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ISFAA, prospects for an implicit Smoothed Particle Hydrodynamics

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Abstract

The explicit nature of the smoothed particle hydrodynamics technique restricts its applications to dynamical phenomenae such as collisions or explosions. Nevertheless a large field of applications in astrophysics are related to quasi-hydrostatic evolution as for instance the pre-explosive stage leading to novae or Type Ia supernovae or advanced stellar evolutionary phases. If we want to apply the SPH technique to these systems an implicit scheme has to be built. Nevertheless devising an implicit SPH presents a number of numerical difficulties which have prevented its development until recent times (Knapp 2000, PhD Thesis, LANL). We explain the main features of an parallelized implicit SPH called ISFAA (Implicit SPH for Astrophysical Applications) which extends the work of Knapp by including a more powerful numerical scheme, and incorporates artificial viscosity, gravity, conductive transport and nuclear reactions. We have checked the scheme through several tests such as simulating a the wall heating shock test, Sedov like explosion or stability of a massive white dwarf. These tests were calculated using a low number of particles (20,000). Our conclusion is that although the scheme is promising it would be necessary to make use of supercomputers to carry out realistic calculations with ISFAA. Another important improvement would be to enhance the stability of the numerical scheme in order to increase the time step to overpass the Courant time-step in a larger factor which until now is around 50.