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Neutrino Mass and Mass Ordering with Cosmic Gravitational Focusing

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The cosmic gravitational focusing (CGF) is the 3rd cosmological way of measuring the neutrino masses. Different from the existing methods with CMB and large scale structure that have linear dependence on the neutrino mass sum, CGF is sensitive to the fourth power of the neutrino masses and hence can provide an independent measurement of the neutrino mass. We thoroughly explore the cosmic gravitational focusing of cosmic neutrino fluid (CνF) by dark matter (DM) halo using both general relativity for a point source of gravitational potential and Boltzmann equations for continuous overdensities. Derived in the general way for both relativistic and non-relativistic neutrinos, our results show that the effect has fourth power dependence on the neutrino mass and temperature. We take DESI as an example to illustrate that the projected sensitivity as well as its synergy with existing terrestrial neutrino oscillation experiments and other cosmological observations can significantly improve the neutrino mass and mass ordering measurements.

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