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Compton Polarimetry on Rayleigh Scattering of Highly Linearly Polarized Hard X-rays

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Rayleigh scattering refers to the 2nd order QED process where a photon is scattered by a bound electron without a change in the photon energy [1]. For photon energies up to the MeV range it is the dominant contribution to the fundamental photon-matter interaction process of elastic scattering. This process is highly polarization-sensitive, making the analysis of polarization transfer in Rayleigh scattering suitable for a stringent test of the underlying theory [2].

A first experiment where an incident highly linearly polarized hard x-ray beam was used and the degree of linear polarization of both the incident and the scattered radiation was observed was performed in the work of Blumenhagen et al. in 2015 at the synchrotron facility PETRA III at Hamburg [3]. In this experiment the polarization-dependent features of the radiation being Rayleigh scattered within the polarization plane of the incident beam were analyzed. For the measurement of the polarization characteristics of the scattered radiation a prototype 2D sensitive strip detector, which was developed in the framework of the SPARC collaboration for precise and efficient x-ray polarimetry, was used serving as a dedicated Compton polarimeter [4]. Well in accordance with theory a dependence of the degree of linear polarization on the polar scattering angle and the degree of polarization of the initial beam was observed.

In a recent follow-up experiment we performed at the beamline P07 of the synchrotron facility PETRA III at DESY we extended on this previous measurement. For the first time, the polarization-dependent features of the Rayleigh scattered beam were measured outside the polarization plane of the incident, highly linearly polarized hard x-ray beam. For this experiment, the hard x-ray beam delivered by the synchrotron which was set to a photon energy of 175 keV was scattered on a gold foil target of 1 μm thickness. The scattered radiation was detected by an improved prototype Compton polarimeter [5], also developed in the framework of the SPARC collaboration, which was located under several scattering angles inside and outside of the polarization plane of the initial beam.

Preliminary results show a strong dependence of the orientation of the polarization vector of the scattered beam with respect to the scattering plane on the polar and azimuthal scattering angles outside the polarization plane of the incident beam.

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- [1] P.P. Kane et al., Phys. Rep. 140, 75 (1986)
- [2] Strnat et al. Phys. Rev. A 103, 012801 (2021)
- [3] K.-H. Blumenhagen et al., New J. Phys. 18, 103034 (2016)
- [4] G. Weber et al., J. Phys.: Conf. Ser. 583, 012041 (2015)
- [5] M. Vockert et al., NIM B 408, 313 (2017)

Is this abstract from experiment?

Yes

Name of experiment and experimental site

Is the speaker for that presentation defined?

Yes

Details

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Internet talk

Maybe

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