Statement of Research Interests

Tom Goffrey

My Ph.D project, which currently forms my primary area of research is entitled "An Arbitrary Lagrangian Eulerian Cylindrical MHD Code." The arbitrary Lagrangian Eulerian (ALE) description involves the explicit solution of the Euler equations in a Lagrangian frame, followed by an optional remapping step, should the grid have become too tangled. Primarily my work is involved in the modelling of shock related phenomena, as such I have implemented a number of different shock viscosities [1, 2] to provide the necessary dissipation in order to resolve shocks. Furthermore multiple options for the control of hourglass (and other unphysical) modes, either in conjunction with the viscosities [3], or independently [4] have been included. The code is capable of running in both two dimensional Cartesian (xy) and cylindrical (rz) coordinates. Written in Fortran, and parallelised through MPI, this section of the code has gone on to form the core hydrodynamic solver of a code developed jointly between the University of Warwick, and Imperial College London, under the EPSRC grant "A Radiation-Hydrodynamic ALE Code for Laser Fusion Energy."

More recent efforts have been involved in the addition of the magnetic field to the Euler equations required for a full MHD solver. Magnetohydrodynamic shocks require slightly different treatment to pure hydrodynamic shocks, and viscosities have had to be adjusted. The addition of the magnetic field involved the first implementation of the Cauchy solution for the magnetic field of Craig and Sneyd [5] within the ALE frame work, coupled with Evans and Hawley's constrained transport [6]. This has resulted in multidimensional divergence free evolution of the magnetic field. I have presented talks on the subject of MHD in ALE codes both at the IOP Computational Plasma Physics conference and the annual Centre for Inertial Fusion Studies meeting. A publication summarising the technique is under preparation.

The development of detailed, parallel scientific software, from the ground up can mean a delay in scientific application. However, having completed initial development I am now undertaking a number of varied scientific investigations that will lead to further publications, for example the study of the effect of implosion asymmetry on targets relevant to the National Ignition Campaign, and the modelling of the Biermann Battery Mechanism, specifically near shocks.

Outside of my Ph.D I have also initiated an active collaboration with the University of Leicester. I am currently in the process of adapting a pre-existing MCMC algorithm [7, 8] used for reproducing the phase space of galaxy clusters for use on a GPU using CUDA. Programming for a unconventional computational platform in itself presents a number of new challenges, whilst adaptation of an existing algorithm follows a different development path from writing new software, however the work is progressing well, and first results are expected by April.

In summary, in the past two and a half years I have gained experience in many aspects of computational physics, on different architectures. I am part of multiple collaborations with other universities, and believe I am in a strong position to take these skills forward with me to develop further novel scientific software.

References

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