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The Future of High-Energy Astrophysical Neutrino Measurements: Standard Model and beyond

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The next generation of neutrino telescopes, including Baikal-GVD, KM3NeT, P-ONE, TAMBO, IceCube-Gen2 and TRIDENT, will be able to determine the flavor of high-energy astrophysical neutrinos precisely. With the aid of future neutrino oscillation experiments – in particular JUNO, DUNE, and Hyper-Kamiokande – the regions of flavor composition at Earth that are allowed by neutrino oscillations will shrink by a factor of ten between 2020 and 2040. The observation of Glashow resonant events will also break the degeneracy between the neutrino production from hadronuclear and photohadronic processes. We critically examine the ability of future experiments and show how these improvements will help us pin down the source of high-energy astrophysical neutrinos. As illustrations of beyond-the-Standard-Model physics, we also show that future neutrino measurements will constrain the decay rate of heavy neutrinos and the quantum gravity scale in theories of extra dimensions.

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