Topological Defects in the Georgi-Machacek Model

Chandrasekhar Chatterjee\textsuperscript{1}, Masafumi Kurachi\textsuperscript{1}, and Muneto Nitta\textsuperscript{1}

\textsuperscript{1}Department of Physics, and Research and Education Center for Natural Sciences, Keio University, Hiyoshi 4-1-1, Yokohama, Kanagawa 223-8521, Japan

Abstract

We discuss topological defects in the Georgi-Machacek model in a hierarchical symmetry breaking in which extra triplets acquire vacuum expectation values before the doublet. We find a possibility of topologically stable non-Abelian domain walls and non-Abelian flux tubes (vortices) in this model. In the limit of the vanishing \( U(1) \) gauge coupling in which the custodial symmetry becomes exact, the presence of a vortex spontaneously breaks the custodial symmetry, giving rise to \( S^2 \) Nambu-Goldstone (NG) modes localized around the vortex corresponding to non-Abelian fluxes. Vortices are continuously degenerated by these degrees of freedom, thereby called non-Abelian. By taking into account the \( U(1) \) gauge coupling, the custodial symmetry is explicitly broken, the NG modes are lifted, and all non-Abelian vortices fall into a topologically stable \( Z \)-string. This is in contrast to the standard model in which \( Z \)-strings are non-topological and are unstable in the realistic parameter region. Non-Abelian domain walls also break the custodial symmetry and are accompanied by localized \( S^2 \) NG modes. Finally, we discuss the existence of domain wall solutions bounded by flux tubes, where their \( S^2 \) NG modes match. The domain walls may quantum mechanically decay by creating a hole bounded by a flux tube loop, and can be cosmologically safe.