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Why interpretation matters for BSM searches: a case study with Heavy Neutral Leptons at ATLAS

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Even the simplest consistent models of Heavy Neutral Leptons (HNLs) already feature significant complexity, making them impractical for reporting experimental results. In order to keep this complexity manageable, experiments typically interpret their results within simplified models, where e.g. one HNL couples to a single lepton flavor. Unfortunately, such models are in direct contradiction with the observed neutrino oscillation data. This can significantly reduce the impact of these results, which cannot easily be reused by model builders. In this work, we perform a detailed reinterpretation of the latest ATLAS search for prompt HNLs in W decays within a minimal low-scale seesaw with two HNLs. We show that the exclusion limits obtained using the detailed reinterpretation can differ by *several orders of magnitude* (in either direction) from the limits quoted for the simplified models. Hence naively comparing the mixing angles from a realistic model to the reported limits could lead to *wrongly excluding* entire regions of parameter space! To overcome this issue without requiring experiments to report constraints on all possible HNL models, we propose a simple framework that allows to easily and accurately reinterpret exclusion limits within closely-related models, hence significantly broadening their impact. We outline a number of concrete steps which can be taken by experiments to implement this method with minimal effort, and we discuss its applicability to other models of feebly interacting particles.

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Collaboration / Activity

Phenomenology

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