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Compton Polarimetry on Rayleigh scattered hard x-rays

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Elastic scattering of hard x-rays on atoms is the fundamental photon-atom interaction process where both the incident and scattered photon carry the same energy. It is usually described as a coherent sum of different scattering processes depending on the scattering partner. Rayleigh scattering, being the 2nd order QED process of elastic scattering from bound electrons is the dominant scattering process from a few keV up to the MeV range, while at higher photon energies also other scattering processes as the scattering from vacuum fluctuations (Delbrück scattering) and nuclear scattering become important. In such a scattering scenario, the polarization transfer between incident and scattered photon is a highly sensitive observable allowing for a more stringent test of the underlying theory than conventional cross section measurements. For a sensitive polarization analysis both a brilliant, highly polarized hard x-ray source as provided by third generation synchrotrons and an efficient polarimeter for the hard x-ray regime are necessary. Such a detector is realized by a state-of-the-art 2D sensitive strip detector serving as highly efficient Compton polarimeters in the hard x-ray regime. In an experiment at the synchrotron facility PETRA III @ DESY, Hamburg we combined both technologies, scattering a highly linearly polarized synchrotron beam with a photon energy of 175 keV on a thin gold foil. In this experiment we were for the first time able to both determine the polarization of the incident synchrotron beam by cross section measurements as well as analyze the polarization of the elastically scattered radiation within and out of the polarization plane of the incident synchrotron beam with the help of a Compton polarimeter.

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