Contribution ID: **24** Type: **not specified**

Low-Scale Seesaw and the CP Violation in Neutrino Oscillations

Wednesday 4 July 2018 09:30 (30 minutes)

We consider a version of the low-scale type I seesaw mechanism for generating small neutrino masses, as an alternative to the standard seesaw scenario. It involves two right-handed (RH) neutrinos ν_{1R} and ν_{2R} having a Majorana mass term with mass M, which conserves the lepton charge L. The RH neutrino ν_{2R} has lepton-charge conserving Yukawa couplings $g_{\ell 2}$ to the lepton and Higgs doublet fields, while small lepton-charge breaking effects are assumed to induce tiny lepton-charge violating Yukawa couplings $g_{\ell 1}$ for ν_{1R}, $l = e, \mu, \tau$. In this approach the smallness of neutrino masses is related to the smallness of the Yukawa coupling of ν_{1R} and not to the large value of M: the RH neutrinos can have masses in the few GeV to a few TeV range. The Yukawa couplings $|g_{\ell 2}|$ can be much larger than $|g_{\ell 1}|$, of the order $|g_{\ell 2}| \sim 10^{-4} - 10^{-2}$, leading to interesting low-energy phenomenology. We consider a specific realisation of this scenario within the Froggatt-Nielsen approach to fermion masses. In this model the Dirac CP violation phase δ is predicted to have approximately one of the values $\delta \simeq \pi/4$, $3\pi/4$, or $5\pi/4$, $7\pi/4$, or to lie in a narrow interval around one of these values. The low-energy phenomenology of the considered low-scale seesaw scenario of neutrino mass generation is also briefly discussed.

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Session Classification: Morning Session I