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Interpreting the neutrino signal from core-collapse supernovae using neural networks

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When massive stars (⊠ 10M⊠) reach the end of their life cycle, the instability of their iron core leads to the collapse of the star. This collapse is halted upon reaching extreme densities, as the strong nuclear force prevents further contraction, resulting in the formation of a proto-neutron star (PNS). The collision of the star's outer layers with the PNS generates a shock wave that expels the stellar envelope in an explosion known as a supernova. Core-collapse supernovae have been the subject of theoretical studies for over half a century and observational investigations for even longer. Moreover, decades of simulations suggest that these explosions occur only if the neutrinos emitted by the PNS deposit sufficient energy into the shock wave. Thus, neutrinos play a central role in all phases of the collapse and explosion, being, alongside gravitational waves, the only way
to directly access information about the core of stars at the end of their lives. In this work, our aim is to understand how the detection of neutrinos from a supernova can help to interpret the mechanisms that occur within a PNS. To achieve this, we employ artificial neural networks to predict physical properties based on computational simulations of PNSs.
Keywords: supernovae, neutrinos, neural networks.

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