Internship M2, 2023

Investigation of laser-produced magnetized collisionless shocks and associated particle acceleration

Locations:

- LULI (https://luli.ip-paris.fr/), Ecole Polytechnique, 91128 Palaiseau cedex
- LULI, Sorbonne Université, Campus Pierre et Marie Curie, tour 23-33 4ème étage, boîte courrier 128, 4 place de Jussieu, 75252 Paris cedex 05
- LULI/APOLLON,Parc Les Algorithmes, bâtiment Euclide, route de l'Orme des Merisiers, 91190 Saint Aubin

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Context. Collisionless shocks are ubiquitous in the Universe. Charged particles can be accelerated to high energies by collisionless shock waves in astrophysical environments, such as supernova remnants. With the development of high-power lasers and magnetic field generation, laboratory experiments can play a central role in bridging the gap between theoretical models and astrophysical observations by providing data that helps us to improve our understanding of shock formation, as well as the associated particle energization mechanism [1-3].

Proposed work. The internship is part of an ongoing effort of investigating laser-produced collisionless shocks in a magnetic field of tens of Tesla, both experimentally with high-power lasers worldwide, e.g., LULI2000 (FR), VULCAN (UK), and TITAN (US); and numerically with fully kinetic particle-in-cell simulations performed with the code SMILEI [4].
During the internship, the student will contribute to:

- Experimental data analysis (e.g., energy spectrum of the energetic ions from Thomson parabola, the electromagnetic field structures from proton radiographs, and the plasma condition characterization from Thomson scattering).
- Numerical simulations of the collision of two magnetized shocks, particularly tracking the charged particles and digging into their energization mechanism.

Required competencies and skills:

- knowledge in general physics and mathematics
- skills and interest in computational development and simulations

References:

[1] W. Yao, et al., Nat. Phys. 17, 1177–1182 (2021)
[2] W. Yao, et al., MRE 7, 014402 (2022)
[3] W. Yao, et al., JPP 89.1, 915890101 (2023).
[4] J. Derouillat, et al., Comput. Phys. Commun. 222, 351-373 (2018)