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Multi-Messenger Signals from Magnetorotational Stellar Core Collapse

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Multi-messenger signals of gravitational waves and neutrinos from supernovae carry information about properties of supernova cores, which cannot be directly observed with electromagnetic waves. To maximize impacts of future detection of these multi-messenger signals, it is important to understand the relationship between the characteristics of the multi-messenger signals and the properties of the supernova cores.

We performed fully general relativistic three-dimensional neutrino-radiation magneto-hydrodynamic simulations of stellar core collapse with spectral neutrino transport to explore the impacts of characteristic fluid motions on the gravitational wave and neutrino signals from progenitors with various rotation speeds and magnetic field strengths. In this talk, I show the results of the time-frequency analysis of the gravitational wave and neutrino signals obtained from our simulations. In the non-magnetized rapidly rotating models, non-axisymmetric instabilities develop and generate the characteristic gravitational wave and neutrino signals that are correlated in the time-frequency plane. The highly magnetized rapidly rotating model shows that, for an observer on the equatorial plane perpendicular to the rotation axis, the low-frequency gravitational wave amplitude from anisotropic neutrino emission from deformed proto-neutron star becomes more than one order-of-magnitude bigger than that from the bipolar magnetohydrodynamic jets. I also discuss the detectability of their characteristic features.

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