Guiding Center Equation

reference ::

$$\frac{\partial f}{\partial t} + \vec{v} \cdot \frac{\partial f}{\partial \vec{x}} + \dot{v}_{\parallel} \frac{\partial f}{\partial v_{\parallel}} = 0$$

$$\vec{v} = v_{\parallel} \frac{\vec{B}^*}{B_{\parallel}^*} + \frac{\vec{D}}{B_{\parallel}^*} \times \vec{b}$$

$$\dot{v}_{\parallel} = \frac{q}{m} \vec{D} \cdot \frac{\vec{B}^*}{B^*{}_{\parallel}}$$

$$\vec{D} = \vec{E} - \frac{\mu}{q} \nabla \vec{B} - \frac{m}{q} \left(v_{\parallel} \frac{\partial b}{\partial t} + \frac{\partial \vec{v_E}}{\partial t} + \nabla \frac{v_E^2}{2} \right)$$

$$\vec{v_E} = \frac{\vec{E}}{B} \times \vec{b}$$

$$\vec{B}^* = \vec{B} + \frac{m}{q} \left(v_{\parallel} \nabla \times \vec{b} + \nabla \times \vec{v_E} \right)$$

$$B_{\parallel}^* = \vec{B}^* \cdot \vec{b}$$

$$B = |\vec{B}|$$

if pitch angle is 90 degree, $v_{\parallel} = 0$

$$\frac{\partial f}{\partial t} + \vec{v} \cdot \frac{\partial f}{\partial \vec{x}} = 0$$

$$\vec{v} = \frac{\vec{D}}{B_{\parallel}^*} \times \vec{b}$$

$$\vec{D} = \vec{E} - \frac{\mu}{q} \nabla \vec{B} - \frac{m}{q} \left(\frac{\partial \vec{v_E}}{\partial t} + \nabla \frac{v_E^2}{2} \right)$$

$$\vec{v_E} = \frac{\vec{E}}{B} \times \vec{b}$$

$$\vec{B}^* = \vec{B} + \frac{m}{q} \left(\nabla \times \vec{v_E} \right)$$

$$B_{\parallel}^* = \vec{B}^* \cdot \vec{b}$$

$$B = |\vec{B}|$$