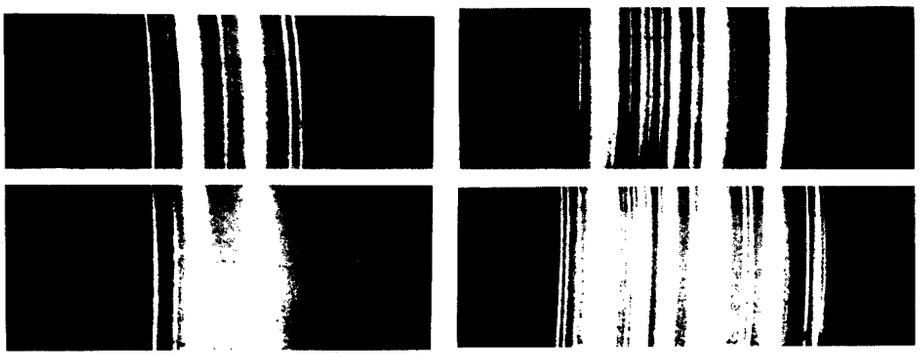

"Some of the first spectra taken by Raman," shown by him in a lecture at the Science Congress in Bangalore in March 1928. [From *Journey into Light*; courtesy Raman Research Institute]

It was no surprise that, well in advance of his retirement from the Indian Institute, he planned and built his own research establishment, the Raman Research Institute, which was later to be his sanctuary for pursuing his quest unhindered by outside influences. In the serenity of this institution he extended his researchers into such new domains as the physiology of vision and the colors of gems and minerals. Often during these years he was a recluse, his free and independent spirit being one with "Nature." However, even during such times, and throughout his professional life, he kept working and publishing the results of his researches.

The author of this biography is also the author of two monographs in condensed matter physics. The material for this book was gathered through extensive surveys of relevant publications, including Raman's monographs, research papers, public lectures, correspondence, newspaper articles, and radio talks. The author also interviewed many relatives, friends, and former associates of Raman's to come up with this authentic account. The task of writing Raman's biography is difficult because of the political turmoil that existed in India owing to foreign rule and the struggle for independence and the many hostile forces Raman had to confront during his long life. A further complication is the unique cultural heritage of India, which necessitates the introduction of names, anecdotes, and customs that are foreign to the rest of the world. The author has nevertheless succeeded in sustaining the interest of the reader till the end of the book, and he provides well-referenced explanatory notes (pp. 502–21). The technical sections or chapters, which expound the mathematical background to Raman's work, require a knowledge of undergraduate physics but are readily identified and may be omitted by the non-technical reader. In writing this book, which appears to be the only comprehensive scientific biography of Raman, the author has rendered a valuable service to the science-oriented reading public.

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The Solar System: Records from $t \geq 0$

Meteorites and the Early Solar System. JOHN F. KERRIDGE and MILDRED SHAPLEY MATTHEWS, Eds. University of Arizona Press, Tucson, 1988. xviii, 1269 pp., illus. $55. Space Science Series.

Observational discoveries beginning in the mid-'70s led to the conclusion that some types of meteorites are quite primitive in the sense that their matrix contains materials that were formed from the solar nebula, long before the accretion of planets. These observations launched a series of ingenious investigations in meteoritics to learn about the evolutionary history of the early solar system. This compilation is an attempt to bring together information that has resulted from these studies.

The methods of decoding the evolution of the solar nebula are many, since characterization of the primitive meteoritic materials includes their physical, chemical, and isotopic compositions. Most of the meteorites that fall on the earth have, in addition, been altered by secondary processes such as heating, shock, and exposure to water. It is thus imperative to distinguish meteoritic records that are indicative of solar nebular processes from those that primarily tell us about later processes operating in the solar system.

The most fascinating aspects of the study of the early solar system are those which take us closer to $t=0$, the time of collapse of the solar nebula. The book contains appropriate discussions of several such topics. High-precision nuclear chronologies with clocks reset at different times after the isolation of the molecular cloud that collapsed to form the sun and the solar system, exotic isotopic anomalies indicating specific nucleosynthetic inputs from various stellar sites into the solar nebula, and cosmogenic records that perhaps date back to the beginning of the solar nebula have been discovered in primitive meteoritic materials. These discoveries, along with chemical and mineralogical characterization of primitive meteoritic components, constitute the most exciting investigations carried out yet, often on microgram- to milligram-size samples, using sophisticated sample-extraction and analytical methods. They have provided a great deal of insight into early solar system processes. The results to date do not lead to any consistent model of the evolution of the solar system; but they do place important constraints on such models. The present gaps appear not just to reflect lack of samples or suitable techniques but to be manifestations of the complexities of solar system evolution, including reprocessing of materials.

The book makes a strong case for further detailed studies, combined with astrophysical observations of young stars, to resolve the difficulties in the modeling of solar system evolution. The character of the meteoritic record, present knowledge of early solar system processes based on it, enigmas and limitations, and future directions are the main subject matter of the book; such a complex treatment of the subject has not been attempted before.

The book is appropriately dedicated to two scientists who made major contributions to the field of meteoritics: H. H. Nininger and H. C. Urey. It is an encyclopedic effort by more than 65 scientists. The coverage is fairly well organized and is comprehensive. The book begins by discussing classification of meteorites, their source regions, processes by which meteoritic materials are altered, effects of their exposure to solar and galactic corpuscular radiation, solar system chronology, protostellar collapse, and solar system formation. There follow papers on topics such as abundances of elements, isotopic anomalies, and interstellar components in meteorites that have a direct bearing on our understanding of physicochemical conditions in the solar nebula. Papers on the enigmatic "chondrules," refractory inclusions (one type of primitive meteoritic component), interplanetary dust, and nucleosynthetic processes make the presentation very comprehensive. The content can be considered adequate to acquaint a

graduate student with the methodology and the principal results to date.

The particular merit of the book lies in excellent summaries of the state of the art and comment on controversies and shortcomings. An example is the treatment of planetesimal formation, a problem that was believed to have its essential solution in the scenario of gravitational instability leading to settling of dust on the central plane, proposed by Safranov in 1969 and Goldreich and Ward in 1973. Recent theoretical considerations (chapter 6.4) highlight the difficulties with this model in the presence of turbulence; even a low degree of turbulence would make the gravitational instability mechanism inoperative.

Vital new information has been obtained since the book was written. Evidence has been presented for the presence of preserved interstellar grains of silicon carbide in carbonaceous chondrites. The long-standing controversy over model predictions of early solar nebula temperature as compared to those based on meteorite evidence seems to be under resolution. It has recently been shown that in certain nebular models high temperatures (~1500K) can result in the inner nebula; these are necessitated by the meteoritic evidence. In spite of such advances, the book should have a useful life of at least a decade.

I have asked myself, however, whether after reading this book I would have chosen meteoritics for my graduate studies. I feel that I would have been scared by the complexity of the field and the range of experimental and analytical approaches it now requires. Moreover, an outsider to the field attempting to use this book to learn what the meteorites tell about the early solar system would have to read through most of it, pick out the bits of information deduced and the methods used, and synthesize the data himself or herself. This could be a formidable task. Considerable help and cautionary notes would, however, be provided by the chapters "Boundary conditions for the origin of the solar system" and "Future directions in meteoritic research."

It is my opinion that the book is an invaluable contribution to our knowledge of the subject, presented largely without bias in interpretation of data, and it upholds the high tradition of editing and publishing style set by the Arizona Space Science Series. As for shortcomings, I would pick on two things: it is weak on linkage of meteorite data with observational data on star formation and evolution of young stars, and it is too voluminous. For example, the groups of papers on secondary processing and chondrules take up over 200 pages. One can more easily justify the two other rather lengthy sections on the chemistry of chondrites and the early solar system and on primitive material surviving in chondrites, but even these could have been shorter. The editors' coordination of so much material is a miracle by any standard, however. A great deal of work remains to be done in the study of the early solar system, and further success will emerge only through close coordination with astrophysicists. This is bound to happen in the coming decades with discoveries of young stellar systems with circumstellar material and probable protostellar disks and observations on their formation and evolution.

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A Nearby Star

Astrophysics of the Sun. HAROLD ZIRIN. Cambridge University Press, New York, 1988. x, 433 pp., illus. $49.50; paper, $22.95.

Covering all fields of solar physics in one book is a formidable task by any standard, and in *Astrophysics of the Sun*, a successor to his *The Solar Atmosphere* (1966), Harold Zirin has undertaken just such a grand effort.

In chapter 1 ("Looking at the sun"), Zirin gives an overview of solar physics. In the next chapter, "Observing the sun," he goes about telling the story of Caltech site selection for the Big Bear Solar Observatory and gives persuasive reasons for establishing solar observatories near lakes (examples: Big Bear and Udaipur in India) or oceans (Hawaii). He also describes various optical telescopes—spectrographs and spectroheliographs—and gives a brief account of the National Radio Astronomy Observatory Very Large Array, which has been used fruitfully for solar work during the last solar maximum.

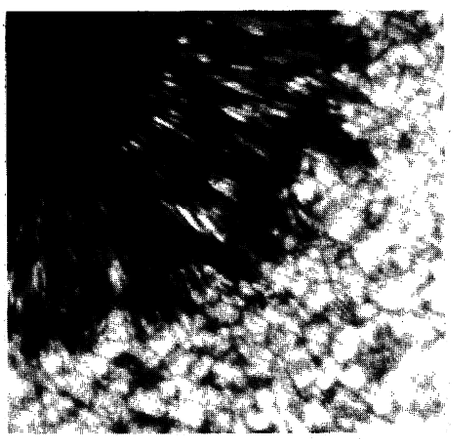
Chapters 3, 4, and 5 discuss plasmas in magnetic fields, interpretation of radiation, and atomic spectra. These chapters, which as Zirin notes are very similar to those in his earlier book, are the most basic from the point of view of learning basic solar physics, and astrophysics in general.

Chapter 6 discusses interior and photosphere, including solar models, the solar neutrino problem, solar rotation and oscillations, and helioseismology. The progress of research in the latter two areas has been so rapid that the discussion of them will have to be updated rather quickly. Excellent phenomenological descriptions of granulation, supergranulation and network structure, and the videomagnetogram observations of dipoles of opposite polarity in and around the network are accompanied by excellent pictures (VMG and other) from Big Bear. The author also discusses the use of the 12-micron line for measuring weak magnetic fields, for example from plage regions, and the measurements of the solar constant by ACRIM aboard the Solar Maximum Mission spacecraft.

Chapter 7 is on the chromosphere. This is a fairly good description of diverse phenomena seen primarily in Hα—spicules, plages, fibrils, and the like—and the nature and origin of spicules are discussed. Observations of spicules in the ultraviolet and extreme ultraviolet suggest that the old idea of the chromosphere being produced by backconduction from the corona is not valid. The author discusses radio (millimeter) observations but does not give a coherent interpretation of them in the light of our knowledge of the chromospheric structure from observations in other spectral domains. Finally, the chromospheres of other stars, binaries and close binaries such as RS CVn stars, are briefly discussed.

Chapter 8 deals with the corona. Most of the material here comes from the author's earlier book except for the treatment of two important items, coronal holes and coronal mass ejection events, and some elementary description of radio observations of the quiet corona and active regions. The discussion of coronal holes is reasonably complete, the discussion of mass ejection less so.

The next two chapters discuss prominences and solar activity. The discussion of prominences is really an update of Zirin's earlier discussion of the subject, including a great deal of discussion of the structure of



"The area around a sunspot photographed at Big Bear by B. LaBonte. Kodak S0424, a very high contrast, almost grainless emulsion was used. The granulation is unchanged up to the boundary of the spot. This picture has been dodged to show both spot and photosphere." [From *Astrophysics of the Sun*; Big Bear Solar Observatory]