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Twisted Photons at DESY

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Vortex light with orbital angular momentum (OAM) have successfully been generated in many laboratories. So far, however, energies of the particles with OAM, called twisted photons or electrons, remain below 0.1 keV. Here we report on the first high energy vortex photon beam obtained via Compton scattering of the topologically charged (OAM=2) 2.3eV laser photons on the PETRA 6 GeV electrons. According to angular momentum conservation, the scattered twisted photons have topological charge 2 near their maximal energy of 588 MeV. This opens up an unprecedented possibility for direct quadrupole excitation of nuclei with evenly-charged twisted photons. After modifying the laser entrance pipe, we plan to expand the energy range of twisted photons from 10 MeV to 1.1 GeV. That will allow exploring multipole resonances in nuclei at MeV, as well in quark matter inside the nucleons at GeV energies. The latter could pave a way towards quark gamma laser with twisted photon pumping and cold nuclear fusion with altered charge distributions in deuteron and tritium. The PETRA twisted photon setup allows for fast flipping of the topological charge between ±2 or ±1 states, which could be used for the quarks' orbital angular momentum measurements, by twisted photons' scattering asymmetry; this could solve the long standing nucleon spin puzzle. Employing the twisted Compton scattering at FLASH and E-XFEL will expand the energy range of the twisted particles from keV to few GeV energies, along with some possible applications. In perspective, extreme power lasers will be required for the transition from proof of principle vortex beam experiments to novel field of science and technology with twisted particles.

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