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Pre-SN neutrino emissions from ONe cores in the progenitors of CCSNe

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Abstract. In order to investigate the distinguishability about the progenitors of FeCCSNe and ECSNe, we calculate the luminosities and spectra of their pre-SN neutrinos and estimate the number of events at neutrino detectors.

Keywords. Supernovae:general, neutrinos

1. Overview

According to the stellar evolution theory, the progenitors with relatively light masses ($\lesssim 9M_\odot$) explode as ECSNe, while more massive ones explode as FeCCSNe. Then pre-SN neutrinos have important roles to distinguish two types of progenitors because neutrinos can escape freely from the core and deliver its information directly. Because of the recent development of detectional techniques, there is a possibility to detect them with low energy comparable to detectional threshold. Therefore, we focus on the distinguishability of SN-progenitors by the observation of pre-SN neutrinos.

We employ the realistic progenitor models until core bounce: a $9M_\odot$ model for ECSN, 12 and $15M_\odot$ models for FeCCSNe (Takahashi *et al.* (2013), Nagakura *et al.* (2014)). Based on their results, we calculate the luminosities and spectra of all-flavor neutrinos emitted via thermal and nuclear weak processes. Finally, we estimate the expected number at neutrino detectors including neutrino oscillation, assuming the distance to the progenitors to be 200 pc. It is demonstrated that $\bar{\nu}_e$'s from the ECSNe-progenitors can hardly be detected at almost all detectors, whereas we will be able to detect ~2500 ν_e's at DUNE. From the FeCCSN-progenitors, both ν_e's and $\bar{\nu}_e$'s will be detected: the number of $\bar{\nu}_e$ events will be largest for JUNO, 134-725 $\bar{\nu}_e$'s, depending on the mass hierarchy whereas the number of ν_e events at DUNE is almost the same as that for the ECSN-progenitor. These results imply that the detection of $\bar{\nu}_e$'s is useful to distinghish FeCCSN- from ECSN-progenitors, while ν_e's will provide us with detailed information on core evolutions regardless of progenitor types (Kato *et al.* (2017)).

References

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