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Electrons acceleration in intense laser-plasma interaction

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Secondary sources of high energy particles and hard X-rays, produced in the interaction of relativistically intense laser pulses with matter, are widely used to create and diagnose extreme states of matter. The production of high-energy electrons, as well as the elaboration of compact sources of relativistic electrons and hard X-rays, requires the development of advanced acceleration methods. Among these methods, the actively developing approach is based on the use of wake fields generated in rarified plasma under the action of relativistically intense femtosecond laser pulses. In the case of a more dense plasmas, the effective transfer of the laser energy to hot electrons was demonstrated by the use of structured targets.

In view of current and future experiments, various methods of electrons acceleration in plasma are discussed. In particular, effective generation of high-energy electrons with an energy of tens of MeV in a plasma of near critical electron density was demonstrated. These collimated high energy electron beams reache effective temperatures that many times exceed those predicted by the ponderomotive Wilks scaling and carry charges of hundreds of nC.

Acceleration of electrons to high energies up to the TeV range with a large acceleration gradient, much higher than that available in conventional radio frequency accelerators, can be achieved in a multistage laser wakefield accelerator, operating in a moderately nonlinear mode. An analytical model of the electron beam emittance dynamics has been developed. Matching the beam with the focusing force at the point of injection prevents the growth of the emittance during acceleration.

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