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Abstract

Dual Symmetry: Magnetic Monopoles in Theory and Experiment †

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The greater symmetry imparted to the Maxwell–Heaviside equations by the existence of magnetic charge was noted in the 19th Century, and the peculiar properties of magnetic charges were explored by Poincaré and Thomson; the heuristic value of magnetic charge had already been noted by Faraday. However, it was not until Dirac showed that magnetic charge was consistent with quantum mechanics in 1931 that the modern concept of magnetic charge was born. Dirac showed that a single magnetic charge in the universe would quantize all electric charges, in that the product of any electric charge e and any magnetic charge g must satisfy eg = n h c/4 pi. If a magnetic monopole exists, a Dirac "string" is associated with it, because the vector potential cannot be a single-valued regular function. The string is invisible; changing the orientation of the string is a singular gauge transformation. The quantization condition and the existence of the string renders perturbation theory untenable.

Since the time of Dirac, there have been many developments in the theory, and numerous dedicated searches made for magnetic monopoles both terrestrially and cosmically. Most unified gauge theories predict the existence of monopoles resulting from symmetry breaking; the mass of such monopoles is set by the symmetry-breaking scale. This talk will review some of the theoretical issues involved in the subject, and the status of the latest experiments, which have, to date, yielded no evidence for magnetic charge. We will also discuss recent "discoveries" of analogues to magnetic monopoles, and discuss the significance of these.