SES17-2017-000044

Abstract for an Invited Paper
for the SES17 Meeting of
the American Physical Society

Fun with mirror fermions: The search for the origin of neutrino masses at the LHC and beyond.

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The seesaw mechanism is the most elegant way to give neutrinos tiny masses, less than O(eV). In a generic model, $m_\nu \sim m_D^2/M_R$, where $m_D \propto O(\Lambda_{EW} \sim 246 GeV)$ is the Dirac mass and M_R, the mass of right-handed neutrinos, which is generically very large (typically GUT mass scale). Right-handed neutrinos in such models are *sterile*, i.e.they do not interact with W and Z bosons. (There is *absolutely* no reason why they should be sterile.) Such a generic scenario makes it impossible to completely test the seesaw mechanism at current and future accelerators. Can one unravel the mysteries of the origin of neutrino masses at the LHC? Yes provided right-handed neutrinos are *non-sterile* (or *fertile*). This is what the Electroweak-scale right-handed neutrinos or EW-ν_R model set out to accomplish. The seesaw mechanism can be fully tested at the LHC. What are the characteristics and achievements of the EW-ν_R model? Its gauge group is still $SU(3)_C \times SU(2)_W \times U(1)_Y$. It contains mirror fermions with characteristic decay signatures such as *displaced vertices*. It satisfies electroweak precision data represented by the parameters S, T and U. It accommodates the 125-GeV scalar and, in fact, came up with two radically different solutions, both of which give signal strengths compatible with experiment. The discovery of mirror fermions and ν_R with masses *naturally* proportional to Λ_{EW} (displaced vertices, like-sign dileptons,..) and associated scalars at the LHC will completely test the seesaw mechanism and unravel the origin of neutrino masses.