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GRAND UNIFIED MONOPOLES AND DUMAND

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The existence of magnetic monopoles as well as baryon decay is predicted in Grand Unified Theories and their detection is of crucial importance for the verification of these theories.

Grand Unified Monopoles (GUMs) are expected to have baryon number violating interactions with matter. Because of the small geometric size of these objects one expects a very small cross section, making them extremely hard to detect.

Recently, however, Rubakov(1) has put forward arguments that $\Delta B \neq 0$ GUM cross sections could be comparable to conventional strong interaction cross sections. This idea has been supported by an analysis of Callan(2).

The reason for the large $\Delta B \neq 0$ GUM cross section is that they presumably are surrounded by a strong condensate of fermion pairs of radius $1/m_q$ and it is the collisions of conventional fermions with this condensate giving rise to baryon number violating interactions.

Ellis,Nanopoulos, and Olive(3) have shown that GUM cross sections of that size are not in conflict with the baryon number of the universe and that these GUMs might have escaped detection so far Applying the present lower limit of $3*10^{30}$ years for the baryon lifetime to catalyzed nucleon decays by GUMs, they find an upper limit for the flux of GUMs

$$F < 2*10^{-3} \; v \; m^{-2} \; day^{-1} \; sr^{-1}$$

where v is the velocity of GUMs in units of c.

So far experimental limits on GUM fluxes apply mainly to fast ($v > 10^{-3}$) ionizing monopoles. The only experimental limit on mono poles independent of their velocities (and sensitive to slow ones) comes from Cabreras experiment(4). From one candidate event an upper limit of

$$F < 0.5 \; m^{-2} \; day^{-1} \; sr^{-1}$$

can be deduced (much higher than the theoretically estimated upper limit).

Because of its large volume, DUMAND would be - at least in principle - an ideal detector for such GUMs. Because of the large $\Delta B \neq 0$ cross section such a monopole would catalyse a baryon decay once evere 5 - 10 cm (for $v \sim 10^{-3}$). It would, however, pass through the detector v^{-1} times slower than a muon, a

unique feature of these monopoles.

Grand Unified Monopoles would thus show up in DUMAND via a whole series of baryon decays along their paths.

So far the experimental upper limit on the flux of GUMs is very poor and an improvement of that limit is desirable. Maybe even with the DUMAND SPS, deployed for about 6 months, one might be able to set a much better upper limit on this flux.

References

(1) V. A. Rubakov, Zh. Eksp. Teor. Fiz. 33 (1981) 658

(2) C. G. Callan, Princeton University Preprints (1982)

(3) J. Ellis, D. V. Nanopoulos, and K. Olive CERN-TH 3323(1982)

(4) B. Cabrera, Phys. Rev. Letters 48(1982)1378