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Detection of the Dirac Monopole with Magnetic Levitation

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Recently it was suggested that an experiment by Mikhailov should be reproduced to confirm the existence of magnetic charge on ferromagnetic aerosols. At the present time, there is controversy about the results of Mikhailov's experiment in regard to a reanalysis by Akers. In this paper, an experiment is proposed to resolve the discrepancy between Mikhailov's earlier results and the latest value for the Dirac charge.

1. INTRODUCTION

In a recent paper (Akers, 1988), evidence was presented for the existence of a Dirac magnetic charge on ferromagnetic aerosols. The evidence was derived from a series of experiments conducted by Mikhailov (1983). These experiments are essentially the type of oil drop experiments performed by Millikan, but instead ferromagnetic particles are used. In addition, a magnetic field **H** is orthogonal to both the vertical electric field **E** and the gravitational field. Mikhailov studied 1198 ferromagnetic particles for observation of magnetic charge. In his calculations, Mikhailov found evidence for magnetic charge in multiples of $g=(1/2)(1/137)(1/3)e$. Akers (1988) argued that the analysis was incorrect and derived the Dirac charge $g=(137/2)e$ from Mikhailov's data.

Moreover, Mikhailov (1988a) has recalculated the ratio of magnetic charge to electric charge and finds multiples of $g=(137/2)e$ on the aerosol particles. On the other hand, Lochak (1989) has suggested that the earlier results are correct and cannot understand the discrepancy between the measurements.

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In this paper, I propose a new experiment of the type conducted by Millikan for the purpose of resolving the discrepancy between the results. In Section 2, a discussion of the experiment is presented. Concluding remarks are made in Section 3.

2. MAGNETIC LEVITATION

The physics of levitation involves the study of effects which allow a solid or liquid to remain suspended at a distance through force fields. In a review article, Brandt (1989) notes that the main problem of levitation is stability; that is, finding an equilibrium position for the levitated body. Stable levitation is the objective of materials scientists who search for ways to make new alloys by rapid solidification of suspended materials. However, these techniques can be utilized to observe the motions of charged particles, such as oil drops in the famous Millikan experiment or ferromagnetic particles in the experiments by Mikhailov (1983).

In Mikhailov's observations of magnetic charge on ferromagnetic particles, he subjected the suspended particles to electromagnetic fields with a time dependence of 1.5 Hz for **E** and of 3.0 Hz for **H**. Brandt (1989) indicates that oscillating electromagnetic fields of 60 Hz make it possible for levitation of conducting bodies by induced eddy currents. Therefore, it is possible that the motion of ferromagnetic particles in Mikhailov's experiments is due to induced eddy currents and not to the existence of magnetic charge. However, Mikhailov (1985, 1987) has shown in another series of experiments that the motions of the aerosols resemble particles carrying magnetic charge, not dipole moments from induced currents.

The possibility of induction currents generated inside the microparticles can be eliminated by levitation of the aerosols in a static magnetic field. Let a static magnetic field **H** be oriented vertical to the gravitational field as in Figure 1. The magnetic field can be generated by a coil with constant current. A particle carrying magnetic charge g will move upward against the force of gravity:

$$\mathbf{F} = g\mathbf{H} = m\mathbf{a} \tag{1}$$

In the experiments by Mikhailov (1983), the ferromagnetic particles were observed in an argon atmosphere under illumination from a He–Ne laser. Therefore, a particle would experience a force given by

$$g\mathbf{H} = (4/3)\pi r^3(\rho - \rho_a)\mathbf{a} \tag{2}$$

where ρ is the density of the particle and ρ_a is the density of the argon gas. **a** is the acceleration due to gravity and r is the radius of the particle.[3] By

[3]It should be noted that there is no evidence for sphericity of the aerosols in Mikhailov's experiments.

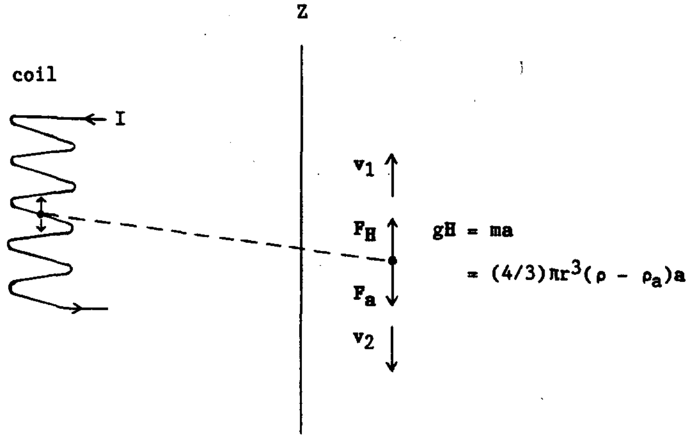

Fig. 1. A ferromagnetic particle is located in a magnetic field **H** generated by a coil with constant current *I*. The magnetic force $g\mathbf{H}$ balances the force of gravity $m\mathbf{a}$ for a position of stability. $\mathbf{v}_1$ and $\mathbf{v}_2$ are, respectively, the terminal velocities in the upward and downward directions. g is the magnitude of magnetic charge on the particle.

adjusting the strength of the magnetic field, one can observe the aerosols moving upward when the **H** field is greater than the force of gravity. Terminal velocities $\mathbf{v}_1$ upward and $\mathbf{v}_2$ downward can be measured to eliminate difficulties in finding a balance position. From Stokes' law, the frictional force on a particle is

$$\mathbf{F} = kr\mathbf{v} \tag{3}$$

and therefore the magnetic charge on a particle is

$$g = [3/4\pi(\rho - \rho_a)|\mathbf{a}|]^{1/2}(k^{3/2}/|\mathbf{H}|)(|\mathbf{v}_1| + |\mathbf{v}_2|)(|\mathbf{v}_2|)^{1/2} \tag{4}$$

The determination of magnetic charge on the ferromagnetic particles is measurable in this type of Millikan experiment. There is no possibility of eddy currents from a static magnetic field, and hence the interaction of the particles with the **H** field would be pure monopole in nature.

3. CONCLUSION

The detection of the Dirac magnetic charge would be a major discovery of science. Recently, evidence for magnetic charge was found in meson spectroscopy by Akers (1986, 1987). Mikhailov's claim for magnetic charge on ferromagnetic particles adds to this evidence. However, the evidence of Mikhailov's work needs to be reproduced by independent researchers. The proposed experiment of this paper will eliminate any discrepancy concerning the nature of the source (i.e., monopoles versus dipole moments).

Criticism of the proposed experiment can include possible corrections to Stokes' equation for the small diameter of the particles (Melissinos, 1966). The nonsphericity of the aerosols should be taken into consideration as well in determining their masses. In addition, it would be of interest to determine the effects of temperature on the viscosity of the gas and on the magnitude of the magnetic charge.

In a more recent experiment, Mikhailov (1988*b*) has studied the motion of ferromagnetic particles in a diffusion chamber with a magnetic field orthogonal to the gravitational field. Although the evidence looks very promising, these experiments need to be verified by other researchers. Moreover, theoretical calculations (Bracci and Fiorentini, 1983) indicate binding energies for monopoles to nuclei of the order of 10–100 keV. It would be interesting to note the effects of X-ray irradiation on the samples in question.

Finally, the results of these experiments will determine not only the magnitude for the magnetic charge, but also the relative abundance of magnetic monopoles in the universe. The monopole abundance is a very important number for astrophysics.

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