Aspects of Ulam

From Cardinals to Chaos. Reflections on the Life and Legacy of Stanislaw Ulam. NECIA GRANT COOPER *et al.*, Eds. Cambridge University Press, New York, 1989. 319 pp., illus. $75; paper, $24.95. First published as a special issue of *Los Alamos Science*.

In an introductory "Esquisse," Françoise Ulam claims that her husband defied description: no one person "ever viewed the whole of him." This volume instead aims at a composite picture, made up of excerpts from his own reminiscences, reflections of colleagues and friends, appreciations of his scientific accomplishments, and accounts of recent research influenced by his work.

The title of the book suggests the breadth of Stanislaw Ulam's scientific work. During Ulam's first year in the Lwów Polytechnic Institute, Kuratowski introduced him to a problem in set theory involving the transformation of sets and infinite cardinals; Ulam later described it as "the first problem on which I really spent arduous hours of thinking" (p. 10). "Chaos" refers to studies of the complex behavior of nonlinear systems, as guided by Ulam's pioneering work in experimental mathematics.

The book's contributors number more than two dozen and include specialists in mathematics, physics, and biology. Some come from the long list of Ulam's collaborators; others work in fields where his influence and example have proven decisive.

The volume begins with excerpts from Ulam's *Adventures of a Mathematician* (first published in 1976). These reminiscences provide a tantalizingly brief biographical sketch, in which Ulam describes how it was "that mathematics had taken possession of me" (p. 11) and how he flourished in the intellectual atmosphere of the Scottish Café in Lwów. The launching of Ulam's career in the United States was conditioned by good fortune and timing: von Neumann's offer of a temporary stipend at the Institute for Advanced Study, Ulam's meeting with Birkhoff and subsequent appointment to the Harvard Society of Fellows, his successful application for an immigration visa shortly before Hitler's advance closed that option for most Poles.

After 1941 von Neumann helped engineer an invitation for Ulam, then at the University of Wisconsin, to participate in the Manhattan Project. Before his departure for Los Alamos, Ulam checked out the WPA guide for New Mexico from the local library, discovering that other colleagues from Madison, who had already disappeared "to hush-hush war jobs" (p. 15) at unknown destinations, had done likewise. Ulam's experiences in wartime and postwar Los Alamos were crucial in his own work and that of the institution. There, as at the other institutions he served, Ulam's intuition and ingenuity spurred colleagues in various fields. They recall: "Like a master of reflecting boundaries, he would bounce ideas back to us from an endless variety of angles" (p. 52); "Stan habitually turned things to view from a variety of directions. . . . and often supplied the connection that dispelled a gathering fog" (p. 288); "Stan did his best work in fields where no one dared to tread" (p. 30). His was a combination of "deep intuition and impatience with detail, playful inventiveness and dislike of prolonged work" (p. 24).

Most contributions to this volume, however, are not meant for the lazy reader. The book, which appeared originally as a special issue of *Los Alamos Science* (1987), was aimed at an audience with ready-made interest in the research programs at Los Alamos National Laboratory. Its republication in this form anticipates a larger audience, with interests in contemporary mathematical research and its applications in physics and biology.

In the opinion of his colleague and friend Gian-Carlo Rota, Ulam's two problem books will secure him a lasting reputation among mathematicians. Contributions to this volume also focus on his leading role in developing computer-aided experimental mathematics. Themes first sounded in the section on mathematics echo elsewhere in the volume, as in Ulam's work itself: witness, for example, the utility of measures of similarity in analysis of DNA sequences, recognition of speech, and graph theory.

The section on physics likewise combines a review of developments and accounts of current research, as inspired by Ulam and aided by computer experiments. Much here is made of Ulam's contributions to research in nonlinear science, customarily defined as the study of systems and phenomena that are not linear. This definition once prompted Ulam to draw an analogy to zoology as the study of "non-elephant animals" (p. 218). The section contains excerpts from "FPU," Fermi, Pasta, and Ulam's influential work on nonlinear systems; a thoughtful overview of nonlinear science by David K. Campbell, which identifies three major paradigms and tracks them through physical and mathematical examples; and more detailed treatment of turbulence and many-particle systems, problems that challenge powerful computer technologies.

Another section explores Ulam's "genius" for casting basic biological problems in the form of mathematical models, including the notion of genealogical distance, encoding in genes of "rules for the change of rules," and "cellular automaton models of growth patterns" (p. 281). The section concludes with Ulam's Gamow Memorial Lecture (1982), "Reflections on the brain's attempts to understand itself," published for the first time in this compilation.

The book has been carefully designed and produced. Variety in format and use of sidebars accommodate much mathematical notation and technical discourse; generous margins and lavish color in illustrations enhance the presentation. The book contains a useful bibliography of Ulam's publications, and most of the contributions also offer suggestions for further reading. The utility of the index is diminished by its brevity.

A final section, The Ulam Touch, includes two pieces closely linked to Los Alamos. One is "a memorable memo" dated 1947, in which Ulam and Carson Mark alphabetized, for the "convenience and ready reference" of the Administration and Services division at Los Alamos, the numbers from 0 to 100. An AEC Commissioner once called it the "best thing to come out of Los Alamos yet!" (p. 294). A second, entitled "Sub rosa," is a playlet dictated by Ulam (1965) in which three characters (Bethe, Teller, and Ulam) debate issues of nuclear testing. Its tone is light, the editor's recommendation "Enjoy!" Both of these pieces remind us, however, of the unique scientific environment and political context in which Ulam operated.

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Cold Episode

The Little Ice Age. JEAN M. GROVE. Methuen, New York, 1988. xxii, 498 pp., illus. $144.

Does the recent warming observed in time series of global temperatures indicate "greenhouse warming," or is it simply a component of natural climatic variability? Is the 20th-century earth, as some suggest, merely escaping the clutches of the 15th- to 19th-century "Little Ice Age"? Could another natural cold episode help compensate human-induced warming? Are warm events such as the 12th- to 13th-century "Medieval Warm Period" real, and could they occur in the future? These questions are currently the subject of hot scientific debate and illustrate how little is known about the patterns and causes of natural decade- to century-scale climatic variability. The scientific community has already unraveled many mysteries of the "big" Quaternary ice ages, but we have yet to even define when and what "the Little Ice Age" was.

Jean Grove's book by this name doesn't offer exact temporal or spatial definitions, but it does synthesize much of what is known about the cold "neoglacial" periods of the past 10,000 years. Grove concentrates on the most recent, and perhaps most pronounced, period of apparent climatic cooling and describes in detail the chronologies of glacial advance and retreat that are available from around the world. She sets an inspiring precedent for studies of past global changes by weaving her perspective as a historian with that of glaciologists, geologists, and climatologists. She presents a number of engrossing historical accounts, clearly illustrating how useful these records can be. She hints at the wealth of long historical accounts that may someday be available from East Asia.

Grove's book adopts the classic Little-Ice-Age view of past climatic change, focusing on glacial activity and records of temperature change. This view must be extended, however, to tap the large number of continuous non-glaciological paleoclimate records that exist from around the world. Global reconstructions of climate change need to be built from as many climatic variables as can be mapped. Many workers have jumped to claim that periods of glacial advance were globally synchronous during the past 10,000 years. Grove correctly urges caution, but seems to support the idea of synchroneity. Cold (or warm) events need not be global to be of concern and interest.

Mary Vaux at the foot of the Illecillewaet glacier in Canada, 17 August 1899. In 1887, "George Vaux, a leading Quaker businessman from Philadelphia who was also a dedicated mineralogist and supporter of the Philadelphia Academy of Sciences, visited the Rockies with his three children, William, George and Mary. . . . When the Vaux returned in 1894 and noticed that the glacier front had retreated they realized the value of their 1887 photographs and became so interested in the study of glaciers that they initiated the first measurement of glacier front positions in Canada." [Courtesy of the Whyte Museum of the Canadian Rockies. From *The Little Ice Age*]

Grove provides a solid summary of the most likely causes of decade- to century-scale environmental change, but in doing so makes it all too apparent that we lack the insight to predict such changes. The time

has come to unravel how volcanic eruptions, variations in solar activity, altered circulation of the ocean, and many other factors influence the global climate system on time scales of less than a few human generations. The "Little Ice Age" of recent history provides a stimulus to renew interdisciplinary research on a key topic. *The Little Ice Age* is an impressive place to start.

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Reprints of Books Previously Reviewed

Galileo: Heretic. (Galileo Eretico.) Pietro Redondi. Princeton University Press, Princeton, NJ, 1989. Paper, $9.95. *Reviewed* **237**, 1059 (1987).

Toward a New Philosophy of Biology. Observations of an Evolutionist. Ernst Mayr. Harvard University Press, Cambridge, MA, 1989. Paper, $14.95. *Reviewed* **240**, 1801 (1988).

Books Received

Algebraic Geometry and Commutative Algebra. In Honor of Masayoshi Nagata. Hiroaki Hijikata *et al.*, Eds. Academic Press, San Diego, CA, 1989. 2 vols. xviii, 804 pp. Each vol., $69.

Analysis of Sterols and Other Biologically Significant Sterols. W. David Nes and Edward J. Parish, Eds. Academic Press, San Diego, 1989. xvi, 341 pp., illus. $69.

Anatomy of a Scientific Discovery. Jeff Goldberg. Bantam, New York, 1989. xii, 228 pp. Paper, $8.95. Reprint, 1988 ed.

Animal Motivation. Patrick Colgan. Chapman and Hall (Routledge, Chapman and Hall), New York, 1989. x, 159 pp., illus. $52.50; paper, $19.95. Chapman and Hall Animal Behaviour Series.

Arid Zone Geomorphology. David S. G. Thomas, Ed. Belhaven (Pinter), London, and Halsted (Wiley), New York, 1989. xii, 372 pp., illus. $59.95.

Banking and the Promotion of Technological Development. Nicolas Jequier and Yao-Su Hu. St. Martin's, New York, 1989. x, 220 pp. $35.

Beauty and the Brain. Biological Aspects of Aesthetics. Ingo Rentschler, Barbara Herzberger, and David Epstein, Eds. Birkhäuser Boston, Cambridge, MA, 1988. 332 pp., illus. $49.50. Based on a meeting, Bad Homburg vor der Höhe, F.R.G.

Between MITI and the Market. Japanese Industrial Policy for High Technology. Daniel I. Okimoto. Stanford University Press, Stanford, CA, 1989. xviii, 267 pp., illus. $27.50.

Chemical Sensing with Solid State Devices. Marc J. Madou and S. Roy Morrison. Academic Press, San Diego, CA, 1989. xvi, 556 pp., illus. $89.50.

Classical Novae. M. F. Bode and A. Evans, Eds. Wiley, New York, 1989. xvi, 341 pp., illus. $163.

Cold Dawn. The Story of SALT. John Newhouse. Pergamon-Brassey's, McLean, VA, 1989. viii, 302 pp. $26. A Pergamon-Brassey's Classic.

A Companion to the Physical Sciences. David Knight. Routledge, New York, 1989. iv, 177 pp. $25.

Computational Molecular Biology. Sources and Methods for Sequence Analysis. Arthur M. Lesk, Ed. Oxford University Press, New York, 1988. xii, 254 pp., illus. $49.95. Prepared under the auspices of CODATA Task Group on Coordination of Protein Sequence Data Banks.

Developments in Japanese Economics. Ryuzo Sato and Takashi Negishi, Eds. Academic Press, San Diego, CA, 1989. xiv, 292 pp. $59.95. Twelve papers "summarizing the studies conducted by prominent Japanese economists."

Developments in Ultrastructure of Reproduction. Pietro M. Motta, Ed. Liss, New York, 1989. xxii, 484 pp., illus. $165. Progress in Clinical and Biological Research, vol. 296. From a symposium, Rome, Italy, July 1988.

Exposure of the U.S. Population from Diagnostic Medical Radiation. National Council on Radiation Protection and Measurements, Bethesda, MD, 1989. vi, 103 pp. Paper, $14. NCRP Report no. 100.

First Naples Workshop on Bioactive Peptides. (Capri, Italy, May 1988.) Ettore Benedetti *et al.*, Eds. Wiley, New York, 1989. viii, 530 pp., illus., + plates. Paper, $50. *Biopolymers*, vol. 28, no. 1 (1989).

The Flocks of the Wamani. A Study of Llama Herders on the Punas of Ayacucho, Peru. Kent V. Flannery, Joyce Marcus, and Robert G. Reynolds. Academic Press, San Diego, CA, 1989. xii, 239 pp., illus. $49.95; paper, $24.50.

Forecasting in Business and Economics. C. W. J. Granger. 2nd ed. Academic Press, San Diego, CA, 1989. xii, 279 pp. $34.95.

Fourth Generation Business Systems. Vendor Support Environments and Systems Generation. Alex Varsegi. Wiley, New York, 1989. xiv, 332 pp., illus. $34.95.

From a Life of Physics. H. A. Bethe *et al.* World Scientific, Teaneck, NJ, 1989. x, 92 pp. Paper, $6. Reprint.

Human Retrovirology. Facts and Concepts. Jörg Schüpbach. Springer-Verlag, New York, 1989. viii, 115 pp., illus. $59.

Humans in Space. 21st Century Frontiers. Harry L. Shipman. Plenum Press, New York, 1989. viii, 351 pp., illus. $22.95.

Hypersaline Environments. Microbiology and Biogeochemistry. Barbara Javor. Springer-Verlag, New York, 1989. viii, 328 pp., illus. $59. Brock/Springer Series in Contemporary Bioscience.

Ignorance and Uncertainty. Emerging Paradigms. Michael Smithson. Springer-Verlag, New York, 1989. xiv, 393 pp., illus. Paper, $42.50. Cognitive Science.

Images of the Ice Age. Paul G. Bahn and Jean Vertut. Facts on File, New York, 1989. 240 pp., illus. $35.

The Immune System. Evolutionary Principles Guide Our Understanding of this Complex Biological Defense System. Rodney E. Langman. Academic Press, San Diego, CA, 1989. xlvi, 209 pp., illus. $49.95; paper, $22.95.

Immunoglobin Genes. T. Honjo, F. W. Alt, and T. H. Rabbitts, Eds. Academic Press, San Diego, CA, 1989. xviii, 410 pp., illus. $79.50.

The Information Age and Soviet Society. Richard W. Judy and Virginia L. Clough, Hudson Institute, Indianapolis, IN, 1989. viii, 99 pp. Paper, $10.

Intuitive IC Electronics. A Sophisticated Primer for Engineers and Technicians. Thomas M. Frederiksen. 2nd ed. McGraw-Hill, New York, 1989. xviii, 205 pp., illus. $39.95; paper, $19.95. McGraw-Hill Series in Intuitive IC Electronics.

Inverse Gas Chromatography. Characterization of Polymers and Other Materials. Douglas R. Lloyd *et al.*, Eds. American Chemical Society, Washington, DC, 1989. xii, 331 pp., illus. $69.95. ACS Symposium Series, vol. 391. From a symposium, Toronto, Ontario, June 1988.

Ionizing Radiation Effects in MOS Devices and Circuits. T. P. Ma and Paul V. Dressendorfer, Eds., Wiley-Interscience, New York, 1989. xx, 587 pp., illus. $69.95.

Mechanisms of Psychological Influence on Physical Health. With Special Attention to the Elderly. Laura L. Carstensen and John M. Neale, Eds. Plenum, New York, 1989. 196 pp., illus. $49.50. From a conference, Bloomington, IN, May 1986.

Medical Revolution in Minnesota. A History of the University of Minnesota Medical School. Leonard G. Wilson. Midewiwin Press, St. Paul, MN, 1989. xii, 612 pp., illus. $55.

The Meeting. Gatherings in Organizations and Communities. Helen B. Schwartzman. Plenum, New York, 1989. xvi, 344 pp. $39.50.

Men from Earth. Buzz Aldrin and Malcolm McConnell. Bantam, New York, 1989. xxii, 312 pp + plates. $19.95.

Metallurgy and Materials Science and Engineering at MIT: 1865–1988. Michael B. Bever. Massachusetts Institute of Technology, Department of Materials Science and Engineering, Cambridge, MA, 1988. 135 pp., illus., + chart. $25.

Metaphors of Consciousness. Ronald S. Walle and Rolf von Eckartsberg, Eds. Plenum, New York, 1989. xxii, 521 pp., illus. Paper, $19.95. Reprint, 1981 ed.

Metastasis. Gregory Bock and Julie Whelan, Eds. Wiley, New York, 1989. x, 255 pp., illus. $54.95. Ciba Foundation Symposium 141. From a symposium, London, U.K., April 1988.

Mineral Adsorption in the Monogastric GI Tract. Frederic R. Dintzis and Joseph A. Laszlo, Eds. Plenum, New York, 1989. x, 214 pp., illus. $55. Advances in Experimental Medicine and Biology, vol. 249. From a meeting, Toronto, Ontario, June 1988.

Missing the Meaning? A Cognitive Neuropsychological Study of Processing of Words by an Aphasic Patient. David Howard and Sue Franklin. MIT Press, Cambridge, MA, 1989. xx, 171 pp., illus. $25.

A Model of Its Kind. A. McGehee Harvey *et al.* Johns Hopkins University Press, Baltimore, 1989. Vol. 1, A Centennial History of Medicine at Johns Hopkins. xii, 372 pp., illus. $30. Vol. 2, A Pictorial History of Medicine at Johns Hopkins. x, 172 pp. $20.

Models of Thought. Vol. 2. Herbert A. Simon. Yale University Press, New Haven, 1989. xviii, 508 pp., illus. $55; paper, $29.95. Thirty Reprinted papers, mostly from the 1970s and '80s.

The Molecular Biology of Fertilization. Heide Schatten and Gerald Schatten, Eds. Academic Press, San Diego, CA, 1989. xviii, 384 pp., illus. $85. Cell Biology.

Molecular Endocrinology. Franklyn F. Bolander. Academic Press, San Diego, CA, 1989. x, 318 pp., illus. $39.50.

Multi-Armed Bandit Allocation Indices. J. C. Gittins. Wiley, New York, 1989. xii, 252 pp. $69.95. Wiley-Interscience Series in Systems and Optimization.

Myelination and Demyelination. Implications for Multiple Sclerosis. Seung U. Kim, Ed. Plenum, New York, 1989. viii, 275 pp., illus. $65. From a symposium, Vancouver, BC, June 1987.

Narratives from the Crib. Katherine Nelson, Ed. Harvard University Press, Cambridge, MA, 1989. xii, 350 pp. $30.

Nonlinear Fiber Optics. Govind P. Agrawal. Academic Press, San Diego, CA, 1989. xii, 342 pp., illus. $39.95. Quantum Electronics.

Notes on Science, Technology and Science Education in the Development of the South. Abdus Salam. Third World Academy of Sciences, Trieste, Italy, 1989. 169 pp. Paper.

Nucleic Acid and Monoclonal Antibody Probes. Applications in Diagnostic Microbiology. Bala Swaminathan and Gyan Prakash, Eds. Dekker, New York, 1989. xx, 717 pp., illus. $150. Infectious Disease and Therapy, vol. 2.

Numerical Simulation and Optimal Control in Plasma Physics. With Applications to Tokamaks. Jacques Blum. Gauthier-Villars, Paris, and Wiley, New York, 1989. xviii, 363 pp., illus. $77.95. Wiley/Gauthier-Villars Series in Modern Applied Mathematics.

Nutritional Impact of Food Processing. J. C. Somogyi and H. R. Müller, Eds. Karger, Basel, 1989. viii, 346 pp., illus. $193.50. Bibliotheca Nutritio et Dieta, no. 43. From a symposium, Reykjavik, Sept. 1987.

Observations and Interpretation of Hawaiian Volcanism and Seismicity, 1779–1955. An Annotated Bibliography and Subject Index. Thomas L. Wright ad Taeko Jane Takahishi. University of Hawaii Press, Honolulu, 1989. xxvi, 270 pp., illus. $30.

The Oceans. A Book of Questions and Answers. Don Groves. Wiley, New York, 1989. xviii, 203 pp., illus. Paper, $12.95. Wiley Nature Editions.

The Plant-Feeding Gall Midges of North America. Raymond J. Gagné. Comstock (Cornell University Press), Ithaca, NY, 1989. xii, 356 pp., illus. $45.

Plasma Diagnostics. Vol. 2, Surface Analysis and Interactions. Orlando Auciello and Daniel L. Flamm, Eds. Academic Press, San Diego, CA, 1989. x, 337 pp., illus. Plasma-Materials Interactions.

Plasma Physics for Nuclear Fusion. Kenro Miyamoto. MIT Press, Cambridge, MA, 1989. xvi, 618 pp., illus. Paper, $27.50. Translated from the Japanese edition (Tokyo, 1987).

Plasma Waves. D. G. Swanson. Academic Press, San Diego, CA, 1989. xii, 422 pp., illus. $39.95.

Population and Resources in Western Intellectual Traditions. Michael S. Teitelbaum and Jay M. Winter, Eds. The Population Council, New York, 1989. viii, 310 pp. Paper, $12. *Population and Development Review*, vol. 14 supplement (1988). Based on a seminar, Cambridge, UK, Aug. 1987.

Practical Handbook of Environmental Control. Conrad P. Straub, Ed. CRC Press, Boca Raton, FL, 1989. viii, 537 pp., illus. $45.

Practical Handbook of Marine Science. Michael J. Kennish, Ed. CRC Press, Boca Raton, FL, 1989. viii, 710 pp., illus. $45.

Practical Handbook of Physical Properties of Rocks and Minerals. Robert S. Carmichael, Ed. CRC Press, Boca Raton, FL, 1989. xiv, 741 pp., illus. $45.

Prediabetes. Rafael A. Camerini-Davalos and Harold S. Cole, Eds. Plenum, New York, 1988. xii, 421 pp., illus. $79.50. Advances in Experimental Medicine and Biology, vol. 246. From a symposium, Iguazu Falls, Argentina, April 1988.