the book is well sectioned. On page 118, equation (8.3) concerning Parker's isothermal solar wind model, the first term on the right-hand side should read $4\Theta 1n(\gamma_0/\gamma)$. The dates on which the manuscripts of one or two of the papers in Part 2 were originally received are missing. Spelling errors are few.

The aforementioned reservations aside, Hillas does present us with what is for the most part a highly readable account of cosmic rays since their discovery, which would well appeal (as we are told on the dust-jacket) to undergraduates and postgraduates in physics and space science, and also to the non-specialist wishing to gain an insight to the background of this branch of physics. And the reader will be amused, I am sure, by the delightful numerical magic performed on page 107 in which it is shown (with gross approximations and Ginzburg's astrophysical relationship that $10 \doteqdot 1$ (!)) that supernovae energy production in the galactic disk $= 10^{40.2\pm0.5}$ erg sec^{-1}, and (by all good fortune) the energy input required by cosmic rays $= 10^{41.2\pm0.5}$ erg sec^{-1}. From this it is concluded that supernovae can quite feasibly supply the energy (or at worst a few per cent of it) required by cosmic rays!

As a well-known cosmologist once said, "What are a few powers of ten amongst friends?"

S. G. SYKES

Light Scattering Functions for Small Particles (With Applications In Astronomy). By N. C. Wickramasinghe. Adam Hilger, London, 1973. 506 pp. £12·00

During the past ten years Professor Chandra Wickramasinghe has made an impressive attack on problems concerning the interstellar medium. In particular he has made important contributions towards an understanding of the properties of interstellar grains. Astronomers have known of the existence of dust in the Milky Way for many decades. The dust obscures the light from distant stars, giving the superficial impression of voids in the background star fields; this effect is especially noticeable in photographs taken in the direction of the galactic centre. Other evidence for the existence of dust comes from studies of interstellar polarization and the diffuse galactic light.

What interests the astrophysicist is how this dust interacts with radiation: in this way the properties of the grains might be revealed and a deeper understanding of interstellar extinction result. Central to any profound discussion of the behaviour of the grains in deep space are calculations of the light-scattering properties of small particles. In his preface the author remarks that the need for a set of tables giving the light-scattering properties of spherical and cylindrical grains is now widely felt in astronomy, thus the major part (470 pages) of this book consists of computer output giving data for a diversity of particle properties.

Clearly this book is intended as archival material for major astronomical libraries. Fortunately it is a very high-quality book that will stand several decades on the main shelves. My only criticism concerns the wisdom of setting down such extensive tabular material on a printed page. Would it not have been cheaper, more sensible, and perhaps more convenient to put the tables on standard microfilm?

SIMON MITTON

Interplanetary Flight and Communication. By N. A. Rynin. Translated from the Russian. Superintendent of Documents, Government Printing Office, Washington D.C. 20402, and National Technical Information Service, Springfield, Va. 22151 U.S.A. Paperback; vol. I, no. 1, \$3·00; vol. I, no. 2, \$3·00; vol. I, no. 3, \$3·00 vol. II, no. 4, no price; vol. II, no. 5, \$3·00; vol. II, no. 6, no price; vol. III nos. 7, 8 and 9, no price.

Until the Russian launch of the first Sputnik in October 1957 during the IGY, the scientific world as a whole had looked askance at rocket technology, feeling primarily

that it held no promise for them. But before Sputnik I had been in orbit for long, most astronomers and geophysicists realized that here was a new research technique that could provide answers to a host of intractable questions, although even then proposals for automated exploration of the solar system were not taken too seriously and any idea of manned exploration was looked upon still more as science fiction than sober fact. Now no serious astronomer can seriously doubt the value of space probes—they have extended the range of observable radiation and brought a whole new dimension into astronomical research—nevertheless, on looking back one is tempted to see the advent of space research as a bolt out of the blue: in mid-1957 there was none, by the end of the year a start had been made and the potentialities of a new observational technique with overtones of experimental investigations at least into the solar system could be discussed as a real possibility. Sixteen years later the situation has developed in a way that even the most sanguine dared not hope. Yet what we have witnessed is a culmination of a vast amount of effort going back well before the beginning of the century—effort that was at first the province of a few enthusiasts. And enthusiastic indeed they had to be, for they faced the most immense and discouraging technical and theoretical difficulties, and a book dealing with the general history of rocketry and space travel and mentioning these difficulties, was reviewed in these pages five years ago [*Journal*, **78** (4), 325 (1968)]. But this was a history compiled after the launch of Sputnik I and with manned space exploration already a reality. A much earlier history, recording the hopes and ideas of the pioneers long before these had become a reality, had been compiled by N. A. Rynin and published in Leningrad between 1928 and 1932; but it was in Russian, had only a small printing, and was generally unavailable to the West. Now NASA have had this translated by the Isreal Programme for Scientific Translations—a body expert in translating Russian scientific works into English—and the whole of Rynin's text is thus available in English at what seems to be an almost nominal price in nine paperback volumes.

This is an important history that is itself of historical significance, and NASA are to be congratulated on the foresight to do this, and the wisdom to give us an unexpurgated edition that contains Rynin's useful and interesting first book dealing with "Dreams, Legends, and Early Fantasies" about space exploration (the Russian phrase "Interplanetary Communications" means what we should call 'space exploration'), and in volume I, part 2, with his review of science fiction concerned with space travel and exploration. In the third part (volume I, part 3) we have Rynin's observations on "radiant energy" in practice and in fiction as a power source, and a means of communication between Earth and space vehicle. This part also contains an interesting note (page 128) on the possible uses of atomic energy, and this in 1931. Volume II (part 4 of the series) deals with rocketry and the next part (volume II, part 5) with the theory of rocket propulsion; both parts treat their subject mathematically. Another part (volume III, part 6) is concerned with "Superaviation and Superartillery" and is historically significant because, of course, it was the military potential of rockets that persuaded western governments to develop them to a stage that made space research practicable. It is significant, too, because Rynin was joint founder of the Leningrad Group for the Study of Reaction Motion under Stalin's administration. Volume III, part 7, of the whole work is a biographical volume devoted to Konstantin Tsiolkovskii, the father of rocketry and space travel, which includes some autobiographical notes, volume III (part 8) is on the theory of space flight, and, finally (volume III, part 9), the theory of astro-navigation is discussed, and accompanied by a very full bibliography, as well as an index to all nine parts.

Russian histories of science are not always without some national bias, but in the days when Rynin was writing the pioneers of space exploration had a supra-national outlook, and he does not fail to mention the work of others besides the Russians. Some of the illustrations are poor, but they are copies, not originals, and we cannot expect more, but none detracts from the significance of the text. This is an important

history—especially so considering when it was written—and one that those interested in space research will find well worth while: it is certainly significant enough for institution libraries at least to buy complete and so take advantage of a valuable example of NASA's responsible attitude to the history of a notable aspect of modern technology that is vital to astronomy today.

COLIN A. RONAN

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