Guiding Center Equation

reference:: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2010JA015682

$$rac{\partial f}{\partial t} + ec{v} \cdot rac{\partial f}{\partial ec{x}} + ec{v}_\parallel rac{\partial f}{\partial v_\parallel} = 0$$

$$ec{v} = v_\parallel rac{ec{B}^*}{B_\parallel^*} + rac{ec{D}}{B_\parallel^*} imes ec{b}$$

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

$$ec{D} = ec{E} - rac{\mu}{a}
abla ec{B} - rac{m}{a}(v_\parallel rac{\partial b}{\partial t} + rac{\partial ec{v_E}}{\partial t} +
abla rac{v_E^2}{2})$$

$$ec{v_E} = rac{ec{E}}{B} imes ec{b}$$

$$ec{B^*} = ec{B} + rac{m}{a} (v_\parallel
abla imes ec{b} +
abla imes ec{v_E})$$

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

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

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

$$rac{\partial f}{\partial t} + ec{v} \cdot rac{\partial f}{\partial ec{x}} = 0$$

$$ec{v} = rac{ec{D}}{B_{\shortparallel}^*} imes ec{b}$$

$$ec{D}=ec{E}-rac{\mu}{q}
ablaec{B}-rac{m}{q}(rac{\partialec{v_E}}{\partial t}+
ablarac{v_E^2}{2})$$

$$ec{v_E} = rac{ec{E}}{B} imes ec{b}$$

$$ec{B^*} = ec{B} + rac{m}{q} (
abla imes ec{v_E})$$

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

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