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Laser-driven ion acceleration

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Ion acceleration from solid targets irradiated by high-intensity pulses is a burgeoning area of research, attracting a phenomenal amount of experimental and theoretical attention worldwide. Key to this interest are the ultra-compact spatial scale of the accelerator and the properties of the laser-driven ion beams, under several aspects markedly different from those of "conventional" accelerator beams. In view of such properties they have the potential to be employed, in the future, in many innovative applications in scientific, technological and medical areas. From the point of view of fundamental physics, the underlying dynamics of laser-plasma interaction at ultrahigh field intensities, dominated by a surprisingly vast amount of new challenging phenomena, and the acceleration of macroscopic quantities of matter towards GeV/nucleon energies represent unique examples of relativistic many-body systems which can be studied in a small laboratory scale. The research conducted so far naturally leads to a number of crucial, fundamental questions which the community needs to face to obtain ground-breaking advances in this field.
In this presentation, the subject of laser-driven ion acceleration will be reviewed, with special focus on the description of the ion acceleration mechanisms, a discussion of the role played by the solid target in this physical system and a brief survey of foreseen applications of these ion beams. Also, some novel ideas to optimize the maximum ion energy through an active control of target properties will be presented, with particular reference to experimental and theoretical studies dealing with the fabrication of nano-engineered multilayered targets composed by a main solid foil with an ultralow-density layer on the illuminated side.

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