

Compton Scattering of Deuterons

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Abstract

The Compton scattering of deuterons is accounted for by treating the deuteron as an elementary particle.

Differential cross sections for Compton scattering from deuterium in the process $\gamma D \rightarrow \gamma D$ have been measured by Boyarski *et al.* (1971) for squared four-momentum transfer $-t$ in the range $0.014-0.169$ $(\text{GeV}/c)^2$ and at photon energies of 8 and 16 GeV. The vector dominance model (VDM) of Sakurai (1970) can be used to predict the differential cross sections for this reaction at 8 GeV by using the values for the ρ cross section from deuterium measured by Leith (1969) at 7.5 and 9 GeV and assuming that ω and ϕ production from neutrons and protons are equal. However, the predictions of the VDM are found to be inconsistent with the experimental results of Boyarski *et al.* In this note we show that photon-deuteron elastic scattering can be satisfactorily described by a dual absorptive model in which the real part of the pomeron is considered to be negligible and the process is treated as a two-particle collision, the structure of the deuteron being taken into account by the introduction of a form factor.

The number of independent helicity non-flip amplitudes for $\gamma D \rightarrow \gamma D$ is four. At high energies the pomeron will dominate the behaviour of this process and will be coupled only to helicity non-flip scattering amplitudes. Since the real part of the pomeron term is negligible, any one of the helicity non-flip amplitudes can be written in the form

$$f_0 = i\beta_0(t)(s/s_0)^{\alpha(t)},$$

where β_0 is the residue function and α is the pomeron trajectory. With $s_0 = 1$ $(\text{GeV}/c)^2$, the contribution to the differential cross section may be written as

$$d\sigma/dt = \sum_{\beta_0} \beta_0^2(t) s^{2\alpha(t)} / s p_s^2,$$

where

$$s = m^2 + 2mp_L \quad \text{and} \quad p_s^2 = (s - m^2)^2 / 4s,$$

m being the mass of the deuteron and p_L its laboratory momentum. We find that a very good fit with experiment is obtained by choosing the values

$$\begin{aligned} \beta_0^{(1)}(t) &= 0.576 e^{11.51t} (\mu b)^{\frac{1}{2}} \text{ GeV}, & \beta_0^{(2)}(t) &= 0.253 (\mu b)^{\frac{1}{2}} \text{ GeV}, \\ \beta_0^{(3)}(t) &= \beta_0^{(4)}(t) = 0, & \alpha(t) &= 1 + 0.3t. \end{aligned}$$

Figs 1a and 1b show the experimental results of Boyarski *et al.* (1971) for the differential cross sections at incident photon energies of 8 and 16 GeV respectively, plotted as a function of $-t$ for $0.014 \leq -t \leq 0.169$ (GeV/c)². It can be seen that the theoretical curves from the dual absorptive model described above are in excellent agreement with experiment at 16 GeV over the entire range of $-t$. At 8 GeV the predictions of the model are good except for small values of $-t$. This is probably due to the fact that at this energy the contributions from trajectories other than the pomeron cannot be completely ignored.

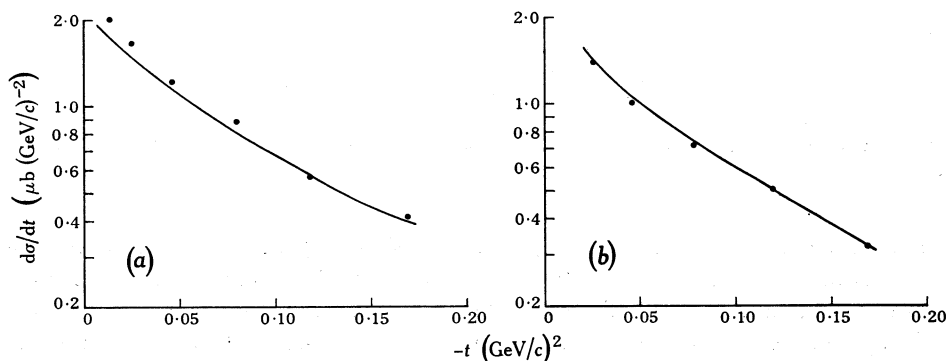


Fig. 1. Comparison of experimental results with the present theoretical predictions (curves) for the differential cross sections $d\sigma/dt$ as a function of $-t$ for photon-deuteron elastic scattering with incident photon energies of (a) 8 GeV and (b) 16 GeV.

References

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