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Pushing the Energy and Cosmic Frontiers of Particle Physics with High-Energy Astrophysical Neutrinos

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The astrophysical neutrinos recently discovered by IceCube have two unique features. First, they have the highest detected neutrino energies — from TeV to PeV. Second, they travel the longest distances — up to a few Gpc. Motivated by this, the decades before discovery saw many proposals for using these neutrinos to measure fundamental particle-physics properties, possibly tiny in size, at energy scales unreachable by any other means. Those exciting proposals have now become a reality. Today, we can perform robust particle-physics tests, in spite of prevalent astrophysical unknowns. In this talk, I will showcase examples of doing fundamental neutrino physics at the most extreme scales, including some of the most stringent tests of physics beyond the Standard Model.

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