Laser Plasma Ion Acceleration

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In this series of lectures, a concise but comprehensive overview of the research on ion acceleration driven by superintense laser pulses is provided. The discovery in 2000 of brilliant, multi-MeV, collimated ion sources from targets irradiated by intense laser pulses stimulated great interest worldwide, due to the ultra-compact spatial scale of the accelerator and ion beam properties. The laser-target system provides unique appealing features to fundamental physics which can be studied in a small lab. At the same time, laser-ion beams could have future potential in many technological areas. This is boosting the development of new labs and facilities all over Europe, but to support these efforts, crucial challenges need to be faced to make these applications a reality.
In these lectures, the main features observed in the experiments, the associated scaling laws with laser and plasma parameters as well as an outlook on present and potential future applications are given. The main acceleration schemes and related models, used both to interpret experimental data and to predict future developments, are described.

In more detail, the program of the 4 lectures is as follows:

1st Lecture: Overview of the main experimental evidences about superintense laser-based ion acceleration. Present and potential future applications of laser-driven ions.

2nd Lecture: Introduction to the ion acceleration mechanisms: Target Normal Sheath Acceleration (TNSA), Radiation Pressure Acceleration (RPA), others. Theoretical models of TNSA I: quasi-neutral, self-similar plasma expansion, effects of non-neutrality, hydrodynamic models for TNSA.

3rd Lecture: Theoretical models of TNSA II: quasi-static isothermal models for TNSA; comparison with experimental data and physical interpretation.

4th Lecture: RPA and other acceleration mechanisms: an introduction. Improved and novel target concepts in laser-driven ion acceleration. Concluding remarks.