VII OFICINA NACIONAL DE TEORIA QUÂNTICA DE CAMPOS

Contribution ID: 79

Type: Vídeo-Poster

Dark Monopoles in Grand Unified Theories

Friday 10 December 2021 15:15 (10 minutes)

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_M^{μ} , 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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Session Classification: Apresentações de vídeo-pôsteres