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Explore Mirror Twin Higgs Cosmology with Present and Future Weak Lensing Surveys

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We explore the potential of precision cosmological data to study non-minimal dark sectors by updating the cosmological constraint on the mirror twin Higgs model (MTH). The MTH model addresses the little Higgs hierarchy problem by introducing dark sector particles. In this work, we perform a Bayesian global analysis that includes the latest cosmic shear measurement from the DES three-year survey and the Planck CMB and BAO data. In the early Universe, the mirror baryon and mirror radiation behave as dark matter and dark radiation, and their presence modifies the Universe's expansion history. Additionally, the scattering between mirror baryon and photon generates the dark acoustic oscillation process, suppressing the matter power spectrum from the cosmic shear measurement. We demonstrate how current data constrain these corrections to the ΛCDM cosmology and find that the proportion of MTH dark matter cannot exceed about 30% of the total dark matter density, unless the temperature of twin photon is less than 30% of that of the standard model photon. While the MTH model is presently not a superior solution to the observed H_0 tension compared to the ΛCDM+$\Delta N_{\rm eff}$ model, we demonstrate that it has the potential to alleviate both the H_0 and S_8 tensions, especially if the S_8 tension persists in the future and approaches the result reported by the Planck~SZ~(2013) analysis. In this case, the MTH model can relax the tensions while satisfying the DES power spectrum constraint up to $k < 10\ h\,{\rm Mpc}^{-1}$. If the MTH model is indeed accountable for the S_8 and H_0 tensions, we show that the future China Space Station Telescope (CSST) can determine the twin baryon abundance with a 10% level precision.

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