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Lorentz Stripping of H$^-$ Ions*†

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When an H$^-$ ion moves in a magnetic field B it experiences a Lorentz force that bends its trajectory and also tends to break it up since the protons and electrons are bent in opposite directions, and the binding energy of the extra electron is only 0.755 eV. The breakup is a probabilistic process and quantum-mechanical in nature. In the ion rest frame, the stripping force is effected by the electric field E that is the Lorentz-transform of the magnetic field B in the lab, $E = \kappa'\beta\gamma B$, where $\kappa' \simeq 0.3$ GV/T-m. For the H$^-$ ion, $E[\mathrm{MV/cm}] = 3.197\, p[\mathrm{GeV/c}]\, B[\mathrm{T}]$ where p is the ion momentum in the lab.

The lifetime of the ion in an electric field can be calculated by applying the WKB approximation to the tunneling probability [2–4]. It has also been measured in several experiments [5–8] whose results, for the ion's lifetime τ *in its own rest frame* is well parametrized as

$$\tau = \frac{A}{E} \exp\left(\frac{C}{E}\right) \tag{1}$$

In the region of values of E where they overlap, the measurements in Refs. 5,7,8 are fairly consistent with each other, but are not consistent with Ref. 6. Ref. 7, which covers the range $E = 1.87 - 2.14$ MV/cm, has $A = 7.96 \times 10^{-14}$ s MV/cm and $C = 42.56$ MV/cm, while Ref. 8, which covers $E = 1.87 - 7.02$ MV/cm, has $A = (2.47 \pm 0.09) \times 10^{-14}$ s MV/cm and $C = 44.94 \pm 0.10$ MV/cm. The mean decay length in the lab is given by

$$\lambda = c\beta\gamma\tau \tag{2}$$

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