Will Magnetic Monopoles be Detected in Our Instruments?

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This work discusses some consequences of a new classical theory of systems of charges, monopoles, photons and the electromagnetic fields associated with these particles (1). The new theory is compared with the presently accepted theory of these systems (2).

In what follows, subscripts (e), (m) and (w) denote quantities related to charges, monopoles and photons, respectively. Units where the speed of light $c = 1$ are used. Greek indices run from 0 to 3.

The difference between the two theories emerges when a system which includes charges and monopoles is examined. The presently accepted theory assumes:

a) matter interacts with fields of charges in the same way as it does with fields of monopoles.

On the other hand, the new theory assumes:

b) the equations of motion of a system of charges, monopoles and fields are derived from a regular Lagrangian function.

It is shown in ref. (1) that if some simple requirements are satisfied then these two assumptions are contradictory.

The two theories defer in the equations of motion of the particles. The presently accepted equation of motion of a charge is (2)

$$\frac{\mathrm{d}P_{(\mathrm{e})}{}^{\mu}}{\mathrm{d}\tau} = F_{(\mathrm{e,m,w})}{}^{\mu\nu} J_{(\mathrm{e})\nu} \,. \tag{1}$$

The equation of motion of a monople is

$$\frac{\mathrm{d}P_{(\mathrm{m})}{}^{\mu}}{\mathrm{d}\tau} = F^{\dagger}_{(\mathrm{e,m,w})}{}^{\mu\nu} J_{(\mathrm{m})\nu} \,, \tag{2}$$

(1) E. COMAY: *Nuovo Cimento B*, **80**, 159 (1984).
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where

$$F^{\dagger}_{(e,m,w)}{}^{\mu\nu} = \tfrac{1}{2}\varepsilon^{\mu\nu\alpha\beta}F_{(e,m,w)\alpha\beta} \tag{3}$$

and $\varepsilon^{\mu\nu\alpha\beta}$ is the complete antisymmetric unit tensor of four indices.

The equations of motion of a charge and of a monopole take a different form in the new theory. The equation of motion of a charge is

$$\frac{\mathrm{d}P_{(e)}{}^{\mu}}{\mathrm{d}\tau} = F_{(e,m)}{}^{\mu\nu}J_{(e)\nu} \tag{4}$$

and the corresponding equation of a monopole is

$$\frac{\mathrm{d}P_{(m)}{}^{\mu}}{\mathrm{d}\tau} = F^{\dagger}_{(m,w)}{}^{\mu\nu}J_{(m)\nu}. \tag{5}$$

The new theory shows that charges do not interact with fields of monopoles and that monopoles do not interact with fields of charges. The fields of photons is the medium through which charges and monopoles interact.

The two theories agree on the duality transformation of classical electrodynamics of systems of charges, photons and the electromagnetic fields associated with these particles. This transformation converts these systems into systems of the dual world whose constituents are monopoles, photons and the fields associated with them. The experimentally established part of classical electrodynamics does not include monopoles. Hence, its dual world does not contain charges. It is evident that both experiment and duality leave open the problem of charge-monopole interaction.

This discussion shows that assumption *a*), which is adopted by the presently accepted theory, is not self-evident. Unless it has a proof of its own, one is free to follow different, and even contradictory, assumptions. Physics is a natural science. Hence, the ultimate proof of a physical idea should be sought in experiment.

A result of the new theory is that it is impossible to detect monopoles in our experimental devices. All these devices are eventually based upon the interaction of a charge with the fields of a monopole. The new theory shows that there is no such interaction. Hence, according to this theory, monopoles will not be detected in our instruments.

This conclusion of the new theory is compatible with presently available data. Monopoles have been searched for in terrestrial soil and in cosmic radiation [2]; on the floor of the ocean [4] and in moon rocks [5]. Data obtained from high-energy accelerators are used also for the purpose of detecting monopoles [3]. These experiments failed to detect monopoles and so do more recent attempts carried out for this purpose [6-10].

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More than ten years ago a paper reporting negative results has concluded that a possible interpretation is that monopoles may just have been tricky enough to evade all searches till now ([5]).

Today, there is only one report of a single monopole event which has not been refuted ([11]). There are two reasons why this single event cannot be accepted:

I) the apparatus which recorded this event consists of a single superconducting ring. This device is not safe against machine failure. Today, such devices consist of three mutually perpendicular rings and events are recorded in coincidence ([12,13]).

II) Applying Poissonian statistics to the fact that there is no other report of an event of this kind, makes the validity of that single event more unlikely as time passes.

It is interesting to note that the idea that the event reported in ref. ([11]) is due to some instrumental problem has already been suggested by several authors ([7,10,14]).

At present, in spite of the intensive and prolonged efforts devoted to the purpose of detecting monopoles, the experimental evidence of their existence is far from being established. Experiment is the ultimate test of a physical theory. The new theory shows that charges are not accelerated by the fields of monopoles. It can be stated that the new theory is in accordance with experiment. If monopoles do exist, then their fields do not accelerate charges and cannot activate all the devices used for their detection. The new theory shows that monopoles are indeed tricky enough to evade all search till now.

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