The Vlasov-Maxwell equations

$$\frac{\partial f}{\partial t} + \boldsymbol{v} \cdot \nabla f + \frac{q}{m}\left(\boldsymbol{E} + \frac{\boldsymbol{v}}{c} \times \boldsymbol{B}\right) \cdot \nabla_{\boldsymbol{v}} f = \left(\frac{\partial f}{\partial t}\right)_{\text{coll}}$$

$$\frac{1}{c}\frac{\partial \boldsymbol{E}}{\partial t} = \nabla \times \boldsymbol{B} - \frac{4\pi}{c}\boldsymbol{j} \ ,$$

$$\frac{1}{c}\frac{\partial \boldsymbol{B}}{\partial t} = -\nabla \times \boldsymbol{E} \ ,$$

$$\nabla \cdot \boldsymbol{E} = 4\pi\rho \ ,$$

$$\nabla \cdot \boldsymbol{B} = 0 \ .$$

$$\rho = \sum_{\text{species}} q \int f(\boldsymbol{x}, \boldsymbol{v}, t) d^3 v \ ,$$

$$\boldsymbol{j} = \sum_{\text{species}} q \int \boldsymbol{v} f(\boldsymbol{x}, \boldsymbol{v}, t) d^3 v \ .$$

Solving the Vlasov-Maxwell equations

Two options:

- Discretize the Vlasov equation on a grid in phase space:

1. computationally expensive to solve in 6+1 dimensions

2. how to determine the boundaries of the grid in momentum space?

3. what if f<0?

- Sample the phase space density with particles, and follow them as LAGRANGIAN tracers.