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Editorial: The pre-history of *Chaos*—An Interdisciplinary Journal of Nonlinear Science **FREE**

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Editorial: The pre-history of *Chaos*—An Interdisciplinary Journal of Nonlinear Science

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For this silver jubilee issue of *Chaos*, my editorial colleagues Elizabeth Bradley, Adilson Motter, and Louis Pecora have assembled an outstanding group of leading researchers to write about the past, present, and future of many different aspects of nonlinear science. This is an impressive tribute to the 25th anniversary of our journal, and I thank them, the authors, and the referees for their efforts.

Liz, Adilson, and Lou have also asked me to draft a short introduction recalling, and reflecting on, the pre-history of *Chaos* and how the journal came to be. This is a most welcome task, for it allows me to revisit a very exciting time in the development of nonlinear science both as a discipline and as an integrated international effort. What follows is a very personal, anecdotal perspective, certainly neither comprehensive nor definitive, but accurate in so far as memory—and my yellowing paper notes and old computer files—permit.

The pre-history of *Chaos*, like most pre-histories, does not have an absolutely clear origin. But it is perhaps most accurate to start with celebrated numerical simulations of Enrico Fermi, John Pasta, and Stan Ulam (FPU), carried out at Los Alamos Scientific Laboratory beginning in 1953 and published as LASL report LA-1940 in 1955 under the title “Studies of Nonlinear Problems. I.”¹ In 2005, *Chaos* published a focus issue entitled “The ‘Fermi-Pasta-Ulam’ Problem; the First Fifty Years,”² celebrating the 50th anniversary of the FPU preprint and demonstrating that the FPU study marked a sea change in the study of nonlinear phenomena. In particular, the FPU study led to birth of “nonlinear science” as an integrated discipline. As discussed in detail in that focus issue, work in the 1960s by (among others) Boris Chirikov and Felix Izrailev in Novosibirsk³ and Joe Ford at Georgia Tech⁴ led to the recognition of “chaos” in the FPU problem and to detailed computational and analytic methods for studying “chaos.” In 1965, work by Zabusky and Kruskal⁵ on a continuum approach to the FPU problem led to the identification and naming of “solitons” in the Korteweg-de Vries equation. Shortly thereafter came the advent of the inverse spectral transformation (IST) and the recognition that soliton-bearing equations corresponded to completely integrable, infinite-degree-of-freedom Hamiltonian systems. Importantly, especially from the perspective of the pre-history of *Chaos*, work on both chaos and solitons proceeded essentially independently on both sides of the East/West divide. For example, the generalization of the IST to solve the sine-Gordon and nonlinear Schrödinger equations (among others) was invented independently in the early 1970s in the USSR by Zakharov and Shabat⁶ and in the United States by Ablowitz, Kaup,

Newell, and Segur.⁷ Separated not only by the political situation but also by language, there was little timely communication, between the Soviet and American nonlinear communities, with the Soviet scientists publishing mostly in Soviet journals that took many months to translate into English and the U.S. journals not readily available in a timely manner in the Soviet Union.

All this is very hard to imagine in today’s age of the arXiv and the Internet, where work done anywhere in the world is available to the international community almost instantaneously. But to understand the origin of *Chaos*, one must cast one’s eye back to those pre-Web days.

In the 1970s, interest in nonlinear science exploded. In chaos, Feigenbaum’s discovery⁸ of universality in the period doubling transition to chaos sparked both theoretical and experimental studies in many traditional disciplines. The classic review article on solitons by Scott, Chu, and McLaughlin⁹ brought that concept to a much wider segment of the scientific community. Joe Ford’s personal undertaking of collecting and distributing “Nonlinear Science Abstracts” helped to build the international community in nonlinear science. There was also an expansion of direct interactions across the East/West divide. A celebrated meeting in Jadwisin, Poland (just outside of Warsaw) in 1977 marked the first time that a large contingent of American and Soviet experts on solitons met in person and compared notes on how they had independently solved the same problems. A longer history would contain many remarkable stories from that meeting, but the essential point is that the Soviet and American nonlinear communities were beginning to tunnel through the East/West divide.

By 1980, various centers, such as the Center for Nonlinear Studies (CNLS) in Los Alamos, were being formed to study nonlinear problems in a wide range of disciplines in an integrated manner. Joe Ford’s “Nonlinear Science Abstracts” morphed into *Physica D*, the first journal devoted solely to nonlinear science. At the same time and during most of the 1980s, Soviet scientists were still publishing primarily in the Soviet journals, often for the simple reason of avoiding page charges or the delays that could occur if one did not pay them. These Soviet journals were translated into English, albeit with a minimum delay of several months. Importantly, the American Institute of Physics (AIP), through a formal agreement with the Soviet copyright agency VAAP (*Vsesoiuznoe agentstvo po avtorskim pravam*), was the publisher of the English translations of the key Soviet physics journals. The fees paid to VAAP by the AIP for the right to translate and sell Soviet journals outside the

USSR were a very important source of hard currency, especially since the ruble was not convertible at that time (and remained non-convertible until 2006!). The non-convertibility of the ruble led to a situation that was the amusing converse of that described by John Updike in his novel “Bech: A Book.” In the chapter “Rich in Russia” Updike’s fictional alter-ego, the author Henry Bech, had to travel to the Soviet Union to claim and spend, in hilarious and exotic ways, the royalties from his book sales in Russia. Instead, in the case of the AIP, as the process of perestroika (formally ratified in 1987) unraveled the economic strictures on individual enterprises in the USSR, the AIP leaders realized that their agreement for the translation rights would likely be subject to new competition from Western commercial publishers and emerging Soviet entrepreneurs, who would attempt to dangle more lucrative hard currency agreements before an increasingly independent VAAP.

In this rather chaotic (Sorry! I could not resist) environment, Ken Ford, the then CEO of AIP, and his director of journal publishing, Darlene Carlin (now Walters), assisted by a consultant, Martin Levin (who already had a history of dealing with the Soviets on publishing matters), entered into negotiations with VAAP and with individual editors and institutes in the unraveling USSR to retain the translation rights to the Russian-language journals in the face of this new competition.¹⁰ The key question was, to quote Lenin, “Chto Delat?” (meaning: What is to be done?). Martin Levin’s insightful contribution was to respond to that question with another: “What can AIP do for the Soviet scientists that others seeking translation rights cannot?” He, Ken, and Darlene formulated the idea of joint conferences sponsored by both sides to be held in alternate years in the two countries. In consultation with various individuals, Ken arrived at the idea that the subject matter of the conferences should be a field of physics that did not involve huge numbers of researchers worldwide, should be theoretical, and to which comparably important contributions are made on the two sides. Again with the help of advisors, he concluded that the field of nonlinear science, and chaos, in particular, met these criteria and would be a good choice. He was made aware of the history of parallel discoveries in nonlinear science in the two countries (as discussed above) and of the rapidly expanding interest in this field.

Shortly after conceiving this idea, Ken approached me, as the then Director of the CNLS, to chair the U.S. side of the organizing committee for the first conference, planned for the summer of 1989. He and I then secured the agreement of Roald Sagdeev and George Zaslavsky in Moscow to serve as Soviet co-chairs, and I also gained Mitchell Feigenbaum’s help on my end. Among us, we drew up a list of proposed invitees. The conference, jointly sponsored by the AIP, VAAP, and the Soviet Academy of Sciences, was held at the U.S. National Academy of Sciences Woods Hole conference center in July 1989 and involved twenty researchers from the United States and ten from the USSR.¹¹ The proceedings were published by the AIP under the title “Chaos/XAOC: Soviet-American perspectives on nonlinear science.”¹²

During the meeting, the conference steering committee discussed the possibility of creating a new journal on chaos.

Among my yellowing paper files is a document called “Notes from Discussion with Chaos Conference Steering Committee” dated simply July 1989 and beginning with a statement:

“THE NEED FOR A JOURNAL ON CHAOS

The committee endorses the idea if the journal has the features outlined below. Otherwise, they are not so sure. They feel that U.S. researchers now have adequate outlets for publication.

THE COVERAGE

The committee questions whether chaos alone is broad enough. Nonlinear science might be better.”

The notes continue with a list of recommended features, which included (among others) that the journal be interdisciplinary, have joint sponsorship of the AIP and the Soviet Academy, have no page charges, have joint editors in both countries, and accept submissions in English or Russian.

Thus, in its embryonic form, this proto-*Chaos* was very much “a tale of two communities,” American and Soviet, designed explicitly to bridge the East/West divide that had plagued the early days of nonlinear science.

In the months that followed the meeting, exchanges between the organizers continued, mostly mediated by Ken Ford, with George Zaslavsky being the primary contact on the Soviet side. In a letter to me dated September 21, 1989, George wrote

“Ken Ford visited Moscow several days ago and we had discussion on the next meeting in USSR and on the new journal foundation with the title “Chaos”—Ken Ford will discuss with you full project and he will ask you to be physical editor of American part of editorial group. I would be delighted if you will find a reason for the journal organizing and a possibility to be the editor. I will be happy to work with you and hope for success of the project.”

Ken followed up his visit to Moscow with an email to me (and several others) discussing a number of matters, including the name of the journal. Ken wrote

“Roald and George, in particular, argue for the simple title “Chaos”, not Nonlinear Phenomena or Nonlinear Physics or something similar.... They would like to see applications articles drawn from fields outside of straight physics and math.”

Ken’s email also included a statement of support for the formation of a new AIP journal on chaos written by George, detailing possible Soviet participants and noting

“It would be advisable, in the spirit of new thinking, to put forward a new joint Soviet-American initiative to found a new international (accessible to everybody)

journal “Chaos” to be published in English...It is of high importance if AIP could take up the publishing of this journal...Bearing in mind the positive experiences of cooperation with AIP, we can certainly look forward to the success of the venture.”

In roughly the same time frame, expressions of support for the new journal came from Boris Chirikov, Yakov Sinai, and Leonid Shil’nikov, reflecting the considerable enthusiasm of the Soviet colleagues.

My own response to Ken, in an email dated October 10, 1989, reflected a more cautious approach:

“Many thanks for your email message forwarding George Zaslavsky’s proposal for a joint U.S./Soviet journal on “Chaos.” I need to mull over the idea before responding; as I indicated when we discussed the matter at Woods Hole, I feel that limiting ourselves to “chaos” misses out the natural and important connections to other nonlinear phenomena, whereas broadening our scope to all of nonlinearity may lead to unnecessary duplication of the efforts of journals such as “Physica D” and “Nonlinearity.” But the appeal of a joint U.S./Soviet journal is strong. So I’ve really got to think things through.”

Fortunately, after thinking it through, I did make the right decision to become involved in this joint venture. At this point, one might be tempted to think “the rest is history.”

Actually, not quite, by a long shot: for the AIP to create a new journal, there had to be a comprehensive business plan, including the review of any existing or anticipated “competing” journals, to be presented to and (hopefully) approved by the AIP Subcommittee on Journals, then by the Publishing Policy Committee, and finally by the AIP Governing Board, where representatives of the member societies held seats. Very importantly, since several of these member societies published their own journals, they had to agree that the new journal would not damage in a significant way their existing publications. During November and December 1989, Ken Ford managed to guide the fledging project through these preliminary wickets and received approval to set up a special Task Force to review all the plans and advise the AIP on whether to proceed. Ken appointed me as chair of the Task Force, and I was joined by Heinz Barschall (representing the APS), James Bayfield, Ben Bederson (also representing the APS), Irving Epstein, Mitchell Feigenbaum, Paul Liao (representing the Optical Society of America), Charles Tresser, Donald Turcotte (representing the American Geophysical Union), and George Zaslavsky (who at the time was visiting the Physics Department at the University of Maryland).

The Task Force held two meetings—on March 7 and May 12, 1990—at the AIP headquarters in New York City. My extensive notes and detailed summaries prepared by the AIP staff document vigorous and wide-ranging discussions, including the benefits of a new journal to readers, authors, and the AIP, the range of topics to be included, the nature of

the potential completion, and the impact on existing journals of the member societies. The written report of the second meeting contained the following recommendation:

“In reviewing the question before it, the Task Force took into consideration the current status of research and publishing in the field, the plans among commercial publishers for other new journals, AIP’s interest in expanding its publication program, the potentially conflicting interests of the AIP Member Societies, and whether the appropriate individuals could be involved. It identified a number of important services to readers, authors, and to AIP that a new journal could provide.

The Task Force concluded that the scientific community would best be served if AIP took the lead in publishing a new, interdisciplinary journal of high standards, wide distribution, and reasonable cost. The Task Force endorsed the proposed project—confirming the proposed title “Chaos: An International Journal of Nonlinear Science”—and recommended that it be developed within the guidelines discussed at the two meetings and summarized below.”

The Task Force also recommended several features of the present journal, including the three-tiered editorial structure with an Editor-in-Chief, Associate Editors, and an Editorial Advisory Board, as well as the quarterly nature of the journal and the idea of “special” (later called “focus”) issues with guest editors.

The nascent journal was taking shape, and in the next few months, things moved along rapidly. On June 9, 1990, Ken Ford sent me a FAX in which he cut directly to the chase: “Dear David, You are the people’s choice to serve as the Editor of the new chaos journal.” In view of the present barely readable condition of the yellowed thermal FAX paper, Ken’s last sentence is particularly amusing: “This is being sent by an unorthodox method—through an email link to Dasnet rather than directly from a fax machine. Please let me know in what shape it arrives.” I assume that at the time it arrived, it was in decent shape, but its present vanishingly faded state seems somehow reminiscent of Shelley’s “Ozymandias.”

My response, in the form of handwritten notes for a FAX dated June 19, 1990, said “With some trepidation—it looks like a lot of work!!—I can say that I AM interested in serving as the Editor of the new AIP Chaos journal, and I am certainly honored to be offered the position.”

In July 1990, the second Soviet-American Chaos/XAOC conference was held in Tarusa, Russia, at a beautiful facility owned by the Institute for Space Research. No proceedings were printed, as the written versions of presentations at that meeting were intended to be the first articles to be published in the new journal, assuming it was approved. At the AIP, Darlene Carlin, the Director of Journal Publishing, and John T. (Terry) Scott, Manager of Editorial Operations, became involved in the detailed planning for administering and producing the journal. Ken Ford’s “Letter from the Director” July/August 1990, included the announcement that¹³

“**CHAOS:** Plans are well along for the launch of a new AIP journal CHAOS in 1991. It is (to quote from its subtitle) an Interdisciplinary Journal of Nonlinear Science. The designated Editor-in-Chief is David Campbell of Los Alamos Scientific Laboratory. Among the editors, who will be distributed geographically and by discipline, are Irving Epstein of Brandeis University, Mitchell Feigenbaum of Rockefeller University, and George Zaslavsky of the Space Research Institute in Moscow....Final plans will be presented to the Governing Board in October. It is intended that the coverage and readership extend well beyond physics....Janis Bennett of our Journal Production Division will serve as Assistant to the Editor in Chief.”

Several points in Ken’s letter are particularly worthy of note. First, the phrase “International” in the subtitle had been replaced by the more relevant “Interdisciplinary,” to make clear that CHAOS (we were using the all capitals form then) would cover nonlinear phenomena across all disciplines. This change was actually still under discussion at the time, but in the end, “Interdisciplinary” prevailed. Second, the final approval of the plans for the journal was to be discussed at a Governing Board meeting in October: more on this below. Finally, the assignment of Janis Bennett as Assistant to the Editor-in-Chief marked the beginning of a wonderful, more than twenty-year collaboration for me with her and also for her with the other editors and the authors and reviewers.

As the October 12 Governing Board meeting approached, Terry Scott and I exchanged several letters about how best to present the proposal for CHAOS to that group. At the meeting, which was held at the AIP offices in New York, I presented our detailed case for the journal, with Ken Ford, Terry Scott, Darlene Carlin, and Janis Bennett present to help. My notes from the meeting indicate that David Lazarus (the Editor-in-chief of the APS at the time) raised several points, including the comment that having page charges would be death for the journal and the question for how long we would run this “experiment”? The answer was that we would review the journal in January 1993. Steven Chu was also present, as the editor of *Optics Letters*, a journal published by the Optical Society of America, which as an AIP member organization, had the right to review any proposals for new AIP journals. As one might expect, Steve asked several penetrating questions about how much nonlinear optics we expected in Chaos. There were some other discussions about finances—the committee told us to reduce the subscription price, as the price per page was too high—and then took a vote. My record of this vote says “majority in favor, 2 opposed, 3 abstained.” So, by a split decision, CHAOS was officially approved for a launch in 1991.

Once the approval was granted, the frantic rush began to assemble the first issue, which was to be based primarily on the articles from the Tarusa Chaos/XOAC conference, and to attract papers for subsequent issues. In her own words, Janis Bennett recalls this period thusly:¹⁴

“At the time that CHAOS was proposed, AIP had just started or proposed other Journals that were assigned to other ‘managers’ in the department. I remember walking into Terry Scott’s office and demanding to be given the new Journal - it was my turn! Little did I know it would be so successful, enjoyable and rewarding. I loved going to work every day!

At the planning meetings, I recall being impressed that the science had attracted young researchers. I had been working with other journals with much older editors and researchers. It made working with everyone fun - we were of the same generation.

I recall the angst associated with the first issue, which was all invited papers, and then stressing for the rest of the year about whether we would have enough accepted articles to make an issue. Some months it was close.

By the first year anniversary, our subscriptions were increasing, as were single issue purchases. I was concerned that our print runs might not be adequate and suggested that we increase the runs to accommodate our increasing circulation. Unfortunately, we did not accomplish this quickly enough, and we had to go back to press expeditiously to back-fill some copies.

In my early days with AIP, I was often the only woman in a meeting, unless Darlene was also there. Early on, CHAOS had women reviewers, moving to associate editors and then on up the ladder. The women’s movement was noticeable. I recall asking each one about their experience on Physics faculty. They all said the same thing - tough being heard and recognized.”

The first issue of CHAOS appeared on July 1, 1991.¹⁵ The editorial I wrote announcing the aims of the new journal clearly reflected the many discussions that had occurred in the pre-history that led to its creation. I wrote:

“With this premier issue of CHAOS, the American Institute of Physics inaugurates another venture that reaffirms its commitment to bringing to the broadest possible audience the most exciting and timely developments in any area of science in which physics plays a significant role. The title CHAOS was selected in part because it is the single word that captures most dramatically the essence of the new “nonlinear science” that has given us deep insights into previously intractable natural phenomena. And yet, as in the case of such established journals as CELL or BRAIN, CHAOS is, as its subtitle implies, meant in a synecdochic sense: the range of topics presented in CHAOS will cover the full spectrum of nonlinear science.”

But, perhaps, an even more compelling reflection of the pre-history of CHAOS is represented by the third article in the first issue. This was not something from the Tarusa meeting, but rather a reprinting of a deleted chapter of Vladimir I.

Arnol'd's doctoral thesis. This chapter was entitled "Cardiac arrhythmias and circle mappings" and did not appear in the published version of the thesis because Arnol'd's advisor, A. N. Kolmogorov, had declared it "not a suitable subject for mathematics."

As I wrote in an Editorial preamble, this article provided a perfect instantiation of the need for the journal CHAOS:

"Editor's note: The following manuscript by V. I. Arnold contains results that were excerpted from the diploma dissertation of Arnold, but were omitted from the published version of the work. The current manuscript is reprinted with permission of V. I. Arnold from *Izrail M. Gelfand: Collected Papers*, Volume III, edited by S. G. Gindikin, V. W. Guillemin, A. A. Kirilov, B. Kostant, and S. Sternberg (Springer-Verlag, Berlin, 1989), pp. 1019–1024. This manuscript presents remarkable results that were obtained by V. I. Arnold in the 1950s. The work was not published, and thus was completely unknown in the west until 1989. This manuscript underscores the interdisciplinary, international scope of nonlinear dynamics, and the necessity for developing improved methods for communication. The manuscript by L. Glass that begins on p. 13 summarizes recent progress on the use of circle maps to model cardiac arrhythmias."

In the ensuing twenty-five years, *Chaos* has remained devoted to increasing our understanding of nonlinear phenomena by publishing high quality content accessible to researchers around the world and from a broad range of disciplines. It will continue this commitment in the future.

I am very grateful to my colleagues Elizabeth Bradley, Adilson Motter, and Louis Pecora for suggesting that I document the pre-history of *Chaos*. I wish especially to thank Janis Bennett, Kenneth Ford, and Darlene Carlin Walters for sharing with me their memories of the origins of *Chaos*. This article is also a valedictory essay, as I will be stepping down as Editor-in-Chief at the end of this year. Over the course of the past twenty-five years, I have benefited from the support, advice, assistance, and insights of many hundreds of colleagues, from all over the globe, who served as editors, advisors, reviewers, and authors. That I cannot possibly name them all in no way lessens my sense of gratitude to each and every one of them. I want also to acknowledge explicitly the contributions of those pioneers of

nonlinear science who are no longer with us and to dedicate this essay to their memories.

Finally, it is indeed a pleasure to welcome my successor, Professor Jürgen Kurths, and to wish him every success in guiding *Chaos* in the future.

¹E. Fermi, J. Pasta, and S. Ulam, "Studies of nonlinear problems: I," Los Alamos Report LA-1940, May 1955, reprinted in *Collected Papers of Enrico Fermi, Vol II, United States, 1939–1954* (University of Chicago Press, 1965), p. 977.

²Focus Issue: "The 'Fermi-Pasta-Ulam' Problem; the First Fifty Years," edited by D. K. Campbell, P. Rosenau and G. M. Zaslavsky, *Chaos* **15**, 015101 (2005).

³F. M. Izrailev and B. V. Chirikov, "Statistical properties of a nonlinear string," *Sov. Phys. Dokl.* **11**, 30 (1966) [*Dokl. Akad. Nauk. SSSR* **166**, 57 (1966) (in Russian)].

⁴J. Ford and J. Waters, "Computer studies of energy sharing and ergodicity in nonlinear oscillator systems," *J. Math. Phys.* **4**, 1293–1306 (1963).

⁵N. J. Zabusky and M. D. Kruskal, "Interaction of 'solitons' in a collisionless plasma and recurrence of initial states," *Phys. Rev. Lett.* **15**, 240–243 (1965).

⁶V. E. Zakharov and A. B. Shabat "Exact theory of 2-dimensional self-focusing and one-dimensional self-modulation of waves in nonlinear media," *Sov. Phys. JETP* **34**, 62–69 (1972) [*Zh. Eksp. Teor. Fiz.* **61**, 118–134 (1971) (in Russian)].

⁷M. J. Ablowitz, D. J. Kaup, A. C. Newell, and H. Segur, "Method for solving sine-Gordon equation," *Phys. Rev. Lett.* **30**, 1262–1264 (1973).

⁸M. J. Feigenbaum, "Quantitative universality for a class of nonlinear transformations," *J. Stat. Phys.* **19**, 25–52 (1978).

⁹A. C. Scott, F. Y. F. Chu, and D. W. McLaughlin, "The soliton: A new concept in applied science," *Proc. IEEE* **61**, 1443–1483 (1973).

¹⁰K. Ford, private communication (2015).

¹¹The U.S. participants were James Bayfield, David Campbell, J. Doyne Farmer, Mitchell Feigenbaum, Joseph Ford, Jerry Gollub, Celso Grebogi, John Guckenheimer, Gemenu Gunaratne, Erica Jen, Peter Koch, Joel Lebowitz, Herbert Levine, Benoit Mandelbrot, Donald Ornstein, Stephen Smale, Katepalli Sreenivasan, Harry Swinney, Robert Westervelt, and Jack Wisdom. The Soviet participants were Genady Berman, Alexander Chernikov, Vladimir Kellis-Borok, Konstantin Khanin, Vladimir Kopolev, Anatoly Neishtadt, Mikhail Rabinovich, Roald Sagdeev, Jacov Sinai, and George Zaslavsky.

¹²*Chaos/XAOC: Soviet–American Perspectives on Nonlinear Science*, edited by D. K. Campbell (American Institute of Physics, New York, 1990).

¹³K. W. Ford, Letter from the Director, Ser. 2, No. 32, July/August 1990.

¹⁴J. Bennett, private communication (2015).

¹⁵The initial Editorial board, with their institutional affiliations at the time, were David Campbell, Editor in Chief (Center for Nonlinear Studies, Los Alamos National Laboratory), F. Tito Arecchi (Istituto Nazionale di Ottica), David Crighton (Cambridge University), Irving Epstein (Brandeis University), Mitchell Feigenbaum (Rockefeller University), Leon Glass (McGill University), Francis Moon (Cornell University), Hazime Mori (Kyushu Kyoritsu University), Anatoly Neishtadt (Space Research Institute, Moscow, USSR), Lev Ostrovsky (Institute of Applied Physics, Gorky, USSR), Harold Swinney (University of Texas, Austin), Charles Tresser (IBM, Yorktown Heights), and George Zaslavsky (Space Research Institute, Moscow, USSR). The Editorial Advisory Board had twenty-seven members.