Scattering Theory of Electro-Magnetic waves :-

Interaction between electromagnetic waves and particles produce unique scattering patterns that are wavelength and particle size dependent.
As electromagnetic waves propogate through matter they interact with particles or inhomogenieties and locally perturb the local electron distribution.

Scattering of electromagnetic waves by particles can be treated by two theoretical frameworks:
Rayleigh scattering ; that is applicable to small dielectric, non absorbing spherical particles, and
Mie scattering ; that provides a general solution to scattering independent of particle size.
Rayleigh scattering is strongly dependent upon the size of the particles and wavelength of illuminating radiation. The intensity of Rayleigh scattered radiation increases rapidly as a ratio of particle size to wavelength increases and is identical in forward and reverse direction.
The inherent scattering that radiation undergoes passing through a pure gas is due to microscopic density fluctuations as the gas molecules move around, which are normally in scale for Rayleigh's model to apply.
This scattering mechanism is a major cause of the blue colour of the Earth's sky on a clear day.

or

$$m_d n_d \frac{dv_d}{dt} = \frac{e}{c}\left(Z_i n_i v_i - n_e v_e - Z_d n_d v_d\right) \times \vec{B}$$

$$- e\left(n_e + Z_d n_d - Z_i n_i\right) \vec{E}$$

$$- \nabla\left(P_e + P_{re} + P_i + P_{ri}\right) + \rho_d \nabla \psi \quad (4)$$

From eqs (A) R_α, the momentum gain of electrons during collisions with ion;

$$P_{ei} = m_e n_e \nu_{ei} (v_i - v_e)$$

and momentum gain of ion during collion with electron

$$P_{ie} = m_i n_i \nu_{ie} (v_e - v_i)$$

P_{ei} and P_{ie} in terms of collision frequency;

$$R_\alpha = m_\alpha n_\alpha \sum \nu_{\alpha\beta} (v_\alpha - v_\beta)$$

where $\nu_{\alpha\beta}$ is elastic collisional frequency of Particles α and β. While for one fluid MHD equations we suppose that collision between particles are frequent. So, their velocities ($v_i \simeq v_e \simeq v_d$) which show conservation of momentum i.e

$$\sum_\alpha R_\alpha = 0$$

So we neglect term R_α in equation of motion.

Applying quasineutrality condition i.e

$\sum n_\alpha e_\alpha = 0$ on eqs (4) we get second term on R.H.S of eqs (4) as zero.

Also the current density $\vec{J}$ for all species can be written as.

$$J_e = -n_e e V_e$$

$$J_i = Z_i n_i e V_i$$

$$J_d = -Z_d n_d e V_d$$

* As charges are equal (quasi neutral) and momentum is conserved. *

So total current density can be written as

$$J = J_e + J_i + J_d.$$

$$J = e\left(Z_i n_i V_i - n_e V_e - Z_d n_d V_d\right)$$

Putting these values in eqs (4) we have

$$m_d n_d \frac{dV_d}{dt} = \frac{1}{c}(J \times B) - 0 - \nabla(P_e + P_{re} + P_i + P_{ri})$$
$$- \rho_d \nabla \psi = 0 \quad \text{--- } (5)$$

An adiabatic expression of Pressure for non-relativistic temperature is given as follows. where $T < m_o c^2$ i-e if temperature is less than the rest-mass of particle then it is non-relativistic and otherwise when $T \geq m_o c^2$ i-e temp is greater then or equal to rest-mass of particles (e.g e^-, ions, dust etc) then it is relativistic temperature.

So for non-relativistic temperature, adiabatic relation is

$$\frac{P_\alpha}{n_\alpha^{5/3}} = C \text{ (Constant)}$$

As $P_{o\alpha}$ and $n_{o\alpha}^{5/3}$ are also constant terms so we can write

$$\frac{P_{o\alpha}}{n_{o\alpha}^{5/3}} = C$$

So putting the value of C in above eqs.

$$\frac{P_\alpha}{n_\alpha^{5/3}} = \frac{P_{o\alpha}}{n_{o\alpha}^{5/3}}$$

or $$\frac{P_\alpha}{P_{o\alpha}} = \frac{n_\alpha^{5/3}}{n_{o\alpha}^{5/3}}$$

or $$\boxed{P_\alpha = \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{5/3} P_{o\alpha}} \quad \text{— (6)}$$

Now we want to write Pressure term in terms of temperature so we know that

$$P = n K_B T$$

or $$P = n T$$ $\quad | \because$ T in energy Units

for α species.

$$P_\alpha = n_\alpha T_\alpha$$

Also $$P_{o\alpha} = n_{o\alpha} T_{o\alpha}$$

Putting the values of P_α and $P_{o\alpha}$ in eqs (6)

$$n_\alpha T_\alpha = \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{5/3} n_{o\alpha} T_{o\alpha}$$

or
$$T_\alpha = \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{5/3} \left(\frac{n_{o\alpha}}{n_\alpha}\right) T_{o\alpha}$$

or $$T_\alpha = \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{5/3} \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{-1} T_{o\alpha}$$

or $$\boxed{T_\alpha = \left(\frac{n_\alpha}{n_{o\alpha}}\right)^{2/3} T_{o\alpha}}$$

So writing above equation for electrons, and ions

for e^- → $$T_e = \left(\frac{n_e}{n_{oe}}\right)^{2/3} T_{oe}$$

for ion $$T_i = \left(\frac{n_i}{n_{oi}}\right)^{2/3} T_{oi}.$$

Similarly Pressure eqs for electron and ions

for e^- $$P_e = \left(\frac{n_e}{n_{oe}}\right)^{5/3} P_{oe}$$

for ion $$P_i = \left(\frac{n_i}{n_{oi}}\right)^{5/3} P_{oi}$$