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General Relativistic Magnetohydrodynamic Simulations of Binary Neutron Star Mergers

Recent detection of gravitational waves (GWs) from the merger of two neutron stars (NSs) by the Advanced LIGO-Virgo interferometers also accompanied by the observation of electromagnetic (EM) counterparts across the entire spectrum has opened the new field for multimessenger astrophysics with GW sources. Binary neutron star (BNS) merger events can be used as a laboratory to investigate the NS equation of state (EOS), short gamma-ray bursts (SGRBs), and kilonova/macronova transients associated with the r-process nucleosynthesis of very heavy elements. General relativistic (GR) numerical simulations play a pivotal role to investigate the merger process. Moreover, to incorporate the crucial effects of magnetic fields, very challenging GR magnetohydrodynamics (GRMHD) simulations are necessary. In this work, we perform GRMHD simulations of BNS mergers using the numerical relativity codes Einstein Toolkit (ET) and WhiskyMHD. In particular, we consider magnetized and unmagnetized irrotational BNS models with different mass ratios, a fixed chirp mass, and the APR4 equation of state for NS matter. For all our models, we study in detail the overall dynamics, the magnetic field evolution, the GW emission, and the matter ejection.

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