

## Neutrino echoes as a probe of secret neutrino interactions

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Beyond the Standard Model (BSM) interactions in the neutrino sector have been of much interest in cosmology and astroparticle physics. We developed a Monte Carlo code to investigate the neutrino time delay distribution caused by BSM interactions en route to the observer. While we find excellent agreement for small optical depths, the optically thick limit show features that are not described by simple analytical estimates. The code can be used to probe BSM interactions in current neutrino detectors such as IceCube and Super-Kamiokande, as well as future detectors. As an example, we show how to constrain neutrino interactions with sub-MeV dark matter in Hyper-Kamiokande via the echo approach, covering a parameter space unexplored by dark matter direct detection experiments.

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