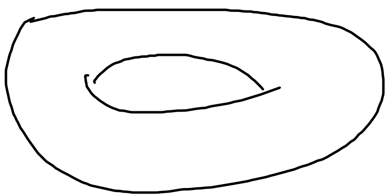
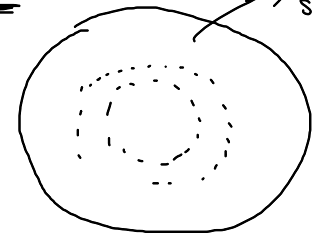
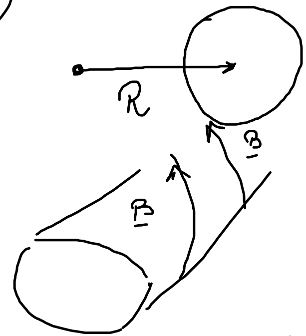
B_T B_P

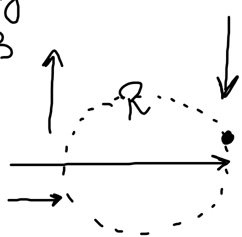
$B_T \propto \frac{1}{R}$

$B_P << B_T$



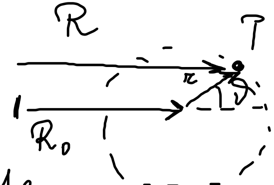






$R = R_0 + r\cos\theta$

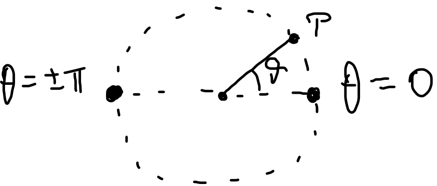
$B_T = \frac{B_0 R_0}{R}$



R_0: major radius

r: minor radius of flux surface

$$B \approx B_T = \frac{B_0 R_0}{R_0 + r\cos\vartheta} = B_T(\vartheta)$$

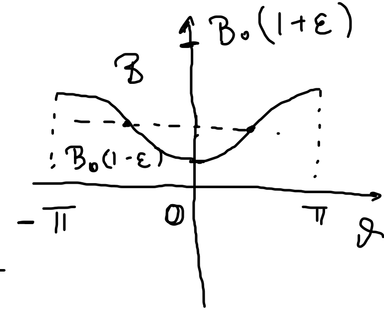


B_T is max if $\vartheta = \pi$

$$B_{max} \approx \frac{B_0 R_0}{R_0 - r}$$

B_T is min if $\vartheta = 0$

$$B_{min} \approx \frac{B_0 R_0}{R_0 + r}$$



$$\varepsilon = \frac{r}{R_0} \ll 1$$

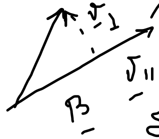
$$B_T \approx \frac{B_0}{1 + \varepsilon\cos\vartheta} \approx B_0(1 - \varepsilon\cos\vartheta) \qquad U_B = \mu B$$

$W < \mu B_{max}$: 2 T.P. exist

$W > \mu B_{max}$: No T.P. exists

$W > \mu B_{max}$: circulating (passing) particle

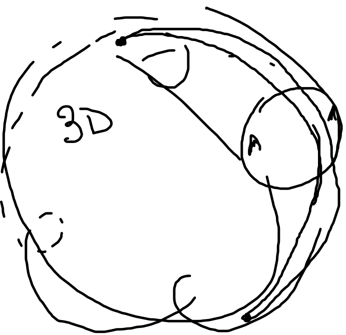
$W < \mu B_{max}$: trapped particle



$$\sin\theta_0 = \frac{v_{\perp 0}}{v_0} \leq \sqrt{\frac{B_{min}}{B_{max}}} = \sqrt{\frac{B_0(1-\varepsilon)}{B_0(1+\varepsilon)}} = \sqrt{\frac{1-\varepsilon}{1+\varepsilon}}$$

place where $B = B_{min}$

Токамак



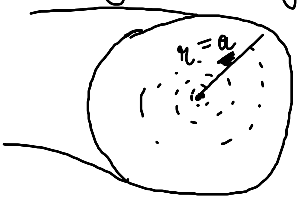
$$\frac{v_{\perp 0}^2}{v_{\parallel 0}^2 + v_{\perp 0}^2} = \frac{v_{\perp 0}^2}{v_0^2} \leq \frac{1-\varepsilon}{1+\varepsilon} \quad ; \quad \frac{v_{\parallel 0}^2 + v_{\perp 0}^2}{v_{\perp 0}^2} \geq \frac{1+\varepsilon}{1-\varepsilon}$$

$$1 + v_{\parallel 0}^2 / v_{\perp 0}^2 \geq \frac{1+\varepsilon}{1-\varepsilon} \approx (1+\varepsilon)^2 \approx 1 + 2\varepsilon$$

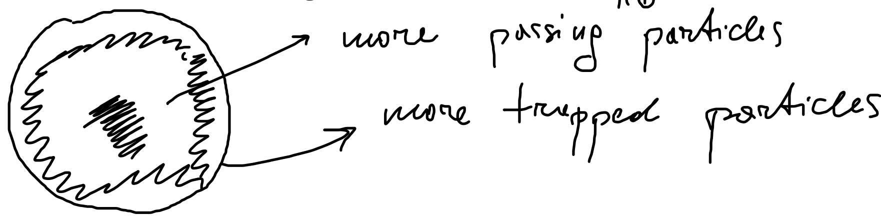
For a trapped particle:

$$\frac{v_{\parallel 0}}{v_{\perp 0}} < \sqrt{2\varepsilon}$$

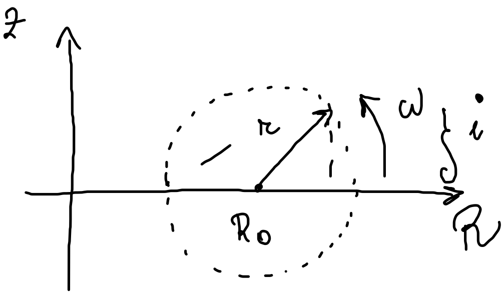
Inner most flux surfaces: $\varepsilon \to 0$



For the outermost flux surface $\varepsilon = \frac{a}{R_0}$



Passing particle orbit



without drift

$$\begin{cases} R = R_0 + r\cos(\omega t) \\ z = r\sin(\omega t) \end{cases}$$

~~rot~~ rotational transform

$$\omega = \frac{\iota}{T} = \frac{\iota}{2\pi R_0} v_\parallel = \frac{2\pi R_0}{r}\frac{B_p}{B_T}\frac{v_\parallel}{2\pi R_0} = \frac{v_\parallel}{r}\frac{B_p}{B_T}$$

$$\iota = \frac{2\pi R_0}{r}\frac{B_p}{B_T}$$

$$v_\parallel = \frac{2\pi R_0}{T} \Rightarrow T = \frac{2\pi R_0}{v_\parallel}$$

toroidal transit time

$\omega \approx$ const

? with drift ?