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ISABELLE PROJECT

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INTERSECTING STORAGE ACCELERATOR NOTES

e-p ELASTIC SCATTERING AT ISABELLE

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As with my CRISP report on inelastic scattering,[1] assume a 10-GeV e^- ring inside the ISABELLE tunnel with an e-p luminosity of 10^{33} cm^{-2} sec^{-1} over the interacting region. We will now estimate the event rate for elastic scattering in the region of $Q^2 = 2$ GeV^2.

In the rest frame of the target proton

$$\frac{d\sigma_o}{d\omega_o} = \frac{\alpha^2}{4E_o^2 \sin^4 \frac{\theta_o}{2}} \cos^2 \frac{\theta_o}{2} \left[1 + \frac{2E_o}{M} \sin^2 \frac{\theta_o}{2}\right]^{-1} G^2(Q^2) ,$$

where

$$E_o = \frac{2E_p}{M} E = 4600 \text{ GeV} .$$

In the region $Q^2 = 2$, $\theta_o \approx 1/2000$ and then

$$\frac{d\sigma_o}{d\omega_o} \approx \frac{4\alpha^2}{Q^4} E_o^2 G^2(Q^2) .$$

The invariant cross section is $d\sigma/dQ^2$, where $Q^2 = 2EE'(1 - \cos\theta)$:

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$$dQ^2 = -2EE'd(\cos\theta) = \frac{EE'}{\pi}\, d\omega$$

$$\frac{d\sigma}{dQ^2} = \frac{\pi}{EE'}\frac{d\sigma}{d\omega} = \frac{\pi}{E_oE_o'}\frac{d\sigma_o}{d\omega_o}$$

$$\frac{d\sigma}{d\omega} \approx \frac{EE'}{E_o^2}\left(\frac{4\alpha^2}{Q^2}E_o^2\,G^2\right)$$

$$= \frac{4\alpha^2}{Q^4}E^2G^2 \qquad \text{since } E' = E - \frac{Q^2}{4E_p} + \frac{Q^2}{4E} \approx E\ .$$

For $Q^2 = 2\ \text{GeV}^2$:

$$\frac{d\sigma}{d\omega} = \frac{4(1/137)^2 \times 10^2}{4}\,G^2 \qquad G^2 = \left(\frac{1}{1+\frac{Q^2}{0.71}}\right)^4 = 4.73 \times 10^{-3}$$

$$\approx 1 \times 10^{-32}\ \text{cm}^2/\text{sr}\ .$$

Outline of Experimental Approach

It is feasible to momentum analyze both the electron and the proton and to put them in coincidence. At $Q^2 = 2\ \text{GeV}^2$ the scattered electrons are 10.05 GeV at $\theta = 11.5^\circ$. They are detected by a simple one-magnet spectrometer similar to that suggested for doing inelastic electron scattering at ISABELLE.[1] The magnet is a septum version of a 30D72. The detectors are proportional chambers and will give an accurate Q^2 value for each event. The proton detector is the same as one of the arms used in the suggested p-p elastic scattering experiment.[2] Protons of a given Q^2 are focused to a point on a proportional chamber. The accompanying electron must have the same Q^2 and correct θ.

Estimated Rate

Solid angle in the electron arm is $\Delta\omega \approx 2 \times 10^{-3}$ sr :

$$N_{ep} = \mathcal{L}\,\frac{d\sigma}{d\omega}\,\Delta\omega = 10^{33} \times 1 \times 10^{-32} \times 2 \times 10^{-3} = 2 \times 10^{-2}/\text{sec}$$

$$= 70\ \text{events/h}\ .$$

The proton form factor is dropping too fast with Q^2 to go much higher in Q^2. Certainly there will be no elastic background to the inelastic experiments in the region $10 < Q^2 < 100\ \text{GeV}^2$.

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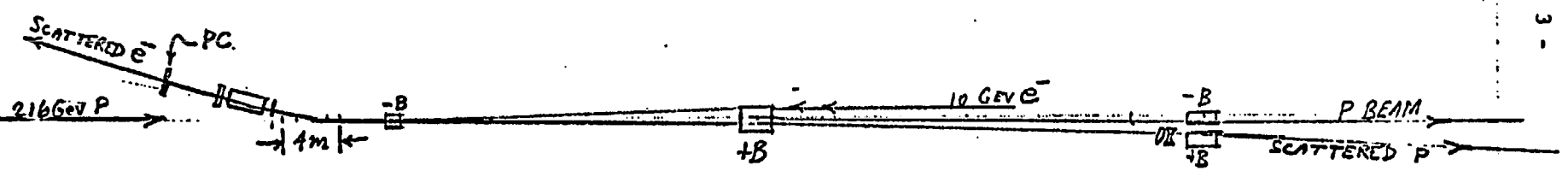
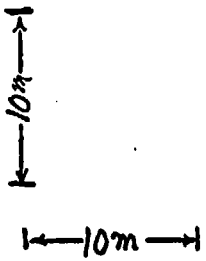
e-P ELASTIC SCATTERING

$Q^2 = 2$ GeV^2





1 INCH = 10 m