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Matter-Antimatter Asymmetry and Composite Higgs Models

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Why do we exist? How the observed Baryon Asymmetry in the Universe (BAU) came to be cannot be explained within the Standard Model of Particle Physics (SM). While the Electroweak Phase Transition (EWPhT) has all the ingredients nececessary for baryogenesis, it lacks quantitatively in two points: the phase transition is not strongly first order and the SM does not provide enough CP-violation. This can be remedied by introducing new physics, e.g. an additional scalar singlet S. A particularly well-researched class of Electroweak Baryogenesis (EWBG) models feature a $Z_2 : S \to -S$ symmetry of the singlet that is spontaneously broken around the electroweak scale. However, such a scenario generically leads to phenomenologically problematic domain walls.

Here, a thermal history in which the Z_2 symmetry is not restored at high temperatures is envisioned, as accomplished by introducing a S^6 operator. This effective field theory (EFT) can be understood as the low-energy tail of a more complete theory, such as a Composite Higgs (CH) model. In CH, the Higgs is thought of as a composite of new fermions and described as a pseudo-Nambu-Goldstone Boson of a spontaneously broken global symmetry, making its mass small and solving the EW Hierarchy Problem. As a possible UV-completion to the Z_2 non-restoration (SNR) scenario, a $SO(6)/SO(5)$ CH model is employed. The scalar potential and Yukawa interactions can be obtained in spurion analyses and spontaneously CP-violating terms arise. Models with SM fermions embedded in (1), 6, 15 and 20′ representations of SO(6) are compared.

The EFT parameter space where a strong first order EWPhT can be obtained is matched to the most promising CH model, finding that all conditions for EWBG can be fulfilled and the correct BAU may be generated.

Category

Particle / Astroparticle / Cosmology (Theory)

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