User case: 3D deterministic Boltzmann solver

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The density $f = f(x, v, t) \geq 0$ of particles follows[1]

The Boltzmann equation

$$\frac{\partial f}{\partial t} + v \cdot \nabla_x f + \frac{q}{m}(E + v \times B) \cdot \nabla_v f = Q(f), \quad x \in \Omega \subset \mathbb{R}^{d_x}, v \in \mathbb{R}^{d_v},$$

For example, the classical *Boltzmann collision operator* reads

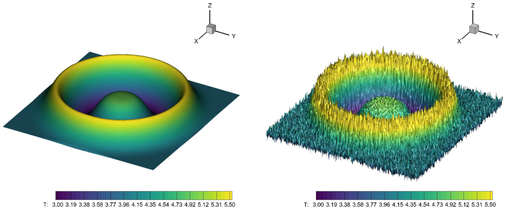
$$Q(f)(v) = \int_{\mathbb{R}^3} \int_{S^2} \sigma(v, v_*, \omega)(f(v')f(v'_*) - f(v)f(v_*))dv_* d\omega,$$

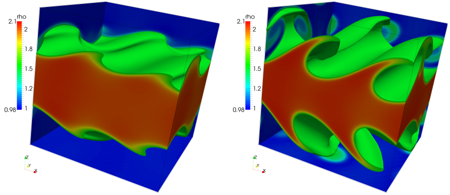
where σ is a nonnegative kernel characterizing the binary interactions. Another leading example is given by the so-called *Landau collision term* for Coloumbian interactions.

[1] C.Cercignani, Springer '88

The numerical method

1. Fast conservative spectral method for the collision operator[2].
2. High order finite volume on structured (3D-3D) and unstructured (2D-2D) meshes[3].
3. The software (Fortran, C++) heavily exploit parallelization techniques and HPC clusters: 3D-3D code tested on EOS Supercomputer Calmip, Toulouse (used 90 nodes and 1800 computational cores, C++), 2D-2D code tested on Marconi supercomputer, Bologna (used 128 cores, Fortran).





[2]L. Pareschi, T. Rey, SIAM Journal of Numerical Analysis, 2022
[3]W. Boscheri, G. Dimarco, Journal of Computational Physics, 2020