Answer on Question 55060, Physics / Astronomy | Astrophysics

Question:

For an electron moving at a non-relativistic speed v in a region of uniform magnetic field strength B, derive the formula for the total emitted power due to gyro radiation. If the magnetic field is in the plane of the sky, how would the gyro radiation be polarized as measured here on Earth? What if the magnetic field lines pointed towards or away from the observer?

Answer:

For gyro radiation, the acceleration is given by:

$$\dot{\upsilon} = \upsilon\omega_G \sin a = \upsilon\left(\frac{eB}{m_e c}\right)\sin a$$

The power emitted by an accelerating electron is given by:

$$P = \frac{2}{3}\frac{e^2\dot{\upsilon}^2}{c^3} = \frac{2}{3}\frac{e^2}{c^3}\left(\frac{\upsilon^2 e^2 B^2 \sin^2 a}{m_e^2 c^2}\right) = \frac{2}{3}\frac{e^4\upsilon^2 B^2 \sin^2 a}{m_e^2 c^5}$$

If the magnetic field is in the plane of the sky, the acceleration vector is always perpendicular to the sky and rotates with the gyro frequency. Therefore, the observed electric field due to this radiation varies sinusoidally, which means that the radiation is linearly polarized.

If the magnetic field is along the line of sight, then the acceleration vector rotates in the plane of the sky. The incoming radiation is circularly polarized. Specifically, for magnetic field lines pointing away from the observer, it is left circularly polarized, and for field lines pointing toward the observer, it is right circularly polarized.