

## Kinetic description

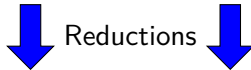
- VLASOV equation: dynamics of the distribution function  $f(\mathbf{x}, \mathbf{v}, t)$  of particles in phase space

$$\frac{\partial f}{\partial t} = -\mathbf{v} \cdot \nabla f - \frac{q}{m} (\mathbf{E} + \mathbf{v} \times \mathbf{B}) \cdot \frac{\partial f}{\partial \mathbf{v}} = \{f, \mathcal{H}\}$$

along with MAXWELL's equations for  $\mathbf{E}(\mathbf{x}, t)$  and  $\mathbf{B}(\mathbf{x}, t)$

- **Hamiltonian structure**: alternating bracket  $\{\cdot, \cdot\}$  which is bilinear and satisfies the JACOBI identity

$$\{F, \{G, H\}\} + \{H, \{F, G\}\} + \{G, \{H, F\}\} = 0$$



## Fluid description

- dynamics in configurations space:  $\mathbf{x}$  instead of  $(\mathbf{x}, \mathbf{v})$
- infinite number of field variables (density, velocity, pressure, ...)  
⇒ need to close these equations

Objective: obtain closed fluid models that preserve the Hamiltonian structure of the kinetic equations

## Framework

- 1D VLASOV-AMPÈRE:  $\partial_t f = -v\partial_x f + E\partial_v f$  and  $\partial_t E = 4\pi \int v f dv$
- 4+1 field model: density  $\rho(x, t)$ , velocity  $u(x, t)$ , pressure  $P(x, t)$ , heat flux  $q(x, t)$  and electric field  $E(x, t)$

## Result

- our model:

$$\partial_t \rho = -\partial_x(\rho u)$$

$$\partial_t u = -u\partial_x u - \frac{1}{\rho}\partial_x P - E$$

$$\partial_t P = -u\partial_x P - 3P\partial_x u - 2\partial_x q$$

$$\partial_t q = -u\partial_x q - 4q\partial_x u + \frac{3P}{2\rho}\partial_x P - \partial_x \left( \frac{P^2}{2\rho} + \frac{2q^2}{P} \right)$$

- discussions of invariants/conserved quantities