ABOVE THE ATMOSPHERE

Telescopes in Space

By Z. Kopal. Pp. 140+35 plates. (London: Faber and Faber, Ltd, 1968.) 50*s*. net.

"TWINKLE, twinkle little star" runs the nursery rhyme, and this is also precisely the trouble with ground-based telescopes. Fluctuations in the refractive index of the atmosphere, caused by turbulence, make star images dance about at the focus of the telescope. This problem did not become important until the end of the nineteenth century—hitherto optical and mechanical imperfections in the telescopes themselves limited their performance. But as technology advanced, astronomers began to move from urban observatories to search for places where the seeing conditions were better. The establishment of observatories on mountains eased the problem, but the only way to surmount it entirely is to take telescopes into space.

This is the theme of Professor Kopal's book. He briefly describes the development of telescopes from Galileo's time, through the dinosaurian age of telescopes when the curvature of the objective lens was small and the focal length long—an attempt to reduce the effects of chromatic aberration, to the development of the modern reflector. It is these instruments which suffer so much from bad seeing; according to Professor Kopal, the image of a point source of light produced by a perfect 200 in. mirror should theoretically be 0·33″ of arc across, but in fact the Mount Palomar 200 in. seldom produces an image less than 0·5″ of arc across, chiefly because of bad viewing conditions. The larger part of the book is concerned with successful—and some unsuccessful—attempts to take astronomical instruments above the atmosphere, by balloon, rocket and satellite.

There are a number of advantages in having telescopes in space, apart from the important one of getting above the turbulence. The atmosphere makes it impossible to observe stars in the daytime, a result of the scattering of light by air molecules. From space, stars will be visible even when the Sun is in the sky. And it is well known that the atmosphere is opaque to large parts of the spectrum, which also contain information about astronomical objects.

Professor Kopal lists the achievements so far of astronomical satellites, and his book includes a chapter on lunar and planetary probes. There are thirty-five plates, which include some of the historic photographs of the Moon and Mars taken by spacecraft.

Perhaps the most interesting part of the book is devoted to prospects for the future. Here Professor Kopal is in a unique position, as he is astronomical adviser to the Boeing Space Research Laboratories, who have carried out design work on an orbiting 120 in. telescope, described here in some detail.

Briefly, *Telescopes in Space* provides a readable account of developments so far, and an insight into what may be expected in the future. EDWARD PHILLIPS

SOIL STUDIES WITH ISOTOPES

Isotope and Radiation Techniques in Soil Physics and Irrigation Studies

(Proceedings of a Symposium jointly organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, Istanbul, June 12–16, 1967.) Pp. 444. (Vienna: International Atomic Energy Agency; London: HM Stationery Office, 1967.) 233 schillings; 63*s*. 6*d*.; $9.

RADIOACTIVE isotopes and the radiations which emanate from them have been used in soil studies in three different ways. First, the density of solid matter and the content of water may be determined by measuring the attenuation of a collimated beam of emanation, usually gamma radiation but sometimes neutrons, which traverses a column of soil material between a source and an aligned detector. Second, the content of soil water may be determined on site by the neutron probe method, which relies on the particular efficacy of the hydrogen atom in slowing fast neutrons by successive elastic collision until they come into thermal equilibrium with the soil. The steady state distribution is nearer the probe which contains the source when the soil is wetter, so that a slow neutron detector mounted on the probe provides a count rate which depends on the moisture content of the soil. A similar probe with a source of gamma radiation instead of, or in conjunction with, a source of fast neutrons, may be used to determine soil density, as well as moisture content, by measurement of the back scatter. Third, one may use isotopes in solution or combined chemically in structures as tracers to discover the path of particles which they label, whether of water, dissolved ions, or of minerals, usually clay minerals.

Papers are presented on all of these topics, and the terms of reference are even strained to include the use of steam from nuclear reactors for the desalination of water. The proceedings are divided into five sections dealing respectively with equipment and procedure; soil water content and the soil moisture profile; soil water movement; the interaction between soil, vegetation and water; and desalination of water for agriculture. Among the most valuable contributions are comparisons between the performance of certain commercially available probes and moisture meters, and among the more disturbing features is a difference of evidence and opinion, after twenty years of development and experience, as to whether the dry density of the soil has an influence on the calibration curve of the neutron meter.

The value of these methods of measuring soil water content lies in the fact that destructive sampling of the site, unavoidable in gravimetric methods, is avoided, so that continuous measurement at the same site is possible, with a consequent reduction of errors due to soil variation from point to point, and with much saving of time. It is natural therefore that the bulk of sections 2 to 4 is devoted to an extension of hydrological and agricultural empirical studies, such as the succession of soil water profiles in the hydrological cycle and the response of crops to the soil water environment, of a kind already familiar before the advent of the new tools. One or two papers deal with relatively new topics, such as the linear dispersion of dissolved ions and the combined passage and uptake of water and nutrients. E. C. CHILDS

ANOTHER ADVANCE

Advances in Nuclear Physics

Vol. 1. Edited by Michel Baranger and Erich Vogt. Pp. xiv+416. (New York: Plenum Press, 1968.) $18.50.

THIS is the first volume in a series which is intended to provide regular reviews of topics in nuclear physics. It is intended to choose topics which range over the entire field of nuclear physics and to present in each article a discussion of the physical basis of the subject rather than a review of recent results. The series is to be aimed at a wide audience, including research students, and the approach is to be essentially pedagogical.

The first volume contains two articles which can be classified roughly as falling in the field of nuclear structure. These are the articles by M. Harvey on the nuclear SU_3 model and by G. Ripka on the Hartree–Fock theory of deformed light nuclei. In the field of scattering theory and nuclear reactions there are three articles: one by E. Vogt on the statistical theory of nuclear reactions, one by I. Duck on recent work in the non-relativistic theory of three-particle scattering, and one by J. de Boer and J.