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Neutrino Beacons: Illuminating New Physics with Cosmic Messengers

Thursday, 26 June 2025 11:00 (30 minutes)

The origin of tiny neutrino masses remains an open question in particle physics, prompting extensions beyond the Standard Model (SM). In this talk, I will present a study of a $U(1)$ gauge extension of the SM that incorporates three generations of Majorana-type right-handed neutrinos. This framework leads to the emergence of a neutral beyond-the-Standard-Model (BSM) gauge boson, denoted as Z', whose interactions can be chiral or flavored.

We explore the potential of high-energy cosmic events, such as gamma-ray bursts (GRBs) and active galactic nuclei (AGNs), to probe Z' neutrino interactions. Specifically, we analyze the process $\nu\nu \to e^+e^-$, which can contribute to energy deposition in events like GRB221009A, the highest energy GRB observed to date. By estimating the observables of such processes, we constrain the $U(1)$ gauge coupling (g_X) and the Z' mass ($M_{Z'}$) under Schwarzschild and Hartle-Thorne scenarios.

Additionally, we investigate ν-dark matter (DM) scattering mediated by Z′ bosons, utilizing data from the IceCube Neutrino Observatory. By considering high-energy neutrinos from cosmic sources such as the blazar TXS0506+056 and the active galaxy NGC1068, along with Cosmic Microwave Background (CMB) and Lyman-α data, we further constrain the g_X–$M_{Z'}$ parameter space.

Finally, we compare our findings with current and prospective bounds from scattering experiments, beam-dump experiments, and measurements of the anomalous magnetic moment (g–2). This comprehensive analysis highlights the complementarity of astrophysical observations in probing chiral and flavored Z' bosons.

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Compact Objects & Particles

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