Society for 33 years.

Albert T. Bharucha-Reid of Atlanta University, died on February 26, 1985, at the age of 57. He was a member of the Society for 29 years. See the obituary in the AMS Reports and Communications section of this issue.

Svend Bundgaard Professor Emeritus of Aarhus University, Denmark, died on December 21, 1984, at the age of 72. He was a member of the Society for 36 years.

Paul B. Burcham, Professor Emeritus of the University of Missouri, Columbia, died on March 13, 1985, at the age of 69. He was a member of the Society for 46 years.

Robert T. Gregory of the University of Tennessee, Knoxville, died on November 14, 1984, at the age of 64. He was a member of the Society for 36 years.

Akitsugu Kawaguchi, president of the Kawaguchi Institute of Mathematical Sciences, Japan, died on July 30, 1984. He was a member of the Society for 56 years.

Gvandji Michailovich Manija Chief of the Sector of Probability Theory and Mathematical Statistics at Tbilisi Mathematical Institute of the Georgian Academy of Sciences, and Chief of the Department of Probability Theory and Mathematical Statistics at Tbilisi State University, USSR, died on March 16, 1985, at the age of 66. He was a member of the Society for 4 years.

Correction

In the January 1985 issue of *Notices*, page 97, we mistakenly listed the death of Opris Gheorge of Romania. The death notice forwarded to us was for another university professor (a nonmathematician) with a similar name. We greatly regret the confusion and inconvenience caused by this error.

Unpublished Lecture Notes

The following lecture notes are available from the sources listed.

Brandeis University

1. Claudio Procesi (notes by Giandomenico Boffi), "A Primer of Invariant Theory," Brandeis Lecture Notes 1, September 1982 (218 pages) $7.50.
2. Mark Jankins and Walter D. Neuman, "Lecture on Seifert Manifolds," Brandeis Lecture Notes 2, March 1983 (97 pages) $7.50.
3. David A. Buchsbaum (notes by Giandomenico Boffi), "Generic Free Resolutions and Schur Complexes," Brandeis Lecture Notes 3, December 1983 (160 pages) $7.50.

Please make check or money order payable to The Chairman's Discretionary Fund, Brandeis University, Department of Mathematics, Waltham, Massachusetts 02254.

University of Minnesota

1. Lars V. Ahlfors, "Möbius Transformations in Several Variables," Ordway Professorship Lectures in Mathematics, 1981 (150 pages) $5.95 including postage and handling.

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Visiting Mathematicians

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists.

American Mathematicians Visiting Abroad

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Caperaa, Philippe (Canada)	Université de Grenoble, France	Statistics	1/86 - 12/86
Carmichael, Jean-Pierre (Canada)	Université de Toulouse, France	Statistics	6/85 - 5/86
Conn, Andy (Canada)	University of Grenoble	Numerical Optimization	7/85 - 6/86
Fugate, J. B. (U.S.A.)	Monash University, Australia	Topology	7/85 - 6/86
Gonnet, Gaston (Canada)	Universidad de La Republica, Uruguay	Analysis of Algorithms	4/85 - 7/85
Gragg, William (U.S.A.)	E. T. H., Switzerland	Numerical Analysis	7/85 - 6/86
Grimm, Louis J. (U.S.A.)	University of Gdańsk, Poland	Differential Equations	5/85 - 6/85
Henson, C. Ward (U.S.A.)	RWTH, West Germany	Logic	8/85 - 7/86
Johnson, David (U.S.A.)	The University, Manchester, England	Homotopic Topology	7/85 - 12/85
Kazdan, Jerry L. (U.S.A.)	Kyoto University, Japan	PDE and Applications to Geometry	7/85 - 6/86
Lee, Carl (U.S.A.)	University of Bonn, West Germany	Combinatorics	7/85 - 6/86
Mason, David M. (U.S.A.)	University of Munich, West Germany	Statistics	6/85 - 6/86
May, Warren (U.S.A.)	Universität Gesamthochschule Essen, West Germany	Abelian Groups	9/81 - 3/86
Ramsey, Fred (U.S.A.)	University of Wollongong, Australia	Mathematical Statistics	9/85 - 9/87
Resnick, Sidney I. (U.S.A.)	Sussex University, England	Stochastic Processes	8/85 - 8/86
Rosenkrantz, Walter (U.S.A.)	Institut National de Recherche en Informatique et en Automatique, France	Stability and Control of Multi User Communication Networks	9/85 - 6/86
Serfling, Robert J. (U.S.A.)	University of Freiburg, West Germany	Probability/Statistics	2/86 - 7/86
Taibleson, Mitchell (U.S.A.)	Nanjing University, People's Republic of China	Harmonic Analysis	9/85 - 12/85
Varley, Robert (U.S.A.)	Istituto Matematics "Ulisse Dini"	Algebraic Geometry	1/86 - 6/86
Ziller, Wolfgang (U.S.A.)	I.H.E.S., France	Differential Geometry	7/84 6/86

Visiting Foreign Mathematicians

Alladi, Krishnaswami (India)	University of Hawaii	Number Theory	8/84 - 7/85
Asano, K. (Japan)	University of Waterloo	Topological Graph Theory	4/85 - 3/86
Atiyah, Michael (England)	Harvard University		9/85 - 10/85
Barbu, Viorel (Romania)	Purdue University	Applied Mathematics	1/86 - 2/86
Bar-Lev, Shaul K. (Israel)	State University of New York at Buffalo	Statistical Inference	9/85 - 8/86
Bessis, Daniel (France)	Georgia Institute of Technology	Mathematical Physics	9/85 - 6/86
Besson, Gerard (France)	University of Pennsylvania	Differential Geometry	7/85 - 6/86
Bialostockie, Arie (Israel)	University of Idaho	Graph Theory, Ramsey Theorems	8/84 - 5/86
Broyden, Charles (England)	University of Illinois at Chicago	Optimization algorithms	1/86 - 3/86
Brundu, Michaela (Italy)	Brandeis University	Algebraic Geometry	9/85 - 5/86
Cifuentes, Patricio (Spain)	Texas A&M University	Linear Analysis	9/85 - 5/86
Coates, John H. (France)	Harvard University	Number Theory	2/86 - 3/86
Conway, John (England)	University of Illinois at Chicago	Groups, Coding Theory	9/85 - 12/85
deOliveira, Jose (Portugal)	University of California	Statistics	7/85 - 6/86
Downey, Rodney (Australia)	University of Illinois	Logic	8/85 - 5/86
Elliott, Charles (Great Britain)	Purdue University	Applied Mathematics	8/85 - 5/86
Escorcia, S. G. (Columbia)	University of Waterloo	Systems Engineering Information Computers	9/84 - 8/85
Gould, M. D. (Australia)	University of Waterloo	Lie Group Theory and Applications	5/85 - 8/85
Green, J. A. (England)	Warwick, England	Algebra and Algebraic Geometry	9/85 - 10/85
Greene, J. R. (England)	University of California, Santa Barbara	Statistical Methodology	7/85 - 6/86

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Grotschel, Martin (West Germany)	Cornell University	Combinatorics	8/85 - 10/85
(West Germany			
Herbison-Evans, D. (Australia)	University of Waterloo	Computer Graphics	9/85 - 8/86
Higman, Graham (England)	University of Illinois	Group Theory	8/85 - 5/86
Hoffman, Karl-Heinz (West Germany)	Purdue University	Differential Equations	
Hu, Guan-zhang (People's Republic of China)	University of Waterloo	Combinatorics and Graph Theory	10/84 - 9/85
Huang, Shaoyun (China)	Purdue University	Applied Mathematics	5/85 - 6/86
Humphries, Stephen (England)	University of California, Santa Barbara	Group Theory and Low Dispensiona Topology	7/85 - 6/87
Jeltsch, Rolf (West Germany)	Stanford University	Numerical Analysis	11/85 -
Jeziorski, B. (Poland)	University of Waterloo	Quantum Theory	10/84 - 9/85
Jiang, Li-shang (China)	Purdue University	Applied Mathematics	10/85 - 12/85
Junger, M. (Germany)	University of Waterloo	Operations Research and Combinatorial Optimization	3/85 - 9/85
Kale, B. K. (India)	University of Waterloo	Statistics	9/85 - 12/85
Kaminski, M. (Israel)	University of Waterloo	Probabilistic Algorithms; Algebraic Complexity of Computation	8/83 - 7/85
Karagedrghis, Andreas (Cyprus)	University of Kentucky	Partial Differential Equations	8/85 - 5/86
Karhumaki, J. (Finland)	University of Waterloo	Formal Languages and Automata Theory	1/85 - 12/85
Kennedy, Gerard (Great Britain)	Texas A&M University	Mathematical Physics	9/85 - 5/86
Kennington, Alan (Australia)	University of Kentucky	Numerical Analysis	8/85 - 5/86
Koschorke, Ulrich (West Germany)	University of California, Berkeley	Topology	4/85 - 9/85
Koyama, K. (Japan)	University of Waterloo	Cryptography	9/85 - 8/86
Kraft, Hanspeter (Switzerland)	Brandeis University	Algebraic Groups and Invariant Theory	8/85 - 12/85
Kroo, Andras (Hungary)	Texas A&M University	Approximation Theory	9/85 - 5/86
Kwasik, Slawomir (Poland)	Purdue University	Topology	8/85 - 5/86
Lacey, Andrew (Great Britain)	Purdue University	Applied Mathematics	9/85 -
Lavis, D. A. (England)	University of Waterloo	Quantum Theory of Solid Surfaces	4/85 - 9/85
Li, Jiachun (People's Republic of China)	University of Waterloo	Fluid Mechanics (Water Waves, Flow Stability)	2/85 - 1/86
Liu, Ming-Chit (Hong Kong)	Harvard University	Number Theory	9/85 - 6/86
Lovasz, Laszlo (Hungary)	Cornell University	Combinatorics	8/85 - 12/85
Lubinsky, Doron S. (South Africa)	University of South Florida	Approximation Theory	8/85 - 12/85
Majhoub, A. R. (France)	University of Waterloo	Discrete Optimization and Operations Research	10/85 - 2/86
McLeod, Bryce (Great Britain)	Purdue University	Applied Mathematics	8/85 - 12/85
Meirmanov, A. (U.S.S.R.)	Purdue University	Applied Mathematics	4/86 -
Moccellin, Jao Vitor (Brazil)	North Carolina State University	Allocation of Discrete and Continuous Resources in Multi-Project and Job-Shop Scheduling	9/84 - 8/85
Montes de Oca, Francisco Venezuela)	University of Miami	Differential Equations	8/85 - 12/85
Mori, Shigefumi (Japan)	Columbia University, New York	Algebraic Geometry	9/85 - 5/87
Niijima, Koichi (Japan)	Cornell University	Numerical Analysis	9/85 - 6/86
Ockendon, John (Great Britain)	Purdue University	Applied Mathematics	9/85 -
Polkowski, Lech (Poland(	Ohio University	Topology	9/85 - 8/86
Prolla, Joao (Brazil)	Texas A&M University	Approximation Theory	1/86 - 5/86
Puel, Jean-Pierre (France)	Purdue University	Differential Equations	4/86 -
Puknachov, V. V. (U.S.S.R.)	Purdue University	Applied Mathematics	4/86 -
Rabier, Patrick J. (France)	Southern Methodist University	Bifurcation Theory	1/85 - 5/86

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Ramlau-Hansen, H. (Denmark)	University of Waterloo	Actuarial Science	1/86 - 4/86
Ranicki, Andrew (United Kingdom)	University of Kentucky	Algebraic Topology	8/85 - 5/86
Rätz, Jürg (Switzerland)	University of Massachusetts, Amherst	Functional Equations	10/85 - 11/85
Rejali, Ali (Iran)	Harvard University	Number Theory	9/85 - 6/86
Reyes, J. (Mexico)	University of Waterloo	Surface Physics, Optical Properties of Solids	9/85 - 8/86
Serre, Jean-Pierre (France)	Harvard University		9/85 - 1/86
Shoji, Toshiaki (Japan)	University of Illinois at Chicago	Representation Theory	3/86 - 6/86
Sharir, Micha (Israel)	New York University, Courant Institute	Computer Science, Robutics	9/85 - 6/86
Sinha, Bikas K. (India)	North Carolina State University	Survey Sampling, Design of Experiments	7/85 - 6/86
Sneddon, Ian (Great Britain)	Georgia Institute of Technology	Applied Mathematics	3/86 - 6/86
Staehli, Alfred (Switzerland)	Virginia Polytechnic Institute and State University	Computer Programming and Statistics	5/85 - 11/85
Sugiura, Nariaki (Japan)	Bowling Green State University	Multivariate Analysis	8/85 - 12/85
Telgarsk, Rastislav (Poland)	Ohio University	Topology	9/85 - 8/86
Temam, Roger (France)	University of Colorado	Navier Stokes Equations	9/85 - 12/85
Tintarev, Kyril (Israel)	Purdue University	Applied Mathematics	8/85 - 5/86
Tiwari, Ram Cnandra (India)	University of California, Santa Barbara	Statistics	7/85 - 6/86
van Dulst, Dick (Netherlands)	Georgia Institute of Technology	Functional Analysis	9/85 - 6/86
Waldvogel, J. (Switzerland)	University of South Florida	Celestial Mechanics	1/86 - 4/86
Wallis, W. D. (Australia)	University of Waterloo	Design Theory, Graph Theory and Cryptography	5/85 - 8/85
Wei, Zi Luan (China)	University of California, Berkeley	Optimization Theory	3/85 - 3/86
Zheng, Songmu (China)	Purdue University	Applied Mathematics	8/85 - 5/86
Zlotkiewicz, Eligiusz (Poland)	University of Delaware	Function Theory	6/85 - 2/86

Acknowledgement of Contributions

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Recent Appointments

Committee members' terms of office on standing committees expire on January 31 of the year after the year given in parentheses following their names, unless otherwise specified.

Jean E. Taylor (1988) has been elected to the *Executive Committee of the Council* by the Council members. The other members of the committee are Hyman Bass (1987), Paul R. Halmos (1985), Melvin Hochster (1986), Irving Kaplansky (ex officio), chairman, Everett Pitcher (ex officio) and Julia B. Robinson (ex officio).

Michael G. Crandall (1986), Charles W. Curtis (1986), Ronald A. Fintushel (1986), William H. Jaco (1986), Irving Kaplansky (1986), Everett Pitcher (ex officio), Lance W. Small (1986), Julia B. Robinson (1986), and Jean E. Taylor (1986) have been appointed to the *Committee on Committees* by President Irving Kaplansky. Professor Curtis has also been appointed chairman.

President Lynn A. Steen (MAA) and President Irving Kaplansky (AMS) have appointed George E. Andrews, Judith V. Grabiner, Neil J. A. Sloane, W. Gilbert Strang and William C. Waterhouse to the AMS-MAA *Joint Program Committee for the New Orleans Meeting.* Dr. Sloane will serve a chairman.

Reports of Past Meetings

The November Meeting in Minneapolis

The eight hundred and fourteenth meeting of the American Mathematical Society was held at the University of Minnesota in Minneapolis, Minnesota on Friday and Saturday, November 2-3, 1984. All special sessions and sessions of contributed ten-minute papers took place in Vincent Hall. The invited addresses took place in Mayo Memorial Auditorium. There were 157 registrants, including 133 members of the Society.

Invited Addresses. By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there were four invited addresses. The speakers, their affiliations and the titles of their addresses are as follows:

JERRY L. BONA, University of Chicago, *Developments in the mathematical theory of nonlinear wave motion.*

I. MARTIN ISAACS, University of Wisconsin, Madison, *Characters of solvable groups.*

NARESH C. JAIN, University of Minnesota, Minneapolis, *Occupation times of random walks.*

STEPHEN C. MILNE, Texas A&M University, College Station, *Summation theorems for multiple hypergeometric series.*

The presiding officers at these addresses were Robert Hardt, Louis Solomon, Steven Orey and William Messing, respectively.

Special Sessions. By invitation of the same committee, there were five special sessions of selected twenty-minute papers. The topics of these special sessions, the names of the organizers and the lists of speakers are as follows:

Nonlinear problems in mechanics, CHARLES ANICK, the University of Chicago and WEI-MING NI, University of Minnesota, Minneapolis. The speakers were Nicholas Alikalos, Charles J. Amick, Ilya J. Bakelman, Howard A. Levine, Peter J. Olver, W. G. Pritchard, Michael Reed, Michael Renardy, Jose-Francisco Rodrigues, Robert L. Sachs, Paul Sacks, John Sylvester, R. E. L. Turner and Jean-Marc Vanden-Broeck.

Variational methods in partial differential equations and applications, ROBERT HARDT, University of Minnesota, Minneapolis, and WILLIAM P. ZIEMER, Indiana University, Bloomington. The speakers were Luis Caffarelli, Bruce L. Chalmers, Lawrence C. Evans, Robert Gulliver, Morton E. Gurtin, W. J. Hrusa, Robert Jensen, Robert V. Kohn, Michel L. Lapidus, D. Phillips and Edward W. Stredulinsky.

Mathematical logic—applications to analysis, physical theory and computer science, MARIAN B. POUR-EL, University of Minnesota, Minneapolis. The speakers were Harvey Friedman, Yuri Gurevich, Juris Hartmanis, Yiannis N. Moschovakis, Marian B. Pour-El, Ian Richards, Michael M. Richter, Andrej Scedrov, Dana S. Scott, Michael Sheard and Rick L. Smith.

Algebraic geometry, JOEL ROBERTS, University of Minnesota, Minneapolis, and ROBERT SPEISER, Brigham Young University, Provo. The speakers were Kaan Akin, Susan Jane Colley, François R. Cossec, Lawrence Ein, Henri Gillet, Brian Harbourne, William L. Hoyt, Craig Huneke, William Messing, Rich Miranda, Niels Nygaard, Ziv Ran and Peter F. Stiller.

Enumerative combinatorics, DENNIS WHITE, University of Minnesota, Minneapolis. The speakers were Janet Simpson Beissinger, David M. Bressoud, Richard A. Brualdi, Paul H. Edelman, Ira M. Gessel, Ian P. Goulden, Pierre Leroux, Robert Proctor, Jeffery B. Remmel, Bruce Sagan, Gerard Viennot and Thomas Zaslavsky.

Contributed Papers. There were two sessions of contributed ten-minute papers; Stephen Agard and Clifton Corzatt served as presiding officers. All the ten-minute papers listed in the program were delivered; there were two additional late papers.

Committee. The Local Arrangements Committee consisted of Paul Garrett and Ian Richards. The undersigned Associate Secretary is very appreciative

of the assistance of this committee for help in preparing the announcement of the meeting and for assistance during the meeting. In particular Paul Garrett was on call during the whole meeting. His help is greatly appreciated.

Robert M. Fossum
Urbana, Illinois — Associate Secretary

The Council Meeting in Worcester

The Council met on 19 April 1985 at 1:00 P.M. in Room A of the Howard Johnson Motor Lodge in Worcester. President Kaplansky was in the chair.

The following resolution was introduced by the Secretary and passed by the Council.

> The Council of the American Mathematical Society at its meeting of 19 April 1985 records with sorrow the death of its recently elected member Albert T. Bharucha-Reid on 26 February 1985. The wisdom that he was expected to contribute to Council deliberations will be sorely missed.

The report of the Treasurer was presented informally and will appear in the August issue of the *Notices*.

The Nominating Committee recommended candidates for election to Society offices in the election of 1985. The Council followed the recommendations and made the nominations.

The Secretary announced that petitions with at least 68 valid signatures had been received proposing the name of Vadim Komkov (Winthrop) for candidate for member-at-large. The nomination was made by the Council.

Candidates for the contested offices of vice-president and member-at- large are listed in the 1985 AMS Election information in this issue.

The candidates nominated for uncontested offices and for Trustee are as follows:

President Elect	George D. Mostow
Associate Secretary	Robert M. Fossum Hugo Rossi
Editorial Committees	
American Journal	Spencer J. Bloch
Bulletin	Edgar Lee Stout
Colloquium	Charles L. Fefferman
Mathematical Reviews	Robert G. Bartle
Mathematical Surveys and Monographs	R. O. Wells, Jr.
Mathematics of Computation	Hugh C. Williams
Proceedings	Doug W. Curtis Andrew M. Odlyzko
Committee to Monitor Problems in Communication	
Jozef Dodziuk	Arthur M. Jaffe
Trustee (one to be elected)	
M. Susan Montgomery	Ronald G. Douglas

The meeting adjourned at 3:00 P.M.

Everett Pitcher
Bethlehem, Pennsylvania — Secretary

A. T. Bharucha-Reid

Albert Turner Bharucha-Reid died on February 26, 1985. He was born on November 13, 1927 in Hampton, Virginia, where his father taught at Hampton Institute. At the time of his death, Bharucha-Reid was a Distinguished Professor of Mathematical Sciences and Physics at Atlanta University, Atlanta, Georgia and Director of the Center for Computational Sciences. Bharucha-Reid was educated at Iowa State University, where he received a Bachelor of Sciences degree in 1949. He became an Assistant in mathematical biology at the University of Chicago from 1950 to 1953; a Resident Associate at Columbia University from 1953 to 1955, and an Assistant Resident Statistician at the University of California at Berkeley from 1955 to 1956. In 1956 he began at the University of Oregon as an Instructor of Mathematics. Remaining at the University of Oregon he became an Assistant, and later, an Associate Professor. In 1965 he moved to Wayne State University as professor and subsequently became Director of the Center for Research in Probability. He was Acting Chairman of the Mathematics Department in 1972-1973 and Dean of the Graduate School from 1976 to 1982. He went to the Georgia Institute of Technology as professor in 1982 and to Atlanta University in 1984.

Concurrent with his academic career, Bharucha-Reid held many positions, both in research and in teaching. He was principal and co-principal investigator for several research grants from the United States Army, the Air Force, the National Aeronautics and Space Administration, the National Institute of Health, and the National Science Foundation. As a visiting lecturer, he taught in Madras, India; Warsaw, Poland; the DDR (Berlin, Leipzig, Dresden); and the USSR (Moscow, Kiev, Tbilisi).

His field of research was probability theory, in which he wrote not only papers but also two books, *Elements of Theory of Markov Processes* (McGraw-Hill, 1960) and *Random Integral Equations* (Academic Press, 1972). During his years at Wayne State, he supervised thirteen Ph.D. dissertations.

As an active member of the American Mathematical Society, Bharucha-Reid was involved with many different committees and branches of the Society. Most recently, he was elected as a Member-at-Large of the AMS Council. He also served on the Invitations and Organizing Committee for a Symposium on Stochastic Processes in Mathematical Physics and

Engineering (Spring, 1963), on the Committee on Affirmative Action Procedures (1976–1980), on the AMS-IMS Committee on Translations from Russian and Other Foreign Languages (1978–1980), and on the Committee on Academic Freedom, Tenure, and Employment Security (1978–1980).

Bharucha-Reid delivered many papers concerning his fields of specialization. He gave an invited hour address before the Society in Gainesville in 1974 titled *Probabilistic Operator Theory.* He spoke at the following Special Sessions at AMS Meetings: Probabilistic Analysis (January 1975, Washington, DC), Applications of Vector Measures (January 1976, San Antonio), Approximate Solutions of Random Equations (January 1978, Atlanta), Integral Equations with Emphasis on Fredholm and Hammerstein Equations (January 1979, Biloxi), Stochastic Processes (Summer, 1980, Ann Arbor). He was the Keynote Speaker at the 20th IMACS World Congress in January 1983. He delivered the William W. S. Claytor Lecture at the 1984 meeting of the National Association of Mathematicians in conjunction with the AMS-MAA meeting in Louisville. In 1984 he received an Honorary Doctor of Science degree from Syracuse University. Besides being a member of the AMS, he also held memberships in the American Association for the Advancement of Science, the Society for Industrial and Applied Mathematics, the Institute of Mathematical Statistics, the Association of Mathematical Geology (Vice-President, 1972–1976), the Bernoulli Society, and numerous other scientific organizations.

Bharucha-Reid is survived by two sons, a sister and a brother. At his family's request, a graduate scholarship for Black students in mathematics has been established in his name at Wayne State University.

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SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, exchange or rental of houses, and typing services.

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SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Wahlene Siconio for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P. O. Box 6248, Providence, Rhode Island 02940. Individuals are requested to pay in advance, institutions are not required to do so.

POSITIONS AVAILABLE

INSTITUTE FOR DEFENSE ANALYSES
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Applications are invited from Ph.D. level mathematicians for research positions on our technical staff. Initial appointment would be for one or two years, possibly leading to a permanent position.

Additionally, we also organize each year a summer program (SCAMP) for which places are available. Wide mathematical interests, and the ability to motivate one's own work are more important than knowledge of specific areas of mathematics. Facility in computer programming and some knowledge of statistics would be definite assets.

Salaries will be competitive and commensurate with experience and qualifications.

IDA/CRD is an equal opportunity/affirmative action employer, and encourages applications from women and members of minority groups. Send résumé and publication list to:

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IDA/CRD
Thanet Road
Princeton, NJ 08540

U.S. citizenship required.

UNIVERSITY OF NEVADA, LAS VEGAS
DEPARTMENT OF MATHEMATICAL SCIENCES

A tenure track position is available starting Fall semester of 1985 in the area of Applied Mathematics at the assistant or associate level. Applicants must have a Ph.D in mathematics or applied mathematics with research interest in numberical analysis. Preference will be given to applicants having background and experience in computing and computer graphics. The academic qualifications and experience will determine salary and rank. The successful applicant must be willing and able to teach undergraduate courses in mathematics and at times in applied statistics and shall be expected to participate fully in the department's masters programs with concentration in the area of applied mathematics, computer science, mathematics and statistics. Interested persons should submit a resume, transcripts and names and addresses of four references to: Dr. Harold Bowman, Search Committee, Department of Mathematical Sciences, University of Nevada, Las Vegas, Las Vegas, NV 89154. The above information must be received by May 31, 1985. The University of Nevada, Las Vegas is an equal opportunity, affirmative action employer.

PURDUE UNIVERSITY CALUMET
Hammond, Indiana
Department of Mathematical Sciences

Applications are invited for a tenure track position in computer science starting August 1985. Candidates must have at least a Master's or equivalent in Computer Science. The salary is competitive and there are excellent fringe benefits, including full TIAA/CREF contributions and paid sabbatical leaves. The Department of Mathematical Sciences at Purdue University Calumet has an undergraduate Mathematics and Computer Science option leading to the Bachelor of Science degree, and currently has a full-time staff of twenty. Members of the staff teach the full-range of undergraduate courses. Master of Science programs provide the opportunity to teach specialized courses. Candidates should have an interest in teaching and research. Hammond is located in northwest Indiana and is a thirty minute drive from the Chicago Loop. Applicants are asked to submit résumés and obtain at least three letters of recommendation. Please address correspondence to: Head, Department of Mathematical Sciences, Purdue University Calumet, Hammond, Indiana 46323.
An Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF CALIFORNIA, LOS ANGELES, PROGRAM IN COMPUTING, LOS ANGELES, CA 90024.
R. J. Miech, Director

The Program in Computing at UCLA offers lower division courses in computing to the general student population. We are seeking an individual capable of teaching an assembly language-machine organization course. The basic requirements are:

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The lectureship is a temporary position. The initial appointment is for one year, with the possibility of renewal for a second. The teaching load is five quarter courses a year. The salary will be approximately $28,000 for nine months. There are excellent opportunities for Summer School employment.

Send résumé to:

R. J. Miech, Director
Program in Computing
Department of Mathematics
University of California
Los Angeles, CA 90024

POSITIONS AVAILABLE

Applications are invited for one tenure-track position at the Assistant Professor level starting July, 1985 or 1986. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Starting salary approximately $30,000 (Canadian) per annum. Send vitae and arrange for three letters of reference to be sent to: J. W. Macki, Chairman, Department of Mathematics, University of Alberta, Edmonton, Alberta, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents. Closing date for applications is July 31, 1985.

MATHEMATICS: Position in applied mathematics to begin September, 1985. A Ph.D. in applied mathematics preferred. Degree in related area considered. Demonstrated background in teaching, research and computer applications. Salary and rank dependent on experience. Duties include teaching undergraduate and masters level courses. Send résumé and three current letters of reference to Dr. Marilyn Repsher, Chair, Department of Mathematics/Computer Information Systems, Jacksonville University, Jacksonville, Florida 32211. Application deadline June 15, 1985. Jacksonville University is an affirmative action/equal employment opportunity institution.

The Department of Mathematics and Statistics at McGill University wishes to sponsor a strong candidate for the Natural Sciences and Engineering Research Council of Canada (NSERC) 1985-86 University Research Fellowship Competition. These Fellowships are five year research positions (with a review in the third year), in the nature of Research Assistant Professorships, and carry a teaching load of at most one course throughout the academic year. Applicants should have shown some substantial research ability beyond their doctoral thesis. They should be Canadian Citizens or landed immigrants by October 15, 1985.

Interested candidates should send their curricula vitae to:

The Chairman
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
Montreal, Québec, Canada
H3A 2K6

They should arrange for at least two letters of reference from competent referees to be sent directly to the same address. All documentation should reach the department by September 1, 1985. The department will make its recommendations to NSERC early in October 1985. NSERC announces its final choice by March in each year.

HOWARD UNIVERSITY
Ph.D. in Mathematical Statistics

Tenure-track position at any level in Department of Mathematics. Teaching undergraduate and graduate courses, particularly those statistical courses required in Ph.D. program in Mathematics. Reply, by June 15, to Chairman: Department of Mathematics, Howard University, Washington, D.C. 20059.

Seton Hall University

The Mathematics Department invites applications for a position at the assistant professor level beginning September, 1985. Candidates should have a Ph.D. in Mathematics with a strong commitment to research and teaching. Preference given to candidates with a background and interest in Computer Science. Salary negotiable. Send a curriculum vitae, and three letters of reference to John J. Saccoman, Chairman, Department of Mathematics, Seton Hall University, South Orange, New Jersey 07079.

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NORTHERN MICHIGAN UNIVERSITY

The Mathematics Department at Northern Michigan University invites applications for a one-year temporary position. The person filling this position will be expected to teach undergraduate mathematics, statistics or computer science courses according to the background of the individual. A Ph.D. in mathematics, statistics or computer science is preferred; however, persons with a Master's degree in these disciplines will also be considered. Applications seeking less than full-time employment are also welvome to apply.

Applicants should send a résumé, transcript and three letters of recommendation to Dr. Terrance L. Seethoff, Head, Department of Mathematics, Northern Michigan University, Marquette, MI 49855 (906/227-2021). It is expected that this position is to be filled by June 30, 1985. An affirmative action/equal opportunity employer.

UNIVERSITY OF ARIZONA
DEPARTMENT HEAD SEARCH REOPENED

The Department of Mathematics at the University of Arizona is seeking a permanent Department Head.

The Department of Mathematics offers degree program in Mathematics, from the B.A. through the Ph.D., supports an interdisciplinary Ph.D. Program in Applied Mathematics, and provides service courses for a large undergraduate student body. Department members are involved in numerous research projects. In the last two years, faculty members have received a Sloan Fellowship, a Guggenheim Fellowship, an NSF Post-Doctoral Fellowship, a Presidential Young Investigators Award, and over a dozen research grants. Two NSF Postdoctoral Fellows are currently serving their fellowship tenure at Arizona.

The Head will be asked, first of all, to lead the Department as it continues to develop national prominence in a variety of research areas. The Head will also be involved in the implementation of new undergraduate programs and in the coordination of these programs with other Departments.

Inquiries and applications should be sent to: Head Search Committee, Department of Mathematics, University of Arizona, Tucson, AZ 85721.

Applications should contain a curriculum vita and the names of at least three references who can evaluate the candidate's background in research and administration.

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DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
THE UNIVERSITY OF TEXAS OF THE PERMIAN BASIN
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Two positions starting in the fall of 1985 at the rank of Assistant or Associate Professor. The first position requires a Ph.D. in Computer Science or closely related discipline. The second position, involving the teaching of some mathematics and/or statistics requires a Ph.D. in Mathematics or Computer Science. Preference will be given to candidates who can teach Computer Science courses. UT Permian Basin is an upper level institution enrolling about 2000 students, approximately 130 of whom are majoring in Computer Science or Mathematics. A masters program in Computer Science is anticipated, pending final Coordinating Board approval.

Contact: Dr. James A. Nickel, Chairman

UTPB is an affirmative action/equal opportunities employer.

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Professorship at the Associate level or above, with tenure, beginning July 1, 1986. Salary to be negotiated. Applicants should have outstanding records of research and strong commitment to teaching. Curriculum vitae and 3 letters of recommendation should be received by October 15, 1985. Equal Opportunity/Affirmative Action Employer. Address inquiries to John Wermer, Mathematics Department, Providence, RI 02912, Executive Officer.

POSITIONS AVAILABLE

THE AUSTRALIAN NATIONAL UNIVERSITY
CENTRE FOR MATHEMATICAL ANALYSIS

Enquiries are invited from mathematicians seeking appointment as Research Fellows/Postdoctoral Fellows and Visiting Fellows during the calendar years 1986, 1987. The Centre's main research activities lie in the areas of partial differential equations, numerical analysis and related mathematics but in 1986, 1987 there will be some emphasis on applied mathematics, harmonic analysis respectively. For Research Fellows/Postdoctoral Fellows one or two year appointments are envisaged while Visiting Fellows may be appointed for shorter periods while on leave from their home institutions.

Salary will be in accordance with qualifications and experience within the ranges: Research Fellow $24,840–$32,634 p.a.; Postdoctoral Fellow Grade 1 $21,411–$24,528 p.a. The salary for a Visiting Fellow will also depend on the level of support from other sources.

A grant to defray appointment expenses will also be made. Superannuation benefits are available for applicants who are eligible to contribute. The University reserves the right not to make an appointment or to make an appointment by invitation at any time. Prospective applicants should quote the advertisement reference when requesting further particulars.

Enquiries should be made in the first instance to the Director, Professor N. S. Trudinger, Centre for Mathematical Analysis, Australian National University, G.P.O. Box 4, Canberra A.C.T. 2601, Australia.

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THE UNIVERSITY OF WESTERN ONTARIO
Department of Mathematics

The Department of Mathematics invites applications for a tenure track appointment at either Assistant Professor or Associate Professor level. Candidates should hold a Ph.D. and have demonstrated research ability in an area of pure mathematics. The appointment is expected to commence July 1, 1986. Duties will include teaching and research. In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents of Canada. The appointment is subject to the availability of funds. Applications, including the names of three referees, should be sent to:

Dr. D. Dorwein, Head,
Department of Mathematics,
Middlesex College,
The University of Western Ontario,
London, Ontario. N6A 5B7
Canada.

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THE UNIVERSITY OF ALABAMA
DEPARTMENT OF MATHEMATICS
FACULTY RECRUITING AD

The Mathematics Department at the University of Alabama may have one or more temporary positions available for the 1985-86 academic year. Rank and salary will depend upon qualifications. A Ph.D. (or the equivalent) is required. Applications in all areas will be considered. Areas of particular interest include Algebra, Applied Mathematics, Differential Equations, Topology and Analysis. At least three three letters of recommendation which address teaching and research should be sent to the department. Send a curriculum vita and reprints/preprints to: A. Hopenwasser, P.O. Box 1416, University, Sl 35486. THE UNIVERSITY OF ALABAMA IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

University of Nevada, Las Vegas
Department of Mathematical Sciences

A tenure track position is available in Statistics. RANK AND SALARY NEGOTIABLE with position starting September 1985. Require Ph.D. in Statistics. Prefer Ph.D. in Statistics with an M.S. in Computer Science. Undergraduate assignment: Probability and Statistics. Graduate: Experimental Design, Linear-nonlinear Models, Mathematical Statistics, Biostatistics, Non parametric Statistics, Time Series Analysis, Geostatistics and research in Statistics. Send letter of application, resume, transcripts and names and addresses of four references to: Dr. Harold Bowman, Search Committee, Department of Mathematical Sciences, University of Nevada, Las Vegas, NV 89154. The University of Nevada, Las Vegas is an equal opportunity/affirmative action employer. The above information must be received by May 31, 1985.

University of Nevada, Las Vegas
Department of Mathematical Sciences

Four one-year lectureships available starting September 1985. These are renewable appointments if satisfactory performance is demonstrated. M.A. or M.S. degree in Mathematics is required and the individuals accepting these appointments will be expected to teach 12 credits per semester of large sections of freshman mathematics courses. The salary is competitive and will be commensurate with the qualifications and teaching experience. Send letter of application, resume, transcripts and names and addresses of four references to: Professor Harold Bowman, Search Committee, Departmentsof Mathematical Sciences, University of Nevada, Las Vegas NV 89154. The above information must be received by May 31, 1985. The University of Nevada, Las Vegas is an equal opportunity, affirmative action employer.

UNIVERSITY OF NEVADA, LAS VEGAS
DEPARTMENT OF MATHEMATICAL SCIENCES

A tenure track position in Mathematics is available starting Fall semester of 1985. A Ph.D in mathematics is required. Preference will be given to those who have had considerable research experience. The qualification, experience and the research record of the candidate will determine salary and rank. The successful applicant must be willing and able to teach undergraduate courses in mathematical sciences and shall be expected to participate fully in the department's masters programs with concentration in the area ofsapplied mathematics, computer science, mathematics and statistics. Interested persons should submit a resume, transcripts and names and addresses of four references to: Harold Bowman, Search Committee, Department of Mathematical Sciences, University of Nevada, Las Vegas, Las Vegas, NV 89154. The above information must be received by May 31, 1985. The University of Nevada is an equal opportunity, affirmative action employer.

SUNY COLLEGE AT ONEONTA. Three positions in Department of Mathematical Sciences (pending budgetary approval). Positions and qualifications: Asst./Assoc. Professor Computer Science — Doctorate in one of the Mathematical Sciences desirable (consideration given to an MS in Computer Science or equivalent); Assoc./Full Professor Mathematics — Doctorate in one of the Mathematical Sciences (prefer classical applied mathematics with computer skills); Asst./Assoc. Professor Mathematics Education — Doctorate in Mathematics Education (strong background in one of the Mathematical Sciences). Duties: Undergraduate instruction, related activities and program development. Tenure track positions. Rank/salary negotiable. Send résumé, transcripts and three letters of reference to Chair, Department of Mathematical Sciences, SUNY College, Oneonta, NY 13820 (An equal opportunity/affirmative action employer). Starting date: August 27, 1985. Applications received until position is filled.

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Chairperson, Mathematics. Qualifications: Ph.D. in mathematics or statistics, experience in individualized instruction for students needing academic reinforcement and three years teaching experience, major responsibilities are to oversee the development of a quality mathematics program which serves both the mathematics major and students fulfilling mathematics requirements. The chairman will also be responsible for hiring other faculty, as appropriate, to augment the development of an excellent, unique program which will attract students to major in mathematics. The chairperson will also be responsible for oversight of the Computer Science Program/proposal development and research activities among computer science and mathematics faculty. Deadline is June 10, 1985. Salary is negotiable. Send application, including résumé, official transcripts and three letters of recommendation to:

Dr. Henrie M. Turner
Acting Chairperson, Science Division
Morris Brown College
643 M. L. King Jr. Drive, N. W.
Atlanta, Georgia 30314

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UNIVERSITY OF TORONTO
DEPARTMENT OF MATHEMATICS
TORONTO, ONTARIO M5S 1A1
CANADA

The Department of Mathematics, University of Toronto is looking for strong applicants in pure or applied mathematics to nominate as candidates for NSERC Research Fellowships beginning July 1, 1986. These are five year research positions (subject to a review in the third year) with teaching load of at most one course per year. One of the five years may usually be taken as a sabbatical.

Applicants should be mathematicians with a relatively recent doctorate, who have demonstrated their ability with some substantive post-thesis research accomplishment. They must be Canadian citizens or landed immigrants by November 1, 1985.

Applicants should send an up to date curriculum vitae and a short description of their research program to Professor T. Bloom, Chairman, and arrange to have sent three letters of reference. This material should arrive before Friday, September 13, 1985. The Department's choice of candidates will be made in late September, and the final decision by NSERC is announced (by NSERC) in the spring.

DEPARTMENT OF MATHEMATICS
THE UNIVERSITY OF WESTERN ONTARIO

The Department of Mathematics invites applications for limited term appointments at the Assistant Professor level. The appointments, which are subject to the availability of funds, will be for the period September 1, 1985 to May 31, 1986 or part thereof. Candidates should have a Ph.D. in an area of pure mathematics. Duties will include teaching and research. In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents of Canada. Applications, including the names of three referees, should be sent to:

Dr. D. Borwein, Head
Department of Mathematics
Middlesex College
The University of Western Ontario
London, Ontario N6A 5B7
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UNIVERSITY COLLEGE DUBLIN

Applications are invited by the Governing Body of the College for the following full-time statutory post:

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Prior to application, further information (including application procedure) should be obtained from the Secretary and Bursar, University College, Belfield, Dublin 4. Telephone enquiries: 693244, ext. 431.

The closing date for receipt of completed applications is Thursday, 27th June, 1985.

ILLINOIS WESLEYAN UNIVERSITY
Chair of Mathematics

Illinois Wesleyan University seeks a Department Head in Mathematics. The department is composed of four full-time faculty and offers BA's both in Mathematics and Mathematics-Computer Science. The department currently has 42 majors and delivers 600 course units per year, the majority to students in the natural sciences and in business; thus, the department seeks to offer a strong program for its majors as well as serve the broader interests of the University. Candidates must have a Ph.D. in Mathematics, and a proven record of teaching and research. Preference will be given to candidates with strong credentials in analysis or some area of applied mathematics. Rank and salary are negotiable. Interested candidates should send a current CV and have three references sent to: Roger Schnaitter, Director, Division of Natural Science, Illinois Wesleyan University, Bloomington, IL 61702. Equal Opportunity Employer.

Framingham State College
Department of Mathematics
Framingham, MA 01701

Tenure track position. Rank and salary negotiable. Duties include teaching up to 3 courses (12 semester hours), coordinating math service courses and student placement as well as curriculum development in applied mathematics. Qualifications: Ph.D. in Mathematics with background in applied mathematics (especially computational mathematics and/or statistics). Closing date for applications: July 1, 1985. Affirmative action/equal opportunity employer.

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Assistant or Associate Professor, mathematics (several vacancies). Qualifications: Ph.D., mathematics or statistics. Major responsibilities include teaching mathematics courses to majors and nonmajors, assisting the Chairperson in the development of programs and special projects, implementing an individual research project which may involve student participants. Previous teaching experience desirable. Deadline is June 10, 1985 or until the position is filled. Salary is negotiable. Send application, including résumé, official transcripts, and three letters of recommendation (at least one of them should comment on teaching) to:

Dr. Henrie M. Turner
Acting Chairperson, Science Division
Morris Brown College
643 M. L. King Jr. Drive, N. W.
Atlanta, Georgia 30314

An affirmative action equal opportunity employer

Lectureship in Pure Mathematics. The appointee will be expected to engage in research and to teach at all levels; preference will be given to applicants with expertise in fields related to algebra and well-qualified candidates in all areas of Pure Mathematics are welcome to apply. Salary will be in the range DLRSNZ23.622 to DLRSNZ27.928 per annum; conditions of appointment and method of application are available from the undersigned with Hume applications. Close on July 31 1985. Administrative assistant (appointments); Victoria University of Wellington, Private Bag Wellington, New Zealand.

POSITIONS AVAILABLE

Department of Mathematics and Physics
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Tenure-track position for a Ph.D. in Mathematics starting August 1985. Teaching undergraduate courses and research.

Substitute for a Mathematics instructor. Ph.D. desirable but masters degree may be considered. Contract is for ten months, starting August 1985. Speaking spanish desirable.

Write to: Prof. Jesús Parrilla Calderón
Chairman, Dept. of Math-Physics
C. U. C., Cayey, P. R. 00633

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An Equal Opportunity Employer.

Hiram College announces two openings in its Department of Mathematical Sciences. One is a tenure-track position and the other a one-year sabbatical replacement. We seek candidates at the doctoral level in either mathematics or computer science. Please contact: Robert MacDowell, Hiram College, Hiram, Ohio 44234 (216) 569-5165. AA/EEO.

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MATH SCI PRESS, 53 Jordan Rd, Brookline MA, 02146, 617-738-0307. Just published: Proceedings of the Berkeley-Ames Conference on Nonlinear Problems in Control and Fluid Dynamics, L. R. Hunt and C. F. Martin, (eds), 450 pages, $50. (Lie Groups Series B: Systems Information and Control, vol. II). Topics in the Geometric Theory of Linear Systems, by Robert Hermann, $50. (Interdisciplinary Mathematics, v. 22). The Geometric theory of Ordinary Differential Equations and Algebraic Functions, by G. Valiron, $75. (Lie Groups, v. 14). Topics in the Geometry Theory of Integrable Systems, $65, by Robert Hermann (Interdisciplinary Mathematics, v. 23.). Write or call for special prices on back list.

ANNOUNCEMENTS

University of Wyoming
Rocky Mountain Mathematics Consortium
Three-Week Summer School
July 15–August 2, 1985

The lectures will cover the foundations of modern control theory from the point of view of both the mathematician and the control engineer. The lectures will begin with a treatment of the original control problem—Maxwell's problem of stabilization of a third order model of a steam boiler and will continue to the general problems of controllability, observability, stabilization, optimization, realization, feedback, and equivalence of systems. The lectures will conclude with a survey of problems of current interest both to the mathematician and the control engineer. The background required of the attendees is most importantly a healthy curiosity and a background in the standard graduate courses of algebra, analysis and topology.

Main Speakers:

Christopher I. Byrnes	Clyde F. Martin
Arizona State University	Texas Tech University

Inquiries should be addressed to Professor A. Duane Porter or Melfried Olson, Mathematics Department, University of Wyoming, Laramie, Wyoming 82071.

Cost: $500 plus room and board. Scholarships to cover the $500 fee are available for qualified faculty and graduate students.

The paper "Limesräume" by H. R. Fischer, Math. Annalen, Bd. 137, S. 269–303 (1959), has been translated from the original German into English as a result of a grant from East Central University, Ada, Oklahoma 74820. One hundred copies are available for free distribution by writing to Ray Hamlett at East Central University. Additional copies will be available at $6.00 each.

ANNOUNCEMENTS

Conference Proceedings Include Chapter of Ramanujan's Notebook

The proceedings of the conference on Number Theory held in Edmonton, Alberta in April 1983 and published by the Rocky Mountain Mathematics Consortium, will include Chapter 12 of Ramanujan's second notebook. This chapter, dealing with continued fractions, is edited by Professors Berndt, Lamphere, Wilson, and Askey. The conference proceedings, edited by M. V. Subbarao, also include articles by G. E. Andrews and D. M. Bressoud, Paul Erdos, Carl Pomerance, A. Schinzel, Hugh Williams, Hans Zassenhaus, John Friedlander, James Hafner, Ernst Kani, D. H. Lehmer, Emma Lehmer, M. R. Murty, and V. K. Murty as well as several others. Copies of this special issue of the "Rocky Mountain Journal of Mathematics" can be ordered through the Rocky Mountain Mathematics Consortium, Dept. of Mathematics, Arizona State University, Tempe, AZ 85287.

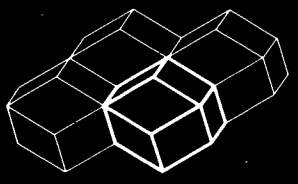
Stochastic Systems

An errata sheet for *Stochastic Systems*, G. Adomian, Academic Press, 1983, is available by writing to Dr. G. Adomian, Center for Applied Mathematics, University of Georgia, Athens, GA 30602.

SITUATIONS WANTED

Established researcher wants to direct doctoral candidates in analysis and topology. Vitae on request. 829 Haverford, Pacific Palisades, CA 90272.

Topologie structurale



UNE REVUE DE GÉOMÉTRIE APPLIQUÉE

A JOURNAL ON APPLIED GEOMETRY

Structural Topology

Structural Topology is an interdisciplinary journal on the applications of classical and contemporary mathematics (especially geometry) to the solution of morphological and structural problems. The problems arise in architecture, design and the plastic arts, and in a host of scientific disciplines ranging from crystallography and chemistry to computer automation and scene analysis. The articles published cover three principal themes: the **morphology** of polyhedral and other special forms, its recognition and its use in the design process, the **juxtaposition** or packing of these forms and the structural **rigidity** of the resulting objects. The aim of the Journal is to promote interchange among researchers in the field and between them and practitioners, to publish recent results, recent applications and unsolved problems and to describe teaching projects and materials pertaining to the field.

The Journal is published by the Structural Topology Research Group with **Dr. Henry Crapo**, as editor in chief, and with the collaboration of the Association mathématique du Québec and of the Université du Québec à Montréal. All text is published in both **English and French**. Since, for most purposes, a picture is worth a thousand words, the journal is profusely **illustrated**.

Subscriptions are sold by series of two issues, at the cost of Can. $37 for institutions and Can. $25 for individuals. The fourth series will comprise issues 10 (November 1984) and 11 (May 1985); the fifth, issues 12 (November 1985) and 13 (May 1986). For more information write to: **La revue Topologie structurale, Département de mathématiques, Université du Québec à Montréal, Case postale 8888, Succursale "A", Montréal, Québec, Canada, H3C 3P8.**

Papers for publication could also be sent to this address. Editors will provide a translation unless the author provides texts in both languages.

SPECIAL DEVELOPMENT FUND OF THE INTERNATIONAL MATHEMATICAL UNION

The Special Development Fund is used primarily for travel grants to young mathematicians from developing countries or from countries where severe money regulations exist, to help their attendance to the International Congresses of Mathematicians. The next goal is to collect money for travel grants for the 1986 Congress in Berkeley.

Donations to the Special Development fund can be sent at any time and in any convertible currency to the following accounts:

No. 0862-656208-21
Schweizerische Kreditanstalt
Stadtfiliale Zürich-Rigiplatz
Universitätstrasse 105
CH-8033 Zürich
Switzerland

No. 100020-411-USD-5705 FR
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SF-00100 Helsinki
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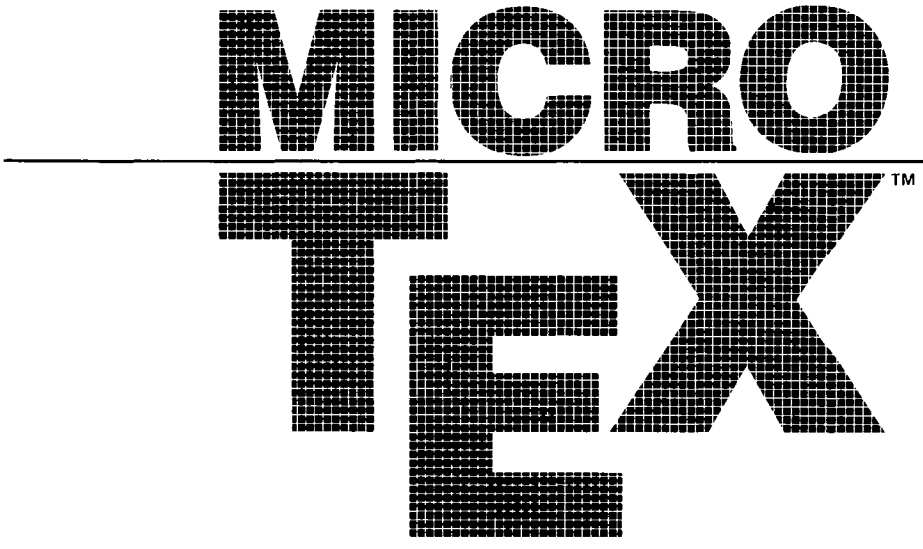

MicroTEX is a full microcomputer implementation of Donald Knuth's technical text processing system, TEX, developed by David Fuchs for the IBM PC/AT, PC/XT, and PC or PC compatibles with hard disk.

TEX represents the state of the art in computerized typesetting. It is particularly valuable where the document, article, or book to be produced contains heavy mathematics, or where the user is concerned about typographical quality. The following mathematical expressions, typeset with MicroTEX, exemplify TEX's capabilities:

$$\mathbf{S}^{-1}\mathbf{T}\mathbf{S} = \mathbf{dg}(\omega_1, \ldots, \omega_n) = \mathbf{\Lambda}$$

$$\sum_{i=1}^{\infty} \frac{1}{2^i} = 1, \quad \underbrace{\{\overbrace{a, \ldots, a}^{k\ a\text{'s}}, \overbrace{b, \ldots, b}^{l\ b\text{'s}}\}}_{k+l \text{ elements}}, \quad \sqrt{1+\sqrt{1+\sqrt{1+x}}},$$

$$A = \begin{pmatrix} a_{11} & \ldots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \ldots & a_{mn} \end{pmatrix}, \quad \left(\int_{-\infty}^{\infty} e^{-x^2}\,dx\right)^2 = \pi,$$

$$2 \uparrow\uparrow k \stackrel{\text{def}}{=} 2^{2^{2^{\cdot^{\cdot^{\cdot^{2}}}}}}\Big\}k, \quad \frac{f(x+\Delta x) - f(x)}{\Delta x} \to f'(x) \text{ as } \Delta x \to 0.$$

MicroTEX contains all the power of TEX implementations on larger machines. It is fully compatible with all implementations of TEX82. Thus, both input and output files can be used interchangeably between MicroTEX and other TEX systems.

Wordstar, Mince, or any editor which produces plain ASCII text files can be used with MicroTEX. MicroTEX provides high-quality local output on several printers, and several professional compositors provide facilities for typesetting MicroTEX files.

In addition to Plain TEX, LaTEX, a TEX macro system, will be available soon as a separate option. LaTEX is extremely helpful in writing, formatting, and producing long manuscripts and documents.

MicroTEX requires 512K of memory to operate the system, and currently supports these printers:

- Epson RX-, FX-, MX-, 80 and 100
- IBM Dot Matrix and Graphics
- Okidata 92 and 93 (with Plug'n Play)
- Toshiba P-1351 and P-1340

The complete MicroTEX package includes the TEX system, a driver for the IBM, Epson, and Okidata dot matrix printers, Plain TEX fonts, a copy of *The TEXbook* by Donald Knuth, and the *MicroTEX System Guide.*

The complete MicroTEX package is available to you now for $495.00. The TEX system and printer drivers with fonts can be ordered separately. Use the order form below to order now!

Addison-Wesley

MicroTEX Order Form

35183

Please send me the complete MicroTEX package	_____ copy(ies) * $495 (per copy)*	Total _____
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Toshiba P-1351/P-1340 driver	_____ copy(ies) * $125 (per copy)*	_____
The TEXbook	_____ copy(ies) * $14.95 (per copy)*	_____
		Total _____

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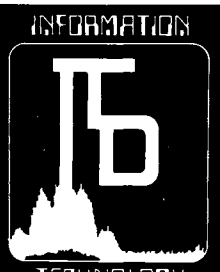

RESEARCH AND MANAGEMENT OPPORTUNITY IN INFORMATION THEORY

Head, Computer Science Section
Information Technology Division

(GM-14/15; salary $44,430–$67,940)

DO YOU HAVE

- **a strong background and research interest in information theory?**
- **a proven ability to market, initiate, and manage research programs?**
- **an expertise in making strong technical presentations?**

If so, then you may be the person to accept the challenge of directing a leading research team into new advances in information theory and its applications. The Computer Science Section has a distinguished record of achievement in:

- foundations of maximum-entropy and relative-entropy inference
- applications to
  - spectrum analysis
  - speech recognition
  - speech processing
  - pattern recognition
  - queuing theory

The Section has recently undertaken a challenging new research project: an investigation of search theory from the information-theoretic point of view—not only classical target search theory, but also problems of heuristic search and combinatory optimization such as arise in computer science, particulary AI.

The Section is part of the Navy's leading computer science research group, the Computer Science and Systems Branch of the Information Technology Division. The Branch has research projects in: **software engineering, computer security, software specifications, expert systems, software measurement, database management systems, and computer networking.**

The Division conducts research in artificial intelligence, digital voice systems and C^3 systems. Facilities include several VAXs, a Gould UNIX system, Dolphins, a Symbolics 3670, LMI Lisp machines, SUN workstations, laser printers, and a Cray X-MP/12 supercomputer.

Interested applicants should submit a Personal Qualifications Statement (SF-171) or detailed résumé. For further information call collect to Ms. Enid Levine at (202) 767-3030.

NAVAL RESEARCH LABORATORY

Civilian Personnel Office, Attention 75-043-11.1
4555 Overlook Avenue SW, Washington, DC 20375-5000 or
Arpanet: wilson@nrl-css uucp: ...!decvax!nrl-css!wilson

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Astérisque
Société Mathématique de France

The AMS distributes Astérisque in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF, B.P. 126-05, 75226 Paris Cedex 05, France, or to OFFILIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France.

Individual members of either AMS or SMF are entitled to the member price.

Discrete Lax Equations and Differential-difference Calculus

B. A. Kupershmidt

(Astérisque, Number 123)

This is the first detailed introduction into the theory of discrete infinite integrable systems and associated mathematical ideas. It covers constructions of the basic, modified, specialized, and deformed equations, their conservation laws and Hamiltonian structures, canonical maps between various equations, continuous limits, formal eigenfunctions of Lax operators, and a τ-function representation. The basic language of the theory is the discrete Calculus of Variations which behaves naturally under the continuous limit. An extensive exposition is given of the abstract Hamiltonian formalism and of the formalism of the dual spaces of Lie algebras over function rings.

The text is useful to mathematicians and physicists interested in "soliton" science and modern Hamiltonian formalism, and is suitable for graduate students.

ISSN 0303-1179
List price $15, Individual member $11
Shipping and handling charges must be added
To order, please specify AST/123N

Séminaire Bourbaki, 1983/1984, exposés 615–632

(Astérisque, Numbers 121–122)

Comme les précédents volumes de ce séminaire, celui-ci contient 18 exposés de synthèse sur des sujets d'actualité: six de géométrie différentielle, cinq d'arithmétique ou de géométrie algébrique, deux d'algèbre, deux de physique statistique, un d'analyse complexe, un de logique, un d'informatique.

Entre autres, on y trouve la démonstration des conjectures de Tate, de Shafarevitch et de Mordell, on y fait le point sur la construction du Monstre, l'homologie cyclique, la reconstruction des phases en cristallographie, le calcul des primitives.

ISSN 0303-1179
List price $25, Individual member $18
Shipping and handling charges must be added
To order, please specify AST/121/122N

Homologie, Groupes Ext^n, Représentations de Longueur Finie des Groupes de Lie

(Astérisque, Numbers 124–125)

Le présent numéro d'Astérisque contient divers travaux récents portant sur le trois sujets d'actualité mentionnés dans le titre. En homologie des groupes de Lie on trouvera notamment des démonstrations du lemme de Shapiro et du théorème de régularisation. En ce qui concerne les espaces Ext^n et les représentations de longueur finie, un travail est consacré aux groupes semi-simples réels, dans le cadre classique des (g, K)-modules, un autre aux groupes nilpotents et aux espaces de vecteurs C^∞ des représentations unitaires irréductibles, les deux derniers portant sur certains produits semidirects, pour lesquels on étudie une théorie de réduction à la Mackey.

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Shipping/Handling: 1st book $2, each add'l $1, max. $25; by air, 1st book $5, each add'l $3, max. $100
Prepayment is required. Order from American Mathematical Society, P.O. Box 1571, Annex Station Providence, RI 02901-1571, or call toll free 800-556-7774 to charge with Visa or MasterCard

American Mathematical Society

Membership Information

The American Mathematical Society is a nonprofit organization devoted to promoting the interests of mathematical scholarship and research. Although known primarily for its concern with fundamental research in pure mathematics, the Society also devotes attention to the applications of mathematics. In recent years its concern with computing and applications has increased significantly. Over 20,000 mathematicians throughout the world maintain contact with each other and keep abreast of progress in mathematics through their membership in the Society and the publications of the Society.

Benefits

- **Subscription to the Notices**
- **Subscription to the Bulletin**
- **Reduced registration fees for attendance at meetings**
- **Reduced rates on publications of the AMS as well as some journals published by other institutions**
- **Voting rights in the election of Society officers**
- **Free copy of the Combined Membership List**
- **Opportunity to participate in the Group Insurance Program**

Dues Structure

- **Annual dues based on professional income**
- **Special reduced rates for:**
  - **— student members**
  - **— unemployed members**
  - **— family members**
  - **— members of certain foreign societies**
  - **— members in developing countries with no mathematical society**

For more information and an application for membership in the Society, call our toll free number, 800-556-7774, or write to:

American Mathematical Society
Membership Secretary
201 Charles Street, P.O. Box 6248
Providence, Rhode Island 02940 USA

1985

Mathematical Sciences
Professional Directory

This directory, published annually, lists key personnel - officers and committee members—of over thirty professional mathematical organizations and of a selected group of government agencies, editors of over 100 journals, over 3,000 heads of academic departments in the mathematical sciences, and heads of the mathematical units in nonacademic organizations. Information includes current addresses (including telephone numbers in many cases), terms of office, and other pertinent information for the organizations represented.

TABLE OF CONTENTS OF PROFESSIONAL DIRECTORY

List price $15, institutional member $12, individual member $15. To order, please specify code ADMDIR/N

Shipping/Handling: 1st book $2, each add'l $1, max. $25; by air, 1st book $5, each add'l $3, max. $100
Prepayment is required. Order from American Mathematical Society, P.O. Box 1571, Annex Station Providence, RI 02901-1571, or call toll free 800-556-7774 to charge with Visa or MasterCard

Change of Address

Members of the Society who move or who change positions are urged to notify the Providence Office as soon as possible.

Journal mailing labels must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members' honors, awards, and information on Society service; information of the latter kind appears regularly in the Notices.

When changing their addresses, members are urged to cooperate by supplying the information requested below—the Society's records are of value only to the extent that they are current and accurate.

If your address has changed, or will change within the next two or three months, please place the peel-off label from the back cover (which contains your name, member code, and address) in the rectangle provided below (or on a copy of this page), supply any other information appropriate for the AMS records, and mail to the address given below.

Place Notices label here

Change effective as of: _____

New Mailing Address: _____

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New Position: _____

If mailing address is not that of your employer, please supply the following information:

New Employer: _____

Location of employer: _____
City State/Province Country Zip Code

Recent honors and awards: _____

_____

_____

Personal Items for publication in the Notices: _____

_____

Mail completed form to:
Membership Department, AMS, P.O. Box 6248, Providence, RI 02940

MAA MINICOURSE PREREGISTRATION FORM, LARAMIE, WYOMING

August 12-15, 1985

MUST BE RECEIVED IN WASHINGTON, DC, NO LATER THAN JUNE 14, 1985

Please complete this form and return it with your payment to

Mathematical Association of America
1529 Eighteenth Street, NW, Washington, DC 20036
Telephone: 202-387-5200

DEADLINE: Preregistration for Minicourse fee(s): June 14, 1985

NOTE: All dues and meeting registration fees paid to AMS or MAA by professional mathematicians are tax deductible.

N.B.: [ ] I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) indicated below. It is my understanding that, should the course(s) of my choice be filled, full refund of the Joint Meetings preregistration fee will be made.

MINICOURSE PREREGISTRATION

1) _____
(Please print) Surname First Middle

2) _____
Mailing address for confirmation of Minicourse(s)

3) Employing institution_____

4) Please enroll me in the following Minicourse(s). Enclosed is my payment of $_____ (Make check payable to MAA. Canadian checks must be marked "In U.S. Funds".) Method of payment:

Check [ ] VISA [ ] MasterCard [ ]

Credit card number_____; expiration date_____

_____
Signature (name as it appears on the credit card)

First Choice	Alternate	Fee	Minicourses - Participants are limited to two Minicourses each.
[ ]	[ ]	$25	#1 - Geometry for college teachers (Branko Grünbaum, U of Washington)
[ ]	[ ]	$25	#2 - Applied mathematics via classroom experiments (Herbert R. Bailey, Rose-Hulman Institute of Technology)
[ ]	[ ]	$25	#3 - Teaching experiential applied mathematics, (TEAM) (James R. Choike, Oklahoma State U)
[ ]	[ ]	$35	#4 - Computing in undergraduate linear algebra (Eugene A. Herman, Grinnell College)
[ ]	[ ]	$35	#5 - Microcomputer software in mathematics instruction (Roy E. Myers, Pennsylvania State U, Kensington)

Summer List of Applicants

Instructions for Applicant Form on facing page

The form. Forms submitted by job applicants who attend the August meetings in Laramie will be posted. The first impression a prospective employer has of an applicant may be based on the appearance of this form.

The forms should be carefully typed using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Hand lettered forms are acceptable if prepared carefully.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.

Address forms to the Mathematics Meetings Housing Bureau, P. O. Box 6887, Providence, RI 02940. The deadline for receipt is **June 14, 1985**.

Ⓐ Specialties

AL = Algebra	AN = Analysis
BI = Biomathematics	BS = Biostatistics
CB = Combinatorics	CM = Communication
CN = Control	CS = Computer Science
CT = Circuits	DE = Differential Equations
EC = Economics	ED = Mathematical Education
FA = Functional Analysis	FI = Financial Mathematics
FL = Fluid Mechanics	GE = Geometry
HM = History of Math	LO = Logic
MB = Mathematical Biology	ME = Mechanics
MO = Modelling	MP = Mathematical Physics
MS = Management Science	NA = Numerical Analysis
NT = Number Theory	OR = Operations Research
PR = Probability	SA = Systems Analysis
ST = Statistics	TO = Topology

Ⓑ Career Objectives

AR = Academic Research	AT = Academic Teaching
NR = Nonacademic R&D	NC = Nonacad. Consulting
NS = Nonacademic Supervision	

Ⓗ Ⓘ Duties

T = Teaching	U = Undergraduate
G = Graduate	R = Research
C = Consulting	A = Administration
S = Supervision	IND = Industry
GOV = Government	DP = Data Processing

Location

E = East		S = South
C = Central		M = Mountain
W = West	O = Outside U.S.	I = Indifferent

Ⓛ U.S. Citizenship Status

C = U.S. Citizen	P = Permanent Resident
T = Temporarily in U.S.	N = Non-U.S. Citizen

Summer List of Applicants

Mathematical Sciences Employment Register

August 1985 Laramie, Wyoming

(Please see instructions on facing page)

APPLICANT: Name_____

Mailing address (include zip code) _____

Ⓐ Specialties_____

Ⓑ Career objectives and accomplishments

ACADEMIC: ☐ Research, ☐ Teaching

NON-ACADEMIC: ☐ Research and Development, ☐ Consulting, ☐ Supervision

Near-term career goals_____

Significant achievements or projects, including role_____

Honors and offices_____

Other (e.g., paper to be presented at THIS meeting)_____

Selected titles of papers, reports, books, patents_____

Ⓒ Degree Year Institution

____ ____ _____ Ⓓ No. of abstracts, internal reports____

____ ____ _____ Ⓔ No. of papers accepted____

____ ____ _____ Ⓕ No. of books and patents____

EMPLOYMENT HISTORY:

	Present	Previous	Previous
Ⓖ Employer			
Position			
Ⓗ Duties			
Years	to	to	to

DESIRED POSITION:_____

Ⓘ Duties_____

Ⓙ Available mo.____ /yr.____ Location_____ Salary____

Ⓚ References (Name and Institution)

Ⓛ Citizenship _____

Ⓜ **I plan to attend the Summer Meeting** yes ☐ no ☐

PREREGISTRATION AND HOUSING FORM, LARAMIE, WYOMING

AMS Short Course
August 10-11, 1985

Joint Mathematics Meetings
August 12-15, 1985

MUST BE RECEIVED IN PROVIDENCE NO LATER THAN JUNE 14, 1985
Please complete this form and return it with your payment to
Mathematics Meetings Housing Bureau
P.O. Box 6887, Providence, Rhode Island 02940 - Telephone 401-272-9500, Ext. 239

DEADLINES: Preregistration: June 14, 1985 for preregistration fee(s)
Residence Hall Room Payments: June 14, 1985
Cancellations: Preregistration may be cancelled until August 9 by writing or calling the Mathematics Meetings Housing Bureau; see above. 50% of the preregistration fee(s) will be refunded if notification is received by this date. Confirmed residence hall reservations may be cancelled until July 25 and full payment will be refunded; however, after that date, only partial refunds will be allowed. Full refunds will be made of MAA 25-year Banquet tickets if notification is received prior to July 25; after that date, 50% refund applies. Barbecue tickets are subject to the same refund policy.
Changes: Changes in arrival and departure dates must be made with the Mathematics Meetings Housing Bureau by August 9. After that date, please call message center number at Laramie.

NOTE: All dues and meeting registration fees paid to AMS or MAA by professional mathematicians are tax deductible.

	REGISTRATION FEES	
	Preregistration (by mail prior to 6/14)	At Meeting
JOINT MATHEMATICS MEETINGS		
Member of AMS, MAA, IIME	$55	$72
* Student, Unemployed or Emeritus	$14	$18
Nonmember	$84	$109
AMS SHORT COURSE		
Member/Nonmember	$25	$30
* Student or Unemployed	$5	$10

* All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income. The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned from their latest position. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more and is retired on account of age from his or her latest position.

PREREGISTRATION SECTION: Please check the function(s) for which you are preregistering:
Joint Meetings [ ] AMS Short Course [ ]

1) _____ Nickname for badge:_____
(Please print) Surname First Middle (optional)

2) _____
ADDRESS: Number and street City State Zipcode

3) _____
Address for confirmation of room reservation, if other than above

4) Employing institution_____ Emeritus member [ ] Unemployed [ ]

5) I am a student at_____ 6) Name of spouse_____ 7) Number of children_____
(List only if accompanying to meeting)

8) Member of AMS [ ] MAA [ ] IIME [ ] Nonmember [ ] (Member discount applies only to members of AMS, MAA, or IIME.) Member of other organizations: AWM [ ] NAM [ ]

9) Joint Meetings fee $_____ 10) AMS Short Course fee $_____

11) MAA 25-year Banquet ticket(s) _____@ $17.25_____(for those not on 3-meal plan)

12) MAA 25-year Banquet ticket(s) _____@ $12.75_____(for those on 3-meal plan)

13) Barbecue Ticket(s) _____@ $8.50 _____

14) FULL PAYMENT for residence hall accommodations enclosed $_____(Partial refund applies after July 25.)

15) TOTAL AMOUNT ENCLOSED FOR 9 through 14 $_____ (Make checks payable to AMS; Canadian checks must be marked "In U.S. Funds".) VISA or MasterCard credit cards may be submitted for payment.

Credit card type: VISA [ ] or MasterCard [ ] Card number_____Expiration date_____

_____
Signature (name as it appears on credit card)

[ ] PLEASE CHECK HERE IF YOU WILL NOT REQUIRE A ROOM.

Please be sure to complete the section on next page if you will require housing.

For office use only:

Codes:	Options:	Dates:	Residence Hall:	Rm. Type [ ]
Special:			Amt. pd:	CC[ ] Check

PREREGISTRATION AND HOUSING REQUEST FORM (continued)

(Please read sections on housing and room rates in meeting announcements.)

UNIVERSITY HOUSING SECTION: (Please complete Sections I through IV below.)

NOTE: Full prepayment for room and board is required as noted in Item 13 on the reverse. Please make checks payable to AMS. Canadian checks must be marked "In U.S. Funds". VISA and MasterCard credit cards will also be accepted.

I. Please reserve the following residence hall accommodations and send confirmation to me at address below:

ADULTS AND CHILDREN (other than those occupying a portacrib)

Rates include breakfast, lunch, and dinner.

	Singles - one person	Doubles - two persons
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