

The particle kinetic energy varies as

$$\frac{\partial}{\partial t} \frac{1}{2} \rho v^2 = \delta \mathbf{v} \cdot \mathbf{E} = \mathbf{j} \cdot \mathbf{E}$$

which can be written

$$\frac{\partial}{\partial t} \left(\frac{1}{2} \rho v^2 + \frac{\mathbf{B}^2}{8\pi} \right) + \nabla \cdot \mathbf{P} = 0$$

with the electromagnetic energy flux given by \mathbf{P} .

Note that, if initially each particle is represented by a localized spike in ρ and δ , it is an easy matter to average over a local volume V because the equations are all linear in ρ and δ .

Note that if $\mathbf{E} = -\mathbf{v} \times \mathbf{B} / c$

$$\text{then } \mathbf{P} = \mathbf{v}_{\perp} \frac{B^2}{4\pi}$$

Where \mathbf{v}_{\perp} is the velocity $\perp \mathbf{B}$

