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Dark Monopoles in Grand Unified Theories

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We consider a Yang-Mills-Higgs theory with gauge group $G = SU(n)$ broken to $G_v = [SU(p) \times SU(n-p) \times U(1)]/Z$ by a Higgs field ϕ in the adjoint representation. We obtain monopole solutions whose magnetic field does not lie in the Cartan Subalgebra. And, since their magnetic field vanishes in the direction of the $U(1)_{em}$ electromagnetic group, we call them Dark Monopoles. These Dark Monopoles must exist in some Grand Unified Theories (GUTs) without the need to introduce a dark sector. We calculate the general hamiltonian and equations of motion, while we also obtain approximate analytical solutions when $r \to 0$ and $r \to \infty$. We show that their mass is given by $M = \frac{4\pi v}{e}\, \tilde{E}(\lambda/e^2)$, where $\tilde{E}(\lambda/e^2)$ is a monotonically increasing function of λ/e^2, with the lower and upper bounds depending on specific parameters of each possible symmetry breaking. For the particular case of the $SU(5)$ GUT, we obtain that $\tilde{E}(0) = 1.294$ and $\tilde{E}(\infty) = 3.262$. In addition, we give a geometrical interpretation to their non-abelian magnetic charge and we show that our monopole solution has a conserved magnetic current J^{μ}_{M}, which is quantized and lies in a non-abelian direction. Finally, we proceed with an asymptotic stability analysis of these $SU(n)$ Dark Monopole solutions, where we show that there are unstable modes associated with them. We obtain the explicit form of the unstable perturbations and the associated negative-squared eigenfrequencies.

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