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CRISP 71-21
 ISABELLE PROJECT

INTERSECTING STORAGE ACCELERATOR NOTES

e-p ELASTIC SCATTERING AT ISABELLE

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MASTER

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 $10^{33} \text{ cm}^{-2} \text{ sec}^{-1}$ over the interacting region. We will now estimate the event rate for elastic scattering in the region of $Q^2 = 2 \text{ GeV}^2$.

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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1. J. Orear, CRISP 71-19.

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

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

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

$$= \frac{4\alpha^2}{Q^4} E^2 G^2$$

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

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

$$\frac{d\sigma}{d\omega} = \frac{4(1/137)^2 \times 10^2}{4} G^2$$

$$G^2 = \left(\frac{1}{1 + \frac{Q^2}{0.71}} \right)^4 = 4.73 \times 10^{-3}$$

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

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 $\Delta\omega \approx 2 \times 10^{-3} \text{ sr}$:

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

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

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 $10 < Q^2 < 100 \text{ GeV}^2$.

e-P ELASTIC SCATTERING

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

