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Timing coincidence search for supernova neutrinos with optical transient surveys

Neutrinos allow us to probe the interiors of stars during core collapse, and detecting them can teach us about the different stages and processes in the collapse. To date, only 24 supernova neutrinos have been detected all originating from a single event, SN1987A. Since then, most studies have focused on two different distance regimes of supernovae neutrinos: Galactic/local events and all past cosmic supernovae neutrinos forming the diffuse supernova neutrino background. We instead focus on an intermediate distance regime that can be thought of as "un-diffusing" the diffuse supernovae neutrino background. We make predictions for an offline, optical timing coincidence search method of neutrinos at Hyper-Kamiokande in tandem with optical supernova surveys. We find that detection prospects require approximately 10 years of operation. We discuss how pinpointing the time of core collapse with optical surveys to within the timescale of hours is vital for confident neutrino detections.

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