MAGNETIC MONOPOLE SEARCHES

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"At the present time (1975) there is no experimental evidence for the existence of magnetic charges or monopoles, but chiefly because of an early, brilliant theoretical argument by Dirac, the search for monopoles is renewed whenever a new energy region is opened up in high energy physics or a new source of matter, such as rocks from the moon, becomes available [1]." Dirac argued that a monopole anywhere in the universe results in electric charge quantization everywhere, and leads to the prediction of a least magnetic charge $G = e/2\alpha$, the Dirac charge [2]. Recently monopoles have become indispensable in many gauge theories, which endow them with a variety of extraordinarily large masses. The discovery by a candidate event in a single superconducting loop in 1982 [6] stimulated an enormous experimental effort to search for supermassive magnetic monopoles [3,4,5].

Monopole detectors have predominantly used either induction or ionization. Induction experiments measure the monopole magnetic charge and are independent of monopole electric charge, mass, and velocity. Monopole candidate events in single semiconductor loops [6,7] have been detected by this method, but no two-loop coincidence has been observed. Ionization experiments rely on a magnetic charge producing more ionization than an electrical charge with the same velocity. In the case of supermassive monopoles, time-of-flight measurements indicating $v \ll c$ has also been a frequently sought signature.

Cosmic rays are the most likely source of massive monopoles, since accelerator energies are insufficient to produce them. Evidence for such monopoles may also be obtained from astrophysical observations.

Jackson's 1975 assessment remains true. The search is somewhat abated by the lack of success in the 1980's and the decrease of interest in grand unified gauge theories.

References

1. J. D. Jackson, *Classical Electrodynamics*, 2nd edition (John Wiley & Sons, New York, 1975).

2. P.A.M. Dirac, Proc. Royal Soc. London **A133**, 60 (1931).
3. J. Preskill, Ann. Rev. Nucl. and Part. Sci. **34**, 461 (1984).
4. G. Giacomelli, La Rivista del Nuovo Cimento **7**, N. 12, 1 (1984).
5. Phys. Rep. **140**, 323 (1986).
6. B. Cabrera, Phys. Rev. Lett. **48**, 1378 (1982) [CABRERA 82].
7. A.D. Caplin *et al.*, Nature **321**, 402 (1986) [CAPLIN 86].