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Heavy Neutrino Physics at Colliders

Heavy neutrino physics at colliders is a particle physics project aimed at advancing our understanding of the origin of neutrino masses. Neutrinos are elementary particles, the second most abundant in the universe after photons, produced in radioactive processes in stars, supernovae, nuclear reactors, the atmosphere, and natural radioactivity on Earth. The existence of neutrino masses requires extending the Standard Model of particle physics for a proper explanation. One approach is the effective extension of the Standard Model (νSMEFT), which not only incorporates mass terms for neutrinos and provides a mechanism explaining the magnitude of the known neutrino masses (the Seesaw mechanism), but also includes interaction terms of heavy neutrinos with other Standard Model particles via effective operators. These interactions could lead to new observable processes at particle colliders such as the LHC.

Our group has been working in this research area for a decade, achieving significant progress in the numerical implementation of the effective theory and the phenomenological study of heavy neutrinos through collider experiment simulations. In the present project, we aim to perform updated calculations of heavy neutrino decays and carry out a recasting (reinterpretation) of existing LHC data in terms of the effective theory operators. The goal of this research is to understand how predictions from the effective theory with heavy neutrinos deviate from Standard Model predictions and thereby constrain the possible values of the theory's parameters based on experimental results.

In this poster, we present the νSMEFT framework and the latest advances in our project.

Academic position of the presenting author

Ph.D. Student

Primary authors: GUILLENEA, Agustin (Universidad de la República); Dr DUARTE, Lucía (Universidad de la República)

Presenter: GUILLENEA, Agustin (Universidad de la República)

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