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.

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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-