Cyclotron

- Cyclotron radiation is so named as it was first seen in cyclotrons
- Both cyclotron and synchrotron radiation are occasionally referred to as magnetobremstrahlung (mostly old texts)
- Synchrotron radiation is relativistic version of cyclotron radiation
- Both are Polarized -because there is a preferred direction.

Magnetic force on an moving electron

- Use Ampere's law on the current (ev)
- Assume that the external field dominates

$$\vec{F} = e(\vec{B} \times \vec{v})$$

- The force is transverse to the motion and field so it doesn't change speed or velocity parallel to the field, just transverse motion across field forcing our charged particle into spiral motion

spiral

- If the spiral has radius R and angular velocity ω
- transverse speed ωR
- centripetal force $m\omega^2 R$

$$m\,\omega^2\,R = F = e\,\omega\,RB$$

$$\omega = \frac{e\,B}{m}$$

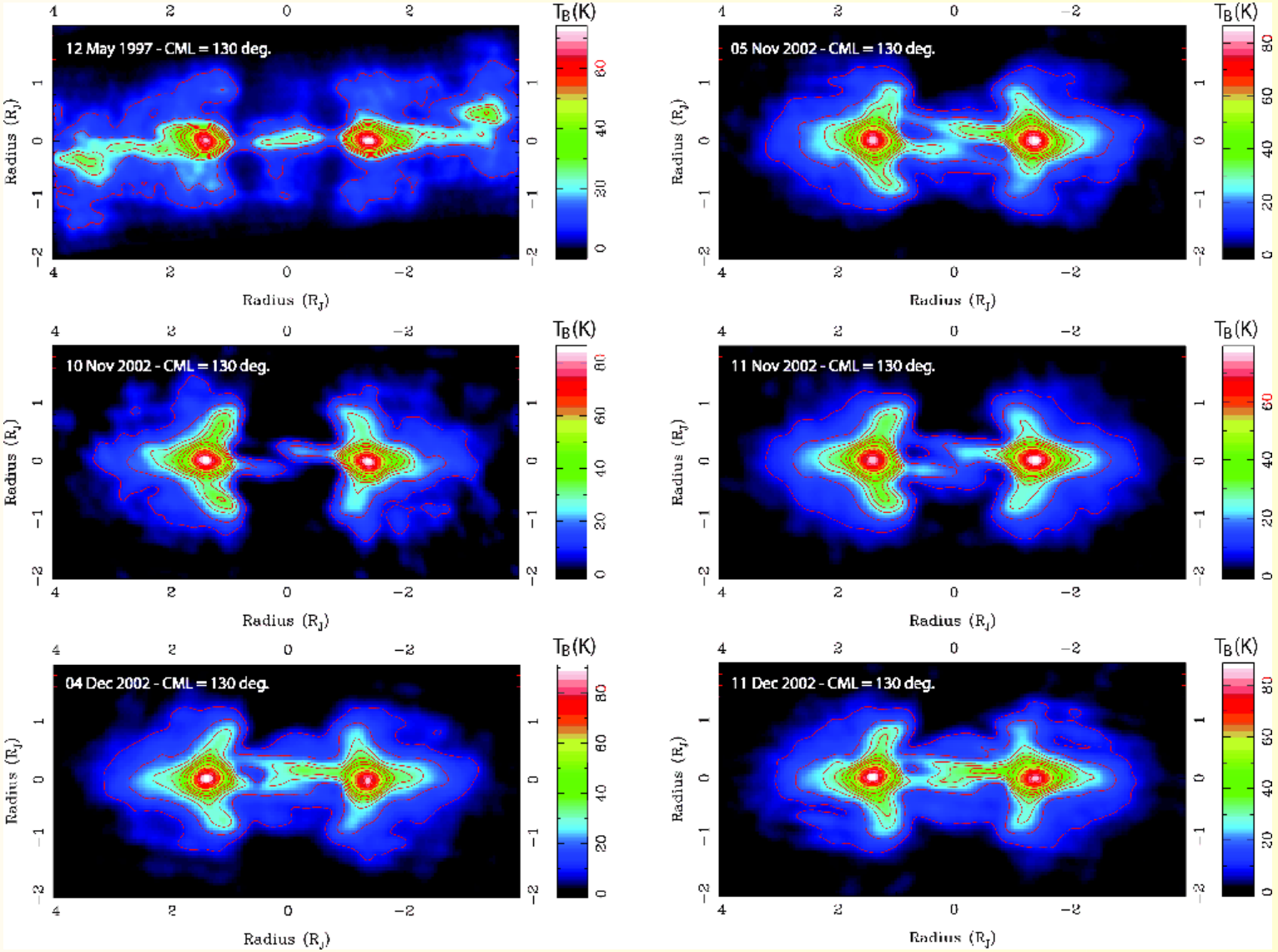
radio gyro frequency

- frequency $\nu = \omega/2\pi$

  in common units $\frac{\nu}{MHz} = 2.8\left(\frac{B}{Gauss}\right) = 2.8\times10^{4}\left(\frac{B}{Tesla}\right)$

- This must be the frequency of the radiation; for many cases this is too low to observe through the ionosphere.
- As it can radiate, it can also absorb at the same frequency

Jupiter's decimetric radio



Energy loss per particle

- for a velocity V

  if we define **Thomson cross section** $\sigma_T = \frac{8\pi}{3}\left(\frac{q^2}{4\pi\epsilon mc^2}\right)^2$

- for electrons this is about $6.6\text{x}10^{-29}\text{m}^2$ or 0.66barn

$$\frac{-dE}{dt} = \frac{\sigma_T B^2 V^2}{c\,\mu}$$