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Studies on Core-collapse Supernova Neutrino at JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO) uses a 20,000-ton liquid scintillator detector to study various aspects of neutrino physics, including the study of neutrinos from supernovae. Thanks to JUNO's large target mass and low energy threshold, it can observe supernova and pre-supernova neutrinos through multiple reaction channels with high statistics. For example, in a typical supernova explosion at a distance of 10 kiloparsecs, JUNO can detect about 5000 inverse beta decay (IBD) events, 2000 proton elastic scattering (pES) events, 300 electron elastic scattering (eES) events, and several other reaction channels, enabling JUNO to obtain the energy spectrum information of all neutrino flavors. Studies using Monte Carlo simulations have shown that a model-independent method combining multiple reaction channels can reconstruct the energy spectra of all supernova neutrino flavors well. JUNO's ability to detect a large number of supernova neutrino events and pre-supernova neutrinos also gives it great potential in supernova early warning. Currently, a supernova early warning system based on field-programmable gate arrays (FPGAs) and data acquisition systems (DAQs) is under development, and simulation studies have been conducted to investigate the sensitivity of the warning system and the direction reconstruction after the warning. This report will present the design and sensitivity of JUNO's supernova early warning system, as well as related studies on the reconstruction of the energy spectra of all neutrino flavors.

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