Sub-grid modeling in MHD simulations of binary neutron star mergers

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The recent gravitational-wave observations of Advanced LIGO and Advanced Virgo of the inspiral and merger of binary neutron stars (BNS) can only be fully understood with the aid of numerical-relativity simulations. Those provide waveform models upon which to perform matched filtering for searches and Bayesian inference for parameter estimation. Unfortunately, these simulations require supercomputer resources and can be computationally very expensive, particularly when the effects of magnetic fields and neutrino transport are included. Insufficient numerical resolution of current grid-based simulations prevents the correct description of the development of turbulence at small scales. This is a key mechanism responsible for the amplification of the magnetic field in hypermassive neutron stars, the transient compact objects that are produced after a BNS merger. As a consequence, current numerical simulations of such mergers may provide imprecise results regarding the lifetime of the post-merger remnant and, in turn, the waveform signals. A possible solution that is starting to be considered by the numerical-relativity community is the use of sub-grid models. We will discuss our first results in our long-term project of developing sub-grid models for general-relativistic magnetohydrodynamics simulations of BNS mergers. We are going to show some tests performed over the so-called gradient model and we will present our own model which is still under development.