PAUL SCHERRER INSTITUT

ETH zürich

Tobia Claglüna :: AMAS Group, LSM

IPPL Meeting

May 23, 2023

Contact: tobia.clagluena@psi.ch

Friction Coefficient: DIH

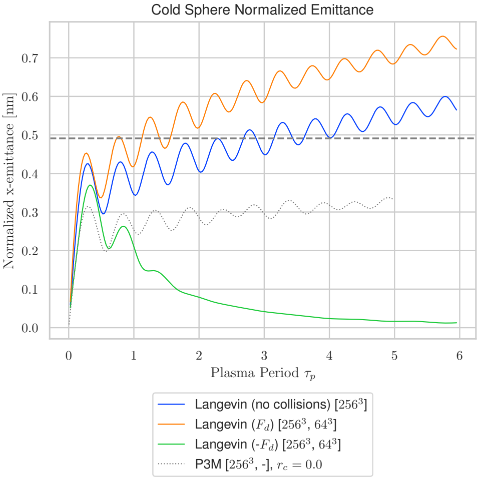

Figure 1: Poisson Solver possibly computes $-F_d(\vec{v})$?

Diffusion Coefficient: DIH

- Simulation crashes after 200-400 timesteps.
- Computed $\boldsymbol{D}(\vec{v})$ are positive definite and symmetric.
- Crashes in `scatterCIC()` as $\boldsymbol{Q}$ is too big (particles leave configuration space).

$\boldsymbol{D}$-Field Analysis: Maxwellian Test-Case

Diagonal elements of 3x3 matrices in the center of the domain Ω, averaged over all velocity cells:

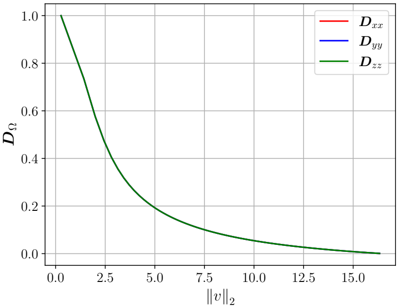

Figure 2: Diagonal elements of Ω (without boundary cells).

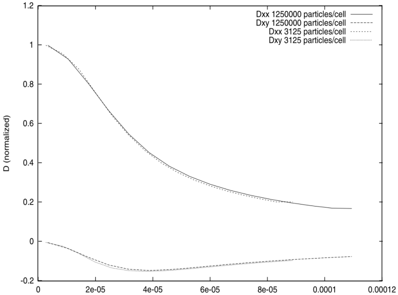

Figure 3: Reference distribution Qiang et al. [2000]

$\boldsymbol{D}$-Field Analysis: Maxwellian Test-Case

Diagonal elements of 3x3 matrices averaged over all velocity cells:

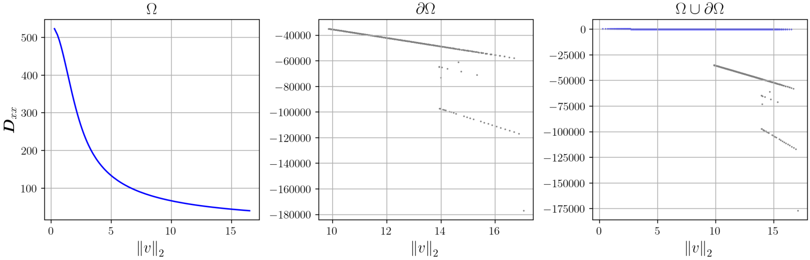

Figure 4: Diagonal elements of boundary cells $\partial\Omega$ compared to center cells Ω.

$\implies$ Onesided Hessian is needed to resolve boundary cells properly.

$\boldsymbol{D}$-Field Analysis: Maxwellian Test-Case

Off-Diagonal elements $\boldsymbol{D}_{xy}$ of 3x3 matrices:

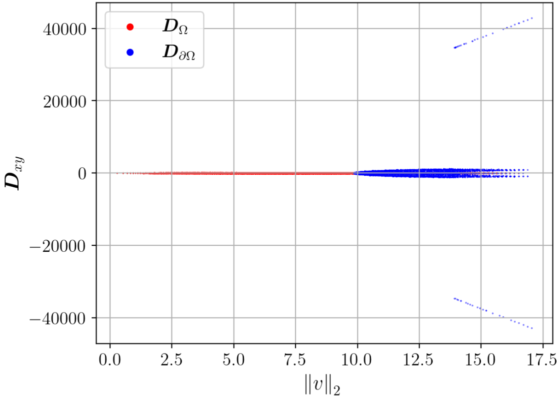

Figure 5: Distribution of off-diagonal entries on both the center domain and the boundary cells.

Progress

- ☑ Maxwellian Test-Case
- ☐ Onesided Hessian: $\boldsymbol{D}(\vec{v}) = \Gamma \frac{\partial^2}{\partial \vec{v} \partial \vec{v}}$
- ☐ Test how FD gradient impacts $F_d(\vec{v})$ (instead of computing it in Fourier space)
- ☐ Check if `FFTPoissonSolver` solves for $\Delta\phi = -\rho$ or $\Delta\phi = \rho$?
- Analyse Diffusion Coefficients on Boundary Cells in DIH:
  - ☑ Check that calculated $\boldsymbol{D}(\vec{v})$ are positive definite and symmetric
  - ☐ Analyse Error introduced by Cholesky decomposition
- Application to DIH:
  - ☑ $F_d(\vec{v})$
  - ☐ $\boldsymbol{D}(\vec{v})$

(Adjusted) Timeline

Date	Target Goals
16/05	Setup v-space datastructures in `LangevinParticles.hpp`. Add Friction coefficient. Add Solver for 2nd Rosenbluth potential $g(\vec{v})$.
23/05	Analyse structure of $\boldsymbol{D}$. Finish Diffusion coefficient computation (via onesided Hessian operator).
30/05	Analyse interplay between collision coeff.'s (see whether Severin's conclusions are confirmed or can be disproved).
	Profiling of runtime and memory consumption.
06/06	Start improving most pressing bottlenecks. Start writing.
17/07	Submission.

Table 1: Timeline with approximate milestones

Ji Qiang, Robert D. Ryne, and Salman Habib. Self-consistent langevin simulation of coulomb collisions in charged-particle beams. In *Proceedings of the 2000 ACM/IEEE Conference on Supercomputing*, SC '00, page 27–es, USA, 2000. IEEE Computer Society. ISBN 0780398025.