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Why interpretation matters in heavy neutral lepton searches: a case study at ATLAS

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 under control, experiments usually interpret search results within simplified benchmarks, such as e.g. one HNL coupling to a single lepton flavor. Unfortunately, these benchmarks turn out to be in direct contradiction with the observed neutrino oscillation data, limiting the usefulness of the results to theorists. In this talk, I present a detailed reinterpretation of the latest ATLAS search for prompt HNLs in W decays within a minimal low-scale seesaw with two HNLs. We observe that the exclusion limits in this more realistic model can differ by *several orders of magnitude* from the limits quoted for the simplified benchmarks. Therefore, one should avoid making a *direct* comparison between these reported limits and the mixing angles in a realistic model, due to the risk of *wrongly excluding* large regions of parameter space! To overcome this limitation and obtain more widely applicable limits without requiring experiments to explicitly test all possible HNL models, we propose a simple framework that leverages the scaling properties of the signal to enable theorists to easily and accurately reinterpret exclusion limits within similar models, allowing them to perform e.g. global scans or Bayesian analyses. We outline the concrete steps that experiments can take to enable the use of this method with minimal effort, and we discuss its applicability to other classes of feebly interacting particles.

Participation

I plan to attend in person

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