Answer on Question #66513, Physics / Electromagnetism

A typical magnetic field strength for the Milky Way Galaxy is 5.0 × 10−10 T. If a cosmic ray electron is moving with a speed of 3.0 × 106 m/s, what is the radius of its spiral path (i.e., the cyclotron radius)? How long does it take such an electron to make one full circle?

Solution:

We use the following equation

$$r = \frac{mv}{qB}$$

Where, r is radius, m is the mass of a charged particle (9.1 x 10^{-31} kg), v is the velocity perpendicular to the line of the magnetic field, q is particle charge (1.6 x 10^{-19} C), B is magnetic induction.

$$r = \frac{9.1 \cdot 10^{-31} kg \times 3.0 \cdot 10^{6} m/s}{1.6 \cdot 10^{-19} C \times 5.0 \cdot 10^{-10} T} = 3.4 \cdot 10^{4} m$$

Time of one complete rotation

$$\tau = 2\pi \frac{m}{qB}$$

$$\tau = 2\pi \times \frac{9.1 \cdot 10^{-31} kg}{1.6 \cdot 10^{-19} C \times 5.0 \cdot 10^{-10} T} = 7.14 \cdot 10^{-2} s$$

Answer: $3.4 \cdot 10^{4} m$ and $7.14 \cdot 10^{-2} s$

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