

Chiral Effects and Transport Theory in Core-collapse Supernovae

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2021/11/23(Tuesday)/14:20~15:20

Google Meet: <https://meet.google.com/tgv-wzqv-ayp>

Abstract: Recently, the anomalous transport phenomena of relativistic fermions associated with chirality induced by external fields have been greatly explored in different areas of physics. Notably, such phenomena are in connection with various quantum effects such as the chiral anomaly and spin-orbit interaction. These chiral effects like the chiral magnetic and vortical effects have been recently included for the study of leptonic transport in core-collapse supernovae (CCSN). In particular, to delineate the chiral effects on neutrino radiation, a novel chiral neutrino radiation transport equation is derived from the chiral kinetic theory, which incorporates quantum corrections pertinent to magnetic and vortical fields in the collision term. Such a novel theoretical framework may be applied to future simulations of CCSN. On the other hand, through this collision term for neutrinos near thermal equilibrium, the anisotropic energy flux of neutrinos triggered by magnetic fields is found, which could have a potential application to pulsar kicks.