

STRUPHY - STRUcture-Preserving HYbrid codes

Stefan Possanner

September 29, 2022

Abstract

We present STRUPHY (STRUcture-Preserving HYbrid codes) - a Python package for energetic particles (EPs) in plasma. The package is easy-to-use (PyPI and Docker installations) and features a collection of PDE solvers for fluid-kinetic hybrid models such as MHD-kinetic current and pressure coupling schemes, among others. Such models represent a decent compromise between physical content and numerical cost, as the bulk plasma is treated with a relatively "cheap" fluid model and only the EPs are described kinetically. The discretization is based on the GEMPIC framework [Kraus et al., GEMPIC: Geometric ElectroMagnetic Particle-In-Cell Methods, J. Plas. Phys. 2017] and leads to provable stability due to exact conservation laws. We will discuss some of the implemented hybrid models, their discretization and some numerical results in the context of magnetized plasmas. STRUPHY kernels are accelerated to Fortran speed using the open source accelerator <https://github.com/pyccele/pyccel>; an MPI/OpenMP hybrid parallelization allows for HPC application of STRUPHY. The package documentation is available under <https://struphy.pages.mpcdf.de/struphy/index.html>.