NEUTRINOS

Tied up with string

Phys. Rev. Lett. **124**, 041804 (2020)

Why does the Universe contain more matter than antimatter? And why are neutrino masses so small compared to other elementary particles? These are two fundamental open questions that may be connected by the ‘seesaw’ mechanism: imagine a new standard-model particle, the heavy right-handed neutrino, produced after inflation (with a corresponding light neutrino). It is inherently unstable, so it will decay to a Higgs particle and a lepton, but there’s also a charge–parity violation (via Yukawa coupling) that prefers the antilepton channel. This violation of baryon and lepton numbers will lead to some of the negative lepton asymmetry being converted to a positive baryon asymmetry. Unfortunately, we cannot search directly for the required right-handed neutrino on Earth, as its mass is above 10^9 GeV. Hence Jeff Dror and co-workers look to gravitational waves for evidence.

As the mass is still below the Planck scale, there must be some symmetry protecting the right-handed neutrinos. The creation of leptons by seesaw (thermal leptogenesis) breaks the symmetry, in the same way that ferromagnetism breaks a symmetry when all the spins line up below the ordering temperature. In the case of leptogenesis, Dror et al. argue that cosmological defects, or cosmic strings of magnetic tubes, are a consequence of that broken symmetry. They study all the possible symmetries and symmetry breaking patterns, always seeing a cosmic string network. The network of defects produces a distinctive gravitational wave spectrum that is, in principle, detectable. With both terrestrial and space observatories, the entire parameter space of right-handed neutrinos can be probed.

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Published online: 27 February 2020

<https://doi.org/10.1038/s41550-020-1048-9>