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Polarized Proton Beams from Laser-induced Plasmas

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Although the field of laser-driven particle acceleration has undergone impressive progress in recent years, one unexplored issue is how the particle spins are influenced by the huge magnetic fields inherently present in the plasmas. As part of the *Ju*SPARC (Jülich Short-Pulse Particle and Radiation Center) project at Forschungszentrum Jülich, the laser-driven generation of polarized particle beams – which are of outstanding importance for nuclear and particle physics – in combination with the development of advanced target technologies is being pursued.

Since the invention of the CPA (chirped pulse amplification) technique in the 1990s in combination with the discovery of the Ti:Sa (titan:saphire) laser medium, it became possible to realize ultra-short pulse lasers and thus ultra-high peak power in a table-top set up. The interaction of such a laser pulse with a suitable target leads to the creation of a plasma out of which charged particles can be accelerated to energies of several MeV.

In order to investigate the influence of the strong laser fields on the spin polarization of particle beams, foil targets, which serve as a source of proton beams of a few MeV kinetic energy, were irradiated in a first experiment with 100 TW laser pulses at the ARCturus Laser Laboratory at Heinrich-Heine University Düsseldorf. No significant build-up of the proton polarization was observed. The proton polarimetry is based on the spin dependence of hadronic scattering off nuclei in a scattering target. Thus, the feasibility of such a measurement was demonstrated in a zero experiment with an unpolarized proton beam [1].

The goal of this working group is first to outline an experiment on the generation of a polarized proton beam from laser-driven particle acceleration. Subsequently, a method for developing a digital detection system for measuring the proton polarization will be worked out.

References:

[1] Natascha Raab, Markus Büscher et al., *Polarization measurement of laser-accelerated protons*, Physics of Plasmas **21**, 023104 (2014); doi: 10.1063/1.4865096