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The puzzle of neutrinos on cosmic scales

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A key question in cosmology is whether massive neutrinos exist on cosmic scales. Current cosmological observations have severely compressed the viable range for neutrino masses and even prefer phenomenologically an effective negative mass. This poses a great challenge to the cosmological search for neutrinos. Based on current background and large scale structure data, taking a full redshift and/or scale tomography method, we obtain one beyond 5 sigma, two 3 sigma and two 2 sigma evidences of massive neutrinos, spanning both high and low redshifts, as well as both small and intermediate scales. Interestingly, these five neutrino masses are well consistent within 1 sigma confidence level, indicating a possible suppression of neutrino mass during the evolution of the universe. Using cosmic microwave background observations to constrain a redshift and scale dependent neutrino mass, we make the first neutrino mass map through the cosmic history and full scales for future high precision search.

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