

Laser Plasma Accelerators

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Since the first idea to use intense laser pulse to generate collective electron motion suitable for electrons acceleration, many new ideas have been proposed and have been successfully demonstrated. The tremendous progresses that have been done over the world these recent years show the vitality of a new and growing community at the interface of accelerator, plasma and laser sciences. These accelerators based on laser plasma cavities have the particularity to support very intense electric field, with values of the order of hundreds of GV/m that can be used to deliver high quality electron beam with unique parameters. This alternative approach, rich in very exciting physical phenomena, opens the route for many applications.

In these 4 hours courses I will introduce in the wonderful world of laser plasma accelerators:

In course I, I will introduce the context and the motivation, the basis of laser interaction with electrons in vacuum and in plasma medium, the basics of plasma physics with collective effects that provide intense and accelerating fields. I will explain the linear theory of laser driven plasma wave and I will explain the trapping conditions.

In course II, I will show the results of external injection in the beatwave and laser wakefield regime. I will explain the different approach with self-injection such as self-modulated and forced laser wakefield, the bubble, the density gradient, the ionization and longitudinal injection.

In course III, I will explain and I will the tremendous results that have obtained when two laser pulses are used such as in the colliding laser pulses scheme including the physics of beam loading that allow to improve the beam quality.

Finally in course IV, I will show some of the potential applications for material science, and for medicine : cancer treatment and cancer tumour imaging. I will also discuss about the use of the laser plasma accelerators for designing future compact Free Electron Laser and for accelerators for high-energy physics. I will discuss for each of them the level of maturity.