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Relic Neutrino Background from Cosmic Ray Reservoirs

The existence of a relic neutrino backgorund (RνB) 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 RνB is that of neutrino capture in tritium, as proposed for PTOLEMY, althoug the actual sensitivity to RνB remains uncertain. An intriguing detection possibility is that a fraction of the RνB has larger kinetic energies compared to that of the diffuse background. For instance, upscatterings of ultra-high-energy (UHE) cosmic rays (CRs) off the RnuB can accelerate relic neutrinos to UHE. In the case of large neutrino overdensities in the regions of space where the UHECRs-RνB interactons take place, the flux of boosted RnuB 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 RνB up-scattered by UHECRs en route to Earth. We find that IceCube excludes RνB 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 RνB boosted in this way exhibits a peculiar flavour composition, thus being distinguishable from other astrophysical UHE neutrino fluxes.

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