Acceleration of spin-polarized proton beams from a dual-laser pulse scheme

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Particle beams of high energy and spin-polarization are necessary for various experiments, i.a. in order to test the Standard Model of particle physics. Over the last few years, several setups for spin-polarized electron and proton beams from laser-plasma interaction have been proposed [1]. In the case of protons, setups are limited to ones with gaseous targets, a solid-state setups cannot be pre-polarized. In this talk, we present a mechanism based on magnetic vortex acceleration (MVA), where the interaction of a single laser pulse with a plasma delivers high spin-polarization of the final beam [2]. In our new scheme, we consider two laser pulses propagating in parallel, forming two separate plasma channels [3]. Besides the proton filaments created in each channel, a third in the space between the pulses is formed. At the end of the target, the strong azimuthal magnetic field inside the channels can expand in the direction transverse to propagation. In turn, a displacement between electrons and protons arises, leading to electric fields that collimate and accelerate the proton beam. Our particle-in-cell simulations show that for a normalized laser vector potential of $a_0 = 100$ proton energies > 100 MeV can be obtained. Compared to single-pulse MVA, our scheme exhibits better spin polarization ($\sim 80\%$) of the final proton beam due to the different field structure over the course of the acceleration process.

References

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