Magnetic Monopole Reconsidered: Another Interpretation

On 14 August, those physicists who had not already heard it by the grapevine were startled to hear in a press conference that a long-sought fundamental particle—a magnetic monopole—may have been detected in a cosmic ray experiment. The account of the discovery (described by some as the discovery of the century) was published shortly thereafter. Since then, the putative monopole has run into tough sledding, and many physicists now believe that publication was premature.

A team headed by P. Buford Price of the University of California at Berkeley and W. Zack Osborne of the University of Houston, using a detector array consisting of a Cerenkov fast film detector, nuclear emulsions, and sheets of Lexan plastic, discovered a single track which was apparently made by a magnetic monopole (*Science*, 5 September, p. 778). The monopole's magnetic charge, as measured, was 137 times as strong as the electric charge of an electron (in accordance with theory), and because the monopole passed cleanly through the detector stack, its mass was set at 200 times that of a proton or greater.

According to the rules of the game played by particle physicists, however, when a new particle is announced, not only must the data be explainable in terms of the new particle, but it must not be explained by any more conventional entity. A number of scientists now say that the track observed in the detector stack could have been made, with a small but nonnegligible probability, by a high atomic number nucleus interacting with the Lexan in such a way as to mimic a monopole. And, to compound matters, the rapid publication of the monopole discovery seems to have resulted in some inaccuracies and omissions in the initial report which have somewhat reduced the credibility of the report by Price, Osborne, and their associates.

At issue is the interpretation of the track in two of the three elements of the detector. Near the top of the stack was the Cerenkov fast film detector. The lack of a Cerenkov image in the film set an upper limit to the particle velocity of 0.68 c, where c is the speed of light; and few physicists seem inclined to dispute this result. The nuclear emulsion lying beneath the Cerenkov detector in the stack fixed the velocity at between 0.45 c and 0.6 c, with the most likely value being 0.5 c. While this determination is itself highly controversial, the proposed alternative to the monopole is based on the track in the Lexan plastic.

An electrically charged particle traveling through the Lexan leaves a wake of damaged material. Using an etching technique pioneered by Price, experimenters can quantitatively analyze the damage to obtain the charge and velocity of the particle. A particle with a velocity of only 0.5 c should have been readily stopped by the Lexan and should have caused increasing damage as it slowed down. Instead, the particle was not stopped, and the track indicated uniform damage, an indication of a monopole.

Armed with preprints, the monopole discoverers journeyed to Munich during the second half of August to present their results to the 14th International Conference on Cosmic Rays with the intention of stimulating as much discussion as possible. Peter Fowler of the University of Bristol in England took on the role of the principal antagonist to the monopole.

Fowler proposed that a fair statistical fit to the Lexan etch rate data could be obtained by assuming that the incoming particle was a platinum nucleus (with an atomic number of 78) and that, during its travel through the Lexan, the platinum nucleus twice interacted with atoms in the plastic. The first interaction caused a loss of two charge units and transformed the platinum into an osmium nucleus. The second interaction caused a loss of three more charges and resulted in a tantalum nucleus. This loss of charge would compensate for the particle's slowing down, resulting in approximately uniform damage along the track.

Particle Velocity Uncertain

Furthermore, according to Fowler's model for the bottlebrush-like track left by a charged particle passing through a nuclear emulsion, an observer could not distinguish between particles going faster than about 0.45 c. Thus, said Fowler, the velocity of the particle making the "monopole" track could not be specified beyond saying it was more than 0.45 c. With this relaxation on the particle velocity, the probability of a platinum nucleus suffering two interactions of the type needed to make the observed track in the Lexan and getting through the stack without being stopped becomes too high to be disregarded.

The weight accorded this proposal, due to Fowler's stature as a leading authority in heavy cosmic ray tracks, is such that many cosmic ray physicists are now skeptical of the monopole.

Substantially the same argument as Fowler's was presented independently (and subsequently widely publicized in the press) by Luis Alvarez of the University of California's Lawrence Berkeley Laboratory when he addressed a meeting on Lepton and Photon Interactions at High Energies held at the Stanford Linear Accelerator Center in late August. However, Alvarez added the finding that the thickness of the detector material above the Lexan sheets was about 33 percent less than originally reported, thus making it much more likely that a relatively slowly moving particle could penetrate all the way through the detector array without being stopped.

The crucial issue still to be decided is how reliable the particle velocity measured by the nuclear emulsion is. If one could establish the velocity at 0.5 c with a small uncertainty, the interacting nucleus interpretation of the data would be virtually eliminated as viable. Osborne and Lawrence S. Pinsky at Houston are now gearing up to do a computerized study of tracks left by heavy cosmic rays (including platinum nuclei) and by the putative monopole in order to verify and calibrate the model they use in analyzing tracks in the emulsion. According to their model, the velocity of particles traveling faster than 0.45 c can in fact be distinguished. Fowler will also engage in a similar study in cooperation with the Houston scientists, and they will exchange and compare data. But results are at least 2 months away.

Meanwhile, at Berkeley, Price and Edward K. Shirk are in the process of analyzing some sheets of Lexan that were not previously etched. These sheets from the top and bottom of the detector may also help determine the outcome of the velocity issue; but, more importantly, they will determine how well the interacting nucleus model can fit all the Lexan data.

Although the importance of the "missing" detector material discovered by Alvarez is still in dispute, this revelation combined with uncertainties in the particle charge as obtained from the Lexan analysis, the absence of published data on Osborne's nuclear emulsion track model, and the failure of the investigators to quantitatively evaluate the interacting nucleus alternative before publishing has had a negative impact on some scientists.

As it turned out, from the discovery of the monopole track on 21 July, it was only 2 weeks until the paper was submitted for publication. In retrospect, Price acknowledges, a preferred course of action would have been to delay publication until some of these questions could have been more fully addressed. Early publication was forced in part by an enterprising newspaper reporter's early discovery of the monopole story and by a desire to encourage discussion at the cosmic ray meeting. Price says his group is prepared to take its lumps now in the belief that the data will justify them in the end.

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