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Testing neutrino mass origins with supernova neutrino time delay

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The origin of neutrino masses remains unknown. Both the vacuum mass and the dark mass generated by the neutrino interaction with dark matter (DM) particles or fields can fit the current oscillation data. The dark mass squared is proportional to the DM number density and therefore varies on the galactic scale with much larger values around the Galactic Center. This affects the group velocity and the arrival time delay of core-collapse supernovae SN neutrinos. This time delay, especially for the ν_e neutronization peak with a sharp time structure, can be used to distinguish the vacuum and dark neutrino masses. For illustration, we explore the potential of DUNE which is sensitive to ν_e. Our simulations show that DUNE can distinguish the two neutrino mass origins at more than 5σ C.L., depending on the observed local value of neutrino mass, the neutrino mass ordering, the DM density profile, and the SN location.

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