Studies on the electromagnetic structure of the nucleon by free and quasi-free Compton scattering at MAMI (Mainz)*

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The electromagnetic structure of the nucleon may be parametrized by the six invariant amplitudes A_i ($i = 1 \cdots 6$) for Compton scattering and through structure constants, of which the electric α and magnetic β polarizabilities, and the spin-polarizabilities γ_0 and γ_π for the forward and backward directions, respectively, are the most important [1]. Systematic studies of Compton scattering by the free proton and of quasi-free Compton scattering by the proton and the neutron bound in the deuteron made it possible to measure these fundamental electromagnetic structure constants for the proton and the neutron. Differential cross sections measured [2] for Compton scattering by the proton at energies between 200 and 800 MeV and angles between 30° and 150° were used to test and confirm the validity of the non-subtracted fixed-t dispersion theory [1]. First precise data for the electromagnetic polarizability of the neutron were obtained by quasi-free Compton scattering on the neutron bound in the deuteron at energies above π meson threshold [3]. This method was tested and found valid by investigating this reaction for the quasi-free proton and comparing the results with free proton data. A remarkable and satisfactory feature of the most recent results for the electric polarizability of the neutron is that three different methods, the electromagnetic scattering of neutrons in a Coulomb field, coherent-elastic photon scattering by the deuteron and quasi-free Compton scattering by the neutron bound in the deuteron led to agreement. This provides us with a firm basis for tests of effective field theories and model calculations. For the latter, recent progress has been made by calculating relativistic corrections due to the center of mass coordinate which were ignored before [4].

structure constant	proton	neutron	unit
α	12.2 ± 0.6	12.5 ± 1.7	$10^{-4}\mathrm{fm}^3$
β	1.8 ∓ 0.6	2.7 ∓ 1.7	$10^{-4}\mathrm{fm}^3$
$\gamma_\pi(\mathrm{total})$	-38.7 ± 1.8	$+58.6 \pm 2.0$	$10^{-4}\mathrm{fm}^4$
$\gamma_\pi(\mathrm{t-channel})$	-43.5	$+43.5$	$10^{-4}\mathrm{fm}^4$
$\gamma_\pi(\mathrm{s-channel})$	$+4.8 \pm 1.8$	$+15.1 \pm 2.0$	$10^{-4}\mathrm{fm}^4$

The table summarizes the results obtained for the electromagnetic structure constants of proton and neutron in recent Compton scattering experiments.

References

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