Assignment #1

Elementary Particle Physics: Phys 4602-5602

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Due January 16th, 2012

Students registered in 4602 and 5602 do ALL problems.

1. Consider an experiment similar to the experiment by J. J. Thomson. A beam of positron ($q = +e$ and $m = m_e$) enters crossed electric and magnetic fields. The speed selector has an electric field E and a magnetic field B. Then the beam enters a mass spectrometer. The magnetic field and the circular deflection are B_0 and d, respectively. Figure 1 describes the experimental apparatus. Express m_e/e in term of E, B, d and B_0.

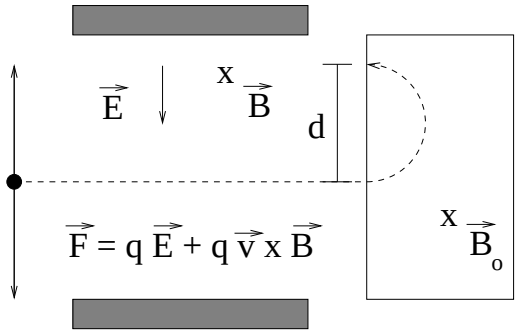

Figure 1: Mass spectrometer.

2. Explain how the positron (*i.e.* anti-electron) was discovered.

3. In the Lawrence cyclotron a constant magnetic field B_0 guides the ions (nuclei) of charge q and mass m in a spiral path (see Figure 2). The acceleration is imparted by an electric field E_0 that has the correct direction any time the partcile is subject to it.

   (a) Show that the cyclotron freqency is $w_c = \frac{q}{m} B_0$.

   (b) What is the kinetic energy of a non-relativistic ion in the emergant beam at a radius r?

(c) When the particle speed gets very large, the relativistic equation has to be used. Explain why the cycloron frequency will no longer be a constant but will vary with the particle speed.

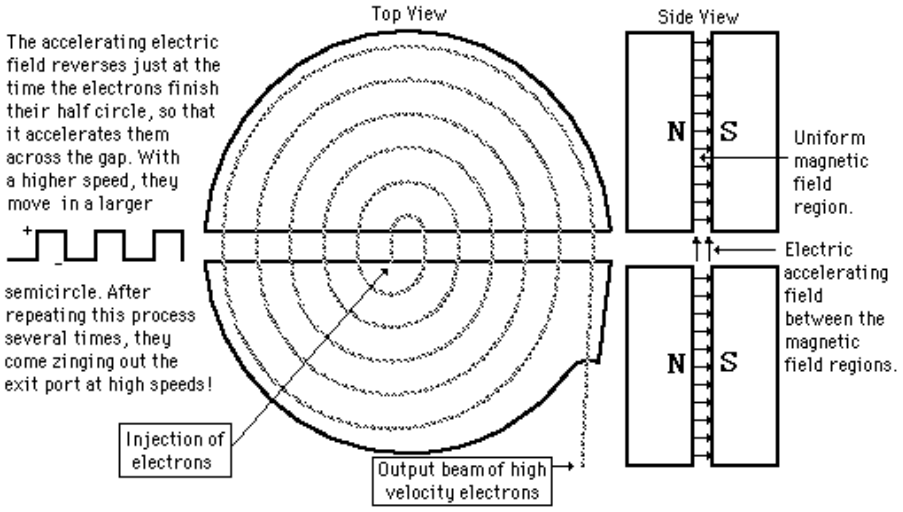

Figure 2: E.O. Lawrence cyclotron.