

WHISPERS FROM THE DARK UNIVERSE – PARTICLES & FIELDS IN THE GRAVITATIONAL WAVE ERA

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Relic Neutrino Background from Cosmic Ray Reservoirs

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The existence of a relic neutrino background (R ν B) is a major prediction of the standard cosmological model, but its detection is one of the hardest tasks in neutrino physics. The main challenge arises because of its extremely low energy, as a consequence of its low temperature $T_\nu \simeq 1.67 \times 10^{-4}$ eV. The most promising experimental technique to detect the R ν B is that of neutrino capture in tritium, as proposed for PTOLEMY, although the actual sensitivity to R ν B remains uncertain. An intriguing detection possibility is that a fraction of the R ν B has larger kinetic energies compared to that of the diffuse background. For instance, upscatterings of ultra-high-energy (UHE) cosmic rays (CRs) off the R ν B can accelerate relic neutrinos to UHE. In the case of large neutrino overdensities in the regions of space where the UHECRs-R ν B interactions take place, the flux of boosted R ν B can be sizeable enough to imprint signals at terrestrial facilities that look for UHE neutrinos. We discuss such possibility concentrating on galaxy clusters that act as CR-reservoirs. The long trapping times of UHECRs make this flux larger than that of R ν B up-scattered by UHECRs en route to Earth. We find that IceCube excludes R ν B overdensities larger than $\sim 10^{10}$ in galaxy clusters, and that future PUEO, RNO-G, GRAND and IceCube-Gen2 will test values down to $\sim 10^8$. Moreover, the flux of R ν B boosted in this way exhibits a peculiar flavour composition, thus being distinguishable from other astrophysical UHE neutrino fluxes.

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