97/09/10
Physics of Astrophysics Vol2 p.298

$I = \oint H \cdot dp = \iint j\, dS = \iint \mathrm{rot} H \cdot dS$

$\varepsilon = -\frac{\partial \Phi}{\partial t}$

$\oint E \cdot dp = -\frac{\partial}{\partial t} \iint B$

$= \iint \mathrm{rot} E\, dS$

$\therefore \mathrm{rot} E = -$

Date 90. 5. 25

○ 磁場の凍りつき

☆ $\mathrm{rot}\,\mathbb{B} - \frac{1}{c}\frac{\partial \mathbb{E}}{\partial t} = \frac{4\pi}{c}\mathbb{j}$ 　　$v \ll c$ のとき無視できる

$$\mathrm{rot}\,\mathbb{B} = \frac{4\pi}{c}\mathbb{j} \qquad (1)$$

☆ $$\mathbb{j} = \sigma\left(\mathbb{E} + \frac{v}{c}\times\mathbb{B}\right) \qquad (2)$$

☆ $$\frac{1}{c}\frac{\partial \mathbb{B}}{\partial t} = -\mathrm{rot}\,\mathbb{E} \qquad (3)$$

(3) より $\frac{\partial \mathbb{B}}{\partial t} = -c\,\mathrm{rot}\,\mathbb{E} = -c\,\mathrm{rot}\left(\frac{\mathbb{j}}{\sigma} - \frac{v\times\mathbb{B}}{c}\right) = -\mathrm{rot}\left(\frac{c}{\sigma}\mathbb{j} - v\times\mathbb{B}\right)$

$= \mathrm{rot}(v\times\mathbb{B}) - \frac{c}{\sigma}\mathrm{rot}\,\mathbb{j}$

$= \mathrm{rot}(v\times\mathbb{B}) - \frac{1}{\sigma}\cdot\frac{c^2}{4\pi}\mathrm{rot}(\mathrm{rot}\,\mathbb{B})$ 　　$\mathrm{grad}(\mathrm{div}\,\mathbb{B}) - $ 　$= -\Delta\mathbb{B}$

$$\boxed{\frac{\partial \mathbb{B}}{\partial t} = \mathrm{rot}(v\times\mathbb{B}) + \frac{c^2}{4\pi\sigma}\Delta\mathbb{B}}$$

$\eta \equiv$ magnetic

$v = 0$ のとき　拡散の式

$\frac{\partial B}{\partial t} = \eta \frac{\partial^2 B}{\partial x^2}$

$B \propto e^{-\frac{t}{T}}\left(Ae^{-i\frac{x}{X}} + \right.$

$\frac{1}{T} = \eta\frac{1}{X^2}$

$\boxed{\eta = \frac{X^2}{T}}$

diffusion timescale $t_D \approx \frac{X^2}{\eta}$

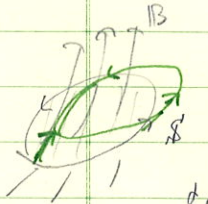
拡散が無視できるとき

$$\frac{\partial \mathbb{B}}{\partial t} = \mathrm{rot}(v\times\mathbb{B})$$

$$\frac{\partial \mathbb{B}}{\partial t} + \mathrm{rot}(\mathbb{B}\times v) = 0$$

$$\boxed{\frac{d}{dt}\iint \mathbb{B}\cdot dS = 0}$$

磁力線は流体に

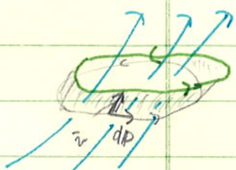


$\frac{d}{dt}\iint \mathbb{B}\cdot dS = \iint \frac{\partial \mathbb{B}}{\partial t} dS$

$+ \oint \mathbb{B}\cdot(v\times dp)$

$= \oint dp\cdot(\mathbb{B}\times v)$

$= \iint \mathrm{rot}(\mathbb{B}\times v)\, dS$



$t_{拡散} = \frac{R^2}{\eta} = \frac{4\pi}{c^2}$

宇宙ではとても大きい

cooo
$\mathbb{A}\cdot(\mathbb{B}\times\mathbb{C})$
$= \mathbb{B}\cdot(\mathbb{C}\times\mathbb{A}) = \mathbb{C}\cdot(\mathbb{A}\times\mathbb{B})$

うらにもある。