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<tr><th>authors</th><td>Daniel M. Siegel
Philipp MÃ¶sta
Dhruv Desai
Samantha Wu</td></tr>
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<tr><th>journal</th><td>The Astrophysical Journal</td></tr>
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https://bitbucket.org/dsiegel/grmhd_con2prim</td></tr>
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<tr><th>abstract</th><td>General-relativistic magnetohydrodynamic (GRMHD) simulations are an important tool to study a variety of astrophysical systems such as neutron star mergers, core-collapse supernovae, and accretion onto compact objects. A conservative GRMHD scheme numerically evolves a set of conservation equations for 'conserved' quantities and requires the computation of certain primitive variables at every time step. This recovery procedure constitutes a core part of any conservative GRMHD scheme and it is closely tied to the equation of state (EOS) of the fluid. In the quest to include nuclear physics, weak interactions, and neutrino physics, state-of-the-art GRMHD simulations employ finite-temperature, composition-dependent EOSs. While different schemes have individually been proposed, the recovery problem still remains a major source of error, failure, and inefficiency in GRMHD simulations with advanced microphysics. The strengths and weaknesses of the different schemes when compared to each other remain unclear. Here we present the first systematic comparison of various recovery schemes used in different dynamical spacetime GRMHD codes for both analytic and tabulated microphysical EOSs. We assess the schemes in terms of (i) speed, (ii) accuracy, and (iii) robustness. We find large variations among the different schemes and that there is not a single ideal scheme. While the computationally most efficient schemes are less robust, the most robust schemes are computationally less efficient. More robust schemes may require an order of magnitude more calls to the EOS, which are computationally expensive. We propose an optimal strategy of an efficient three-dimensional Newton-Raphson scheme and a slower but more robust one-dimensional scheme as a fall-back.</td></tr>
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