Computational Radiation Hydrodynamics

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In this talk, we present new codes developed in order to well report the physics of astrophysical phenomena in the radiative hydrodynamics field.

First of all, we have developed a 2D robust hydrodynamics module allowing high-Mach number simulations and able to run on multiple processor computers. This module, called HYDRO-MUSCL, is based on a MUSCL-Hancock scheme and involves a Riemann solver of HLLC or HLLE types. Vishniac instability has been successfully observed on large time scales.

We have then included a module to update source terms such as a cooling contribution allowing us to simulate the energy losses by radiation valid in optically thin approximation. The numerical combination (HYDRO-MUSCL-COOL) that is obtained reveals extremely robust since tolerating simulations made with high Mach numbers M > 100 that have never been obtained before in the literature. In addition, we performed various simulations to study the impact of the cooling function on young stellar jet morphology.

We have also developed a Radiative Transfer module (RT) based on the M1 method that includes both grey and multigroup models. HYDRO-MUSCL and RT modules have been coupled, forming the code HADES, in order to simulate radiative shocks and radiative jets. The first simulations that have been obtained will be presented. These new codes (e.g. HYDRO-MUSCL-COOL, HADES developed at LUTH) have been partially validated using direct laboratory experiments and comparisons with laser/matter dedicated codes. The question of parallelization of HADES code is finally addressed.