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GRIM: An Implicit Code for Nonideal General Relativistic MHD

MANI CHANDRA, Dept of Astronomy, University of Illinois Urbana-Champaign, CHARLES GAMMIE, Dept of Astronomy, and Dept of Physics, University of Illinois Urbana-Champaign — Highly sub-Eddington black hole accretion flows like Sgr A* are expected to be collisionless yet are commonly modeled as an ideal fluid. Electron conduction, anisotropic pressure, and viscosity can be important in a collisionless plasma and will potentially alter the dynamics and radiative properties of the flow from that in ideal fluid models. We present a new code, GRIM, that enables conduction and other effects to be efficiently incorporated into a GRMHD code. GRIM is a fully implicit Newton-Krylov shock capturing code that converges at second order on smooth flows. It features an efficient and automated Jacobian assembly with finite differences that uses graph coloring to exploit the sparsity of the discretization of a pde. This makes it easy to incorporate additional physics. The code correctly captures classical GRMHD test problems as well as a new suite of test problems with anisotropic conductivity. As a test and an example application we report on a relativistic version of the magneto-thermal instability, and we show an example integration of a black hole accretion flow.

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