1. A simple collision model (Lorentz gas model) is to assume that a particle experience $\nu_s$ collisions per unit time and have a change of momentum of $-m_U_s$ in each collision. Therefore, the collisional drag force is also proportional to $U_s$.

2. The Lorentz gas model can describe well collisions between electron and neutrals, or even between ions and neutrals sometimes.

3. If a constant electric field is applied in a plasma, electron and ion velocities, as well as current density, will grow but saturate at steady values at a time scale of $1/\nu_s$. If there is no large-scale magnetic field, the steady state current density is given by the Ohm’s law: $J = \sigma E$, where $\sigma$ is the conductivity given by

$$\sigma = \sum \sigma_s = \sum \frac{n_s e_s^2}{m_s \nu_s}.$$

4. With a large-scale magnetic field $B_0 = B\hat{z}$, the Ohm’s law becomes anisotropic:

$$\mathbf{J} = \sigma \cdot \mathbf{E},$$

with

$$\sigma = \begin{pmatrix} \sigma_\perp & \sigma_H & 0 \\ -\sigma_H & \sigma_\perp & 0 \\ 0 & 0 & \sigma_i \end{pmatrix},$$

where $\sigma_\parallel$ is the same as $\sigma$ above,

$$\sigma_\perp = \sum \frac{\sigma_s}{1 + \omega_{cs}^2 / \nu_s^2}$$

is called the Pedersen conductivity, and $\sigma_H = \sum \frac{\sigma_s \omega_{ci} / \nu_s}{1 + \omega_{ci}^2 / \nu_s^2}$ is called the Hall conductivity.

5. If we now consider the motion of the plasma is mainly driven by inhomogeneous density (pressure), the flow velocity is then given by the balance among gradient pressure force, collisional drag force, and electric force.

6. Due to the existence of the electric force, ions and electrons have to diffuse at the same rate ($U_e = U_i$). This is called the ambipolar diffusion. Physically, electrons would diffusion faster but the electric field caused by the diffusion would move the ions together and thus reducing the total diffusion rate close to the ion diffusion rate.