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Polarization Effects in Scattering of Relativistic Electrons

ABSTRACT OF DOCTORAL DISSERTATION

Considered in the presented study were polarization effects in Møller (elastic electron–electron) scattering. The primary aim of this work was to verify the predictions of relativistic quantum mechanics regarding polarization transfer (relation between primary-beam polarization and electron polarization after the scattering) and spin correlations between two particles in the final state. This study was motivated by the fact that in all of the spin-correlation experiments performed until now the energy of the particles was too low to observe relativistic effects.

Taking into account the complex nature of the measurement, which consisted of subsequent electron interactions in two different targets, a dedicated experimental setup had to be designed and constructed. A 3 MeV electron beam from the Mainzer Mikrotron accelerator was used in the experiment. In the scattering off a target made of beryllium, a polarized beam electron transferred part of its polarization to an unpolarized target electron. Subsequently, the polarization of the electron originating from Møller scattering was measured using the Mott polarimetry method, by electron scattering off gold nuclei. The use of computer simulation methods, including implementation of a dedicated Mott scattering model, was necessary to optimize the experimental setup and to determine the final result.

Analysis of the data collected in 2020 resulted in the first determination of the polarization transfer in Møller scattering. The results of the experiment were compared to the predictions of relativistic quantum mechanics. The ratio of electron polarizations before and after the scattering was found to be in agreement with the theoretical predictions. The average polarization of electrons in the final state was used to calculate the experimental limits on the correlation function. Results of the nonrelativistic calculations were excluded by the experimental result with high significance.