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A Portalino to Twin Sector—Cosmology and Flavor Physics

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Extensions of the Standard Model are often highly constrained by cosmology. The presence of new states can dramatically alter observed properties of the universe by the presence of additional matter or entropy. In particular, attempts too solve the hierarchy problem through naturalness invariably predict new particles near the weak scale which come into thermal equilibrium. Without a means to deposit this energy into the SM, these models are often excluded. Scenarios of "neutral naturalness" especially, such as the Twin Higgs frequently suffer from this.

However, the Portalino, a singlet fermion that marries gauge neutral fermion operators, can naturally help provide a portal for entropy to return to the SM and to lift fermionic degrees of freedom in the Twin Sector. Together with spontaneous breaking of the Z_2 $\mathrm{SM} \leftrightarrow \mathrm{Twin}$ symmetry, there are new opportunities to confront the cosmological challenges of these models.

Here, we attempt to develop such ideas. We shall show how one can lift many of the light fields by breaking Z_2 with a $U(1)_Y$ scalar and its Twin partner. The introduction of Portalinos can lift the remaining degrees of freedom. We shall find that such models are highly constrained by precision SM measurements, motivating moderate extensions beyond this. We will discuss two, one with additional weak matter and another with additional colored matter. The weak model will involve simple two Higgs doublet models on top of Z_2 breaking. The strong model will involve the presence of new leptoquarks and diquarks. We will discuss the implications for neutrino masses from radiative corrections, g-2, electron-muon transition rate and possible colored signals even within these models of neutral naturalness, some of which might appear at the LHC or future colliders. The e-print of this work is referred as arXiv:1905.00861.

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