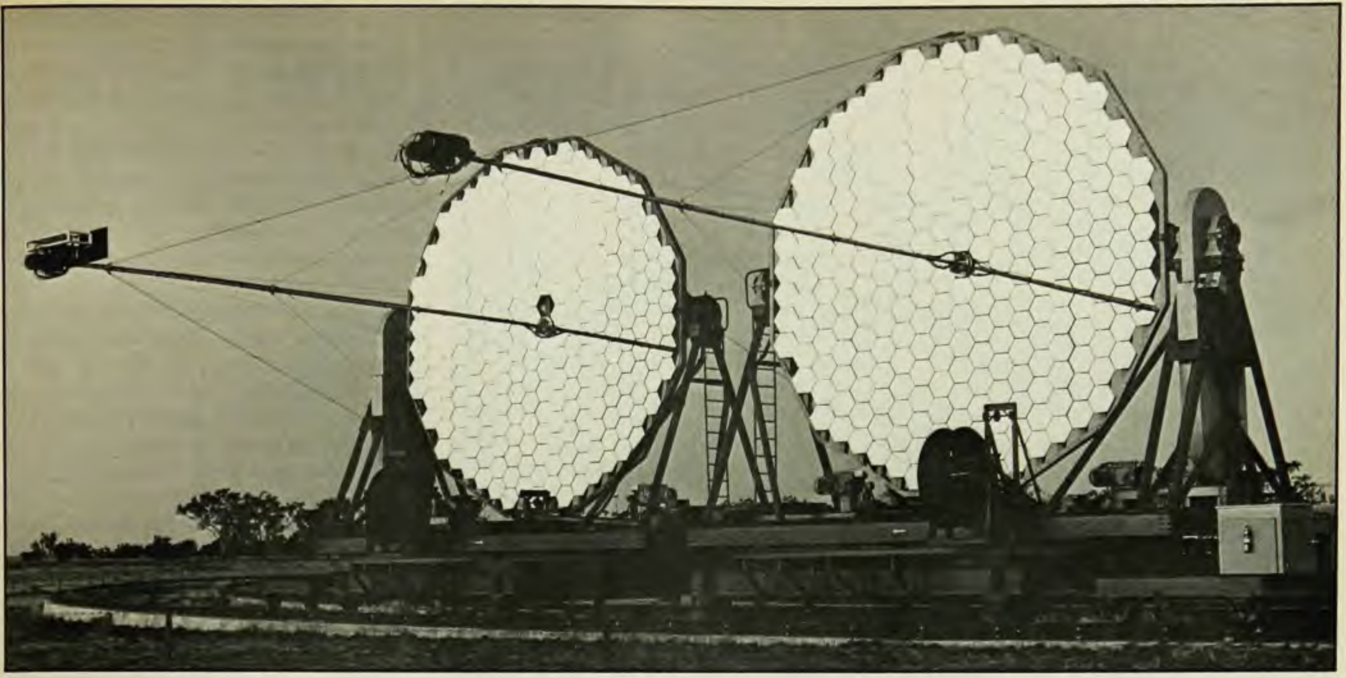
PHOTO BY R. HANBURY BROWN



rors are moved farther and farther apart, the time average of the product of the two intensities decreases, tracing out the second-order spatial correlation function of the light from the star arriving at the Earth. Since the correlation function is the square of the Fourier transform of the star's angular brightness distribution, the intensity interferometer measures stellar angular diameters. It embodies the present limit of Man's ability to measure astronomical angles, an ability that stretches from the 0.2-milliradian capability of the naked eye to the ultimate 0.5-nanoradian uncertainty of this unique instrument.

Robert Hanbury Brown helped to establish the field now known as "quantum optics" by his theoretical analysis and measurements on the correlation between the output of the two square-law detectors, both sampling the same beam of radiation. The early opposition was considerable; two separate experimental groups "proved" that it could not be done. By 1957 the correlation had been seen both between the multiplied detector currents and between individual photon events from two detectors, and the controversy switched to whether second-order correlation required a quantum mechanical description or was a classical consequence of the chaotic radiation field being a Gaussian stochastic process. The resolution of the problem helped to emphasize the power and convenience of the coherent states of the quantized electromagnetic field.

Hanbury Brown's book is a superb description of the conception, theory, design, construction, testing and use of the stellar intensity interferometer at Narrabri. Astronomers will find here a list of the angular diameters of 32 stars that have been measured between 1965 and 1972, along with the actual radii, temperature, and emitted flux of a smaller number of stars for which auxiliary data are available. The instrument discovered several new double stars for which it can provide the individual angular diameters, brightness ratios, and angular separations. Analysis of the data from Spica is the most complete, filling a full page with axis angles, orbit shape, period, sense of rotation, and, in combination with spectroscopic data, the distance, absolute magnitude, mass, radius, surface gravity and temperature of each constituent of this binary system whose maximum separation is less than 3×10^{-3} seconds of arc. The angular-diameter data are supported by a complete description of the parameters of the instrument, data-taking conditions, corrections and uncertainties that sets a high standard for the reporting of experimental results.

Here too are the experimental problems, from drifting electronic correlators to yellow-throated miner birds pecking at the mirror surfaces, together with the experimental philosophy and skill that led to their solution. (The bird problem was solved in an ecologically efficient way.)

Those interested in quantum optics, partial coherence, and signal processing will find a clear classical description of intensity interferometry, an application of second-order spatial correlation in which optical path lengths (including the effects of atmospheric scintillation) must be held constant only within millimeters rather than within the 100 nanometers or so required of conventional interferometers. Several chapters are devoted to the theory of partially coherent light and to its application to first- and second-order interferometry.

This book is the record of a body of work that has contributed to our knowledge of the electromagnetic field and of the diameter of stars. It will be a long-lasting addition to the literature of physics and astronomy.

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Crystal Chemistry of Non-Metallic Materials Vol. 4: The Major Ternary Structural Families

O. Muller, R. Roy
487 pp. Springer-Verlag, New York, 1974. $31.20

This book is volume four of a series edited by R. Roy and is concerned with the crystal chemistry of nonmetallic materials. Unfortunately, volume 1 (R. Roy and R. E. Newnham, *Principles of Crystal Chemistry*), volume 2 (R. E. Newnham, *Properties of Solids in Relation to Structure*), and volume 3 (O. Muller and R. Roy, *The Major Binary Structural Families*) are still in preparation, so that I am unable to discuss this volume in the context of the series. The authors hope that this series will serve as textbooks and reference volumes for graduate students mainly in materials science, ceramics and geochemistry and for practicing materials researchers.

The approach taken by the authors is to discuss the structures, interrelationships between structure and crystal-chemical aspects of ordered ternary nonmetallic materials within the context of several major compositional families, namely, A_2BX_4, ABX_4 and ABX_3. The physical properties of these materials, which are in many cases of considerable technological importance, are not discussed in this volume. Perhaps such information will appear in volume 2. The final chapter (chapter 5) discusses other ternary structural families in the form of a table three pages long, which does not do justice to some phases (ABX_2 chalcopyrite phases, for example) and completely omits phases of stoichiometry A_3BX_4, AB_2X_3 and A_2BX_3.

Nevertheless, the book is encyclopedic and herein lies its value. It contains a wealth of structural information (lattice constants and other significant structural information), information pertaining to phase transitions and temperature, pressure, compositional ranges of stability, and the role of ionic size in determining phase stability for literally hundreds of phases belonging to the above compositional groupings. Much of the structural information is in the form of tables which comprise about one-half of the book. The formula and subject indexes are quite extensive and easy to use. The referencing is also extensive, although the latest references date only to 1971.

In summary, this volume is primarily bibliographical and will serve as a very useful source of factual information and guide to the literature for the materials covered.

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Classical Dynamics: A Modern Perspective

E. C. G. Sudarshan, N. Mukunda
615 pp. Wiley, New York, 1974. $24.95

This is a very interesting book. But its subtitle should have been "A personal perspective." E. C. G. Sudarshan has made contributions to a variety of areas of theoretical physics, and he has usually brought his own touch to bear on them. One of his prevading mathematical favorites has long been the use of group theory. As a result, we have a book here whose principal perspective is that of Lie group theory and Lie algebras as applied to classical dynamics. The stimulus for such an approach is, of course, the quantum theory, and many things done here have direct analogues in quantum mechanics and in quantum-field theory. The authors explicitly state in their concluding chapter: "We have, in this book, presented classical mechanics as a consistent and closed discipline. We have taken some care in demonstrating the intimate relationship between some of the modern developments like the analysis of the Galilei and Poincaré groups and the fundamental concepts of mechanics. These discussions and expositions are within the classical framework. But much of the inspiration for these efforts came from discoveries and developments in quantum theory, even from particle theory."

An example of the influence of quantum mechanics is the discussion of direct analogues of the Heisenberg, Schrödinger and Dirac pictures in classical mechanics. The phase-space density function in one case is fixed in time and the dynamical variables of the particles vary; in the second case, the density function at a fixed phase-space point depends on the time; in the third case both vary as in the interaction picture. If this example is perhaps a bit of a *tour de force,* others are more natural.

The first quarter of the book consists of an exposition of classical mechanics from the Lagrangian and Hamiltonian points of view. The authors present the variational principles carefully, and there is an excellent and detailed chapter on systems with constraints. The remainder of the book deals with groups and their applications to classical mechanics. Topological groups, Lie groups and Lie algebras are introduced and discussed at length, and so are their realizations as transformation groups. From the classical point of view the theory of group representations is, of course, much less important than it is in quantum mechanics. So there is little attention to representation theory here. However, about 65 pages are spent on the three-dimensional rotation and Euclidean groups, 70 pages on the Galilei group, and 120 pages on the Poincaré group and manifest covariance.

I said at the beginning that this is a very interesting and personal book. It is also, in some respects a rather peculiar one. Perhaps the two characteristics go together. There are practically no references, even when names of relatively recent authors are mentioned. And the price for "perspective" is omissions of some things one might have expected to be included. There is no mention of Emmy Noether. If that is too much to be expected, then how about the "little group" in the long chapter on the Poincaré group? That does not appear anywhere, either. Action-and-angle variables are never mentioned. The most astonishing omission, however, occurs in the discussion of canonical transformations. The view of the time development of a system as a continuously unfolding canonical transformation is, as one would expect, very congenial to the authors. In the course of this discussion they write down what amounts to a Hamilton–Jacobi equation, but there is no mention of those names.

It is clear that this is not a textbook for a graduate course in classical mechanics to compete with H. Goldstein's *Classical Mechanics* (Addison-Wesley, 1965) or Emil Konopinski's *Classical Descriptions of Motion* (W. H. Freeman, 1969). There are no problems, either given or worked out, and no guide to any further literature. On the other hand, I think that as a supplement it could be extremely useful for such a course, or to be read by a PhD or a graduate student after a thorough exposure to quantum mechanics.

The principal attraction of this book is that it is, as the authors say in their preface, "the public declaration of an 'affair of the heart' . . . If true beauty implies that she is ever new, then classical dynamics is truly beautiful. And . . . this book is an offering to this ever new, ever beautiful object of our love." If some of this passion for a subject sometimes treated too drily is communicated to the reader he will profit by it.

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Physics of Solar Cosmic Rays

K. Sakurai
428 pp. U. of Tokyo Press, 1974. $39.50

The study of solar cosmic rays is a good example of interdisciplinary research in contemporary physics. The active investigator in this field must be conversant with such diverse areas as the physics and morphology of the solar atmosphere, radiative transfer (extending across the spectrum from radio to x-rays, the physical mechanisms responsible for solar radio bursts and nuclear interactions between solar cosmic rays and the atmospheres of the Sun and the Earth. One might therefore anticipate that the story of the development of our current knowledge and understanding of solar cosmic rays would represent exciting reading to a wide range of physicists. K. Sakurai is to be complimented for attempting to bring such a diverse and extensive body of knowledge into one place.

But it is my feeling that Sakurai has not succeeded in describing the physics of solar cosmic rays in a manner that will appeal to the potentially broad readership that the field deserves. For the most part, he has chosen to present his material in the form of a scientific review paper, relying on extensive refer-