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Abstract for an Invited Paper
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Neutrinos and quantum fields in the Universe[1]

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A core-collapse supernova (CCSN) serves as natures own laboratory. In this talk, I will discuss how neutrinos from various phases of a CCSN can be used to gain insights and understanding in the broader context. I will focus on my work on localizing a progenitor prior to collapse using pre-supernova neutrinos. Hours before a nearby star, like Betelgeuse, becomes a supernova, a modern neutrino detector will record ~ 200 neutrino inverse beta decay interactions. Their topology can give the direction to the star with an error of $\sim 60^{\circ}$. This allows to narrow the list of potential stellar candidates to less than ten, thus facilitating astronomy searches and act as an early-warning system. Next, I will talk about my work in multi-messenger astronomy which involves combining supernova neutrino observations with gravitational wave (GW) observations. When a burst of neutrinos from a CCSN passes by the Earth, it causes a permanent change in the local space-time metric, called the gravitational memory. Long considered unobservable, this effect will be detectable in the near future, for a galactic supernova, at deci-Hertz GW interferometers. I will discuss the physics potential of these next generation GW detectors like DECIGO and BBO to observe the neutrino memory effect in the context of multimessenger astronomy and for tests of gravity.

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