Proposition d'un Projet de Recherche en Laboratoire

Titre : Improving the acceleration of relativistic electrons by surface plasma waves

Laboratoire d'accueil : Laboratoires des Solides Irradiés (LSI), École Polytechnique

Résumé : The interaction of an ultra intense ($I \geq 10^{18}$ W/cm^2) laser pulse with an over-dense plasma (plasma with density above its critical density) is an efficient way of exciting surface plasma waves (SPWs). These SPWs propagate on the vacuum-plasma interface and accelerate electrons towards relativistic velocities, forming a collimated beam with high total charge. The SPW acceleration mechanism has a great potential for use in important new applications, including improved laser-based radiation sources. However, the development of such applications requires further investigation on the SPWs in the high fields regime related to nonlinear and relativistic effects.
In a previous PRL, we analyzed how the plasma temperature affects the SPW dispersion relation, and consequently the electrons dynamics. We also developed a numerical code that allows us to study the acceleration process as a function of the laser, plasma and SPW parameters. In this PRL we will investigate new schemes that may be able to improve the acceleration of relativistic electrons by SPWs. One of these schemes consists in the addition of a stationary magnetic field to the vacuum-plasma interface. Magnetic fields at the vacuum-plasma interface alter the electron acceleration, but were only briefly mentioned in previous works. We will analyze different configurations for the magnetic field, its effects on the electrons dynamics and how it can be used either to increase the electrons energy or to reduce their energy spread. We will also consider the effects produced by the magnetic field auto-generated by the nonlinear interaction between electrons and SPW. Our main goal is to obtain optimal conditions for electron acceleration in the presence of external and/or auto-generated magnetic fields. Theoretical analyses will be supported by numerical simulations performed with the code developed in a previous PRL. Such an approach enables advancements in the current theory of SPWs and the improvement of its acceleration mechanism.

Mots clés : Surface plasma waves, Relativistic electron acceleration, Magnetic fields, Laser plasma-interaction, Wave-particle interactions

Nature : théorique et numérique

Accueil d'un binôme possible : Oui (Si les étudiants peuvent venir en même temps)

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