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Paper: The Magnetic Reconnection Code: an AMR-based fully implicit simulation suite

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Abstract: Extended MHD models, which incorporate two-fluid effects, are promising candidates to enhance understanding of collisionless reconnection phenomena in laboratory, space and astrophysical plasma physics. In this paper, we introduce two simulation codes in the *Magnetic Reconnection Code* suite which integrate reduced and full extended MHD models. Numerical integration of these models comes with two challenges: Small-scale spatial structures, e.g. thin current sheets, develop and must be well resolved by the code. Adaptive mesh refinement (AMR) is employed to provide high resolution where needed while maintaining good performance. Secondly, the two-fluid effects in extended MHD give rise to dispersive waves, which lead to a very stringent CFL condition for explicit codes, while reconnection happens on a much slower time scale. We use a fully implicit Crank–Nicholson time stepping algorithm. Since no efficient preconditioners are available for our system of equations, we instead use a direct solver to handle the inner linear solves. This requires us to actually compute the Jacobian matrix, which is handled by a code generator that calculates the derivative symbolically and then outputs code to calculate it.

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