ID de Contribution: **68** Type: **Non spécifié**

An asymptotic preserving and well-balanced scheme for the M\textsubscript{1} model for radiative transfer

vendredi 4 décembre 2020 11:00 (30 minutes)

The problem of radiative transfer describes the interaction between light and matter, therefore it appears in many astrophysical systems, such as atmospheric physics (Chandrasekhar, 1960). Instead of solving a complex equation in a seven dimensional space, one can use a moment model by averaging over the direction of propagation to follow the radiative energy, flux, pressure, etc in a five dimensional space. By using a closure relation expressing the radiative pressure as a function of radiative energy and flux, one can derive the M1 model (Dubroca and Feugeas, 1999) that is able to accurately capture the two main regimes in radiative transfer: optically thin medium in which photons are free-streaming and the optically thick medium in which photons are constantly interacting and obey a diffusion equation in the asymptotic limit (Mihalas and Mihalas, 1984)

We rewrite the M1 model similarly than Euler equations and, inspired by all-regime schemes for hydrodynamics such as Padioleau et al., 2019, we propose a new solver based on a splitting approach similar to acoustic-transport splitting for hydrodynamics. Unlike Lagrange-projection methods (Buet and Despres, 2008), the extension to the multi-dimensional case is straightforward following the all-regime approach

The implementation is done using the code ARK-RT, a fork of the code ARK developed in Padioleau et al., 2019 in order to achieve high performance computing and portability across different architectures (e.g. multi-core, many-core, GP-GPU).

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Classification de Session: Session parallèle 7