Book Reviews

Monopoles

Magnetic Monopoles. RICHARD A. CARRIGAN, JR., and W. PETER TROWER, Eds. Plenum, New York, 1983. x, 337 pp., illus. $47.50. NATO Advanced Science Institutes Series B, vol. 102. From an institute, Wingspread, Wis., Oct. 1982.

The last few years have seen an upsurge in interest in magnetic monopoles, triggered in part by the observation of a candidate monopole event by Cabrera and by the discovery of Rubakov and Callan that the decay of protons predicted in grand unified theories can be catalyzed by magnetic monopoles. This book consists of the proceedings of a meeting held to survey the status of magnetic monopoles. The papers are divided roughly equally in number between theory and experiment. The theoretical papers emphasize the properties of monopoles that are relevant to their possible detection rather than the more mathematical aspects of monopole theory.

Among the theoretical topics considered are monopole abundance, bounds on the flux of monopoles, energy loss of slow monopoles, and monopole catalysis of nucleon decay. Lazarides presents a critical review of various mechanisms that have been proposed to reduce the monopole abundance that arises when grand unified theories are combined with the standard big bang cosmology but that is incompatible with present observation by 14 orders of magnitude. Guth discusses one particularly attractive such mechanism—the inflationary cosmology. By assuming that the universe went through a period of exponential expansion, he is able not only to reduce the number of monopoles in the observable universe essentially to zero but to solve other cosmological conundrums involving the observed flatness and large-scale homogeneity of the universe as well. Purcell, Turner, and Wasserman discuss the astrophysical implications of magnetic monopoles. Turner reviews the Parker limit on the monopole flux that follows from the destruction of the galactic magnetic field by an incoming flux of monopoles. Purcell presents a similar limit that uses the observed structure of a portion of the galactic disk. These limits are roughly five orders of magnitude smaller than would be needed to explain Cabrera's candidate event. Two possibilities for reconciling these limits with Cabrera's event are analyzed by Turner and Wasserman. Turner analyzes the possibility that the local flux in the solar system is much larger than the galactic flux and concludes that this is unlikely. Wasserman considers the possibility that the galactic magnetic field is caused by a galactic halo of magnetic monopoles and concludes that there are also severe difficulties with this scenario. Turner also discusses a speculative and particularly stringent bound that depends on the catalysis of nucleon decay by monopoles trapped in neutron stars. More theoretical aspects of monopole theory are discussed in papers by Callan and Preskill. Callan discusses the physical mechanisms responsible for monopole catalysis of nucleon decay and argues that the cross section for this process should be a typical strong-interaction cross section. Motivated by an attempt to reconcile Cabrera's event with the possible existence of fractional charge, Preskill discusses the generalization of the Dirac quantization condition to include strong interactions or other possible interactions.

The experimental papers discuss the relative merits of induction and ionization experiments as well as attempts to increase the sensitivity of the experiments. Cabrera discusses a method of detecting magnetic monopoles that involves looking for the change in current induced in a superconducting coil by the passage of a monopole. This technique does not depend on the monopole mass, velocity, or energy loss and can therefore be used without additional assumptions about the structure of monopoles. The elegance of this experiment makes it clear why Cabrera's candidate event deserves serious consideration. However, as Cabrera points out, spurious causes, such as mechanical disturbances, cannot be completely ruled out. In order to reach the Parker flux limit larger-area detectors are required. This subject is addressed by Tsuei, who discusses preliminary investigations of non-superconducting induction experiments and by Barish, who discusses the possibility of detecting an acoustic signal as a monopole passes through a conductor. Calculations of the energy loss of slow monopoles have been surrounded by controversy and are crucial to the design of large-scale experiments to detect monopoles. An excellent discussion of monopole energy loss by Ahlen should clear up various conflicting calculations and provide a basis for further refinements. As is discussed by Loh, existing cosmic-ray detectors and nucleon-decay experiments already provide stringent limits on the monopole flux that are only two orders of magnitude larger than the Parker flux. Other monopole searches described here involve searches in iron ore (Cline) as well as searches for low-mass monopoles using track-etch detectors (Price) or the proton-antiproton collider (Musset *et al.*).

This is a timely book that contains papers of above average interest. It should provide both useful reference for workers in the field and an introduction to current topics in monopole physics for interested astrophysicists and particle physicists.

JEFFREY A. HARVEY
Department of Physics,
Princeton University,
Princeton, New Jersey 08544

Solar Physics

Weather and Climate Responses to Solar Variations. BILLY M. MCCORMAC, Ed. Colorado Associated University Press, Boulder, 1983. x, 626 pp., illus. $29.50. From a symposium, Boulder, Colo., Aug. 1982.

This volume contains the proceedings and a digest of conclusions from the second international symposium on sun-weather relationships. Fifty-two invited papers and contributions range over such topics as the recent extremely accurate "solar constant" measurements from Solar Maximum Mission spacecraft, solar ultraviolet variations, solar modulation of cosmic rays, sun-climate modeling, global electric circuits in the atmosphere, and cycles of all sorts, including those recorded in weather archives, tree rings, and geologic varves. Sorting out the grain from the chaff is an overwhelming task.

I recall the first sun-weather symposium, in 1978, as a relatively freewheel-

ing affair. Much was made of the remarkable coincidence between the orbital period of Jupiter and the 11-year activity cycle. The 22-year drought cycle found for the western states was held up repeatedly as firm evidence for the reality of a sun-weather effect. Frankly I was most strongly impressed by an East Coast forecaster who made a living predicting local weather; his most important input was sunspot number, and his success rate was reputed to be superior to that of the U.S. Weather Bureau.

Four years later comes this second symposium. The discipline is said to have matured, a somewhat dour National Academy report having stressed the need for the discovery of physical mechanisms and this being a symposium theme. And, the active cavity radiometer on the Solar Maximum satellite had actually detected a diminution of the solar irradiance accompanying the transit of large sunspots in 1980, an attainment of significance in understanding past solar constant work.

Sun-weather (or sun-climate) studies remain controversial. A symposium is a proper forum for voicing disparate views, and this symposium provided such a forum. As a result the depth, applicability, and scholarly content of the papers vary enormously.

One contribution that notably spurs imagination comes from an unlikely source, a prospecting geologist with the Broken Hill Mining Company in Australia. George Williams has possibly discovered the signature of the solar cycle in a Precambrian "varved" deposit approximately 680 $\times$ 10^6 years old. These rocks are strikingly layered in (assumed annual) widths of 11, 22, 145, and 290 years. A 20,000-year record is available. If Williams's interpretation is correct, the solar cycle has changed little in the intervening one-tenth of the age of the universe. We may wonder why solar activity back then so clearly modulated conditions on the earth when it seems not to now.

The subject of the relationship of solar events and electric fields receives a fair amount of attention, but a panel discussion on the subject fractures any ideas gained from the individual presentations.

This book is recommended for anyone whose interest is tweaked by the idea of a sun-weather connection. A number of papers are fascinating. I recommend that the reader begin with overviews by Eddy and McCormac and then pick and choose to his or her own satisfaction.

W. C. LIVINGSTON
Kitt Peak National Observatory, Tucson, Arizona 85726

Tropical Biology

Costa Rican Natural History. DANIEL H. JANZEN, Ed. University of Chicago Press, Chicago, 1983. xii, 816 pp., illus. $50; paper, $30.

This book consists of six sections, on agricultural organisms, plants, herpetofauna, mammals, birds, and insects respectively, each with numerous short essays on species that were considered interesting, important, or representative, prefaced by a general introduction for the group concerned. It opens with five background chapters.

As Dryden said of the *Canterbury Tales*, so also in this book, "here is God's plenty." Just as Chaucer described a cross section of English humankind in all its marvelous diversity, so the short essays that make up the meat of this book describe, with singular eloquence, a cross section of the stunning variety of life to be found in Costa Rica. The bane of most compendia is here a virtue: the variety of voices and viewpoints describing these plants and animals adds greatly to the power of the book.

Unfortunately, the prologue to this remarkable collection is quite unworthy of it. The first chapter, on the development of natural history in Costa Rica, opens with a caricature of Spain that

"Small adult *Sus scrofa* exhibiting escape behavior. Potrerillos, Guanacaste, Costa Rica." [Photo, D. H. Janzen; from *Costa Rican Natural History*]

"*Dasypus novemcinctus*, adult male at peak of characteristic leap-hop used to escape the grasp of a potential predator. March 1980, Santa Rosa National Park, Costa Rica." [Photo, D. H. Janzen; from *Costa Rican Natural History*]