Title : **Collective plasma wave amplification for multiple laser beam configuration in the context of Laser MJ**

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Research Area: Lasers and Plasma Physics, theory

Methods: theoretical modeling, partly with already developed simulation tools

PhD track subject : The plasma theory group of CPHT participates in the conception of an experimental campaign that has been selected for the Laser MegaJoule (LMJ) at CESTA close to Bordeaux. A major task for the preparation of these experiments is to develop modeling capacities for the understanding of how the multiple laser beams used at LMJ can provoke collective amplification of a plasma wave. This amplification may be provoked via laser-plasma instabilities that arise due to the non linear coupling between fields of the laser beams, of scattered light fields, and of the plasma wave (electronic and/or ionic). The complexity of the speckled sub-structure of spatially and temporarily “smoothed” laser beams has to be taken into account.
The results of this study, and of the experiments scheduled for 2024/25, are of major importance for the understanding of parametric instability processes that are a major concern for the realisation of inertial confinement fusion with lasers. Experiments of this kind can only be performed at major laser facilities like LMJ or NIF.
In a first step, the task within this project consists of adapting the model usually designed for three-wave coupling (laser, scattered, and plasma wave) to multiple wave coupling, and to adapt already existing wave coupling simulation codes to the most pertinent configuration. Theoretical modeling and the simulation results will then guide to identify the most relevant scenario for the experiment.
The candidate will be involved in discussions and in the collaboration with a very experienced French(CPHT and CEA)-Canadian(U. Alberta) team.

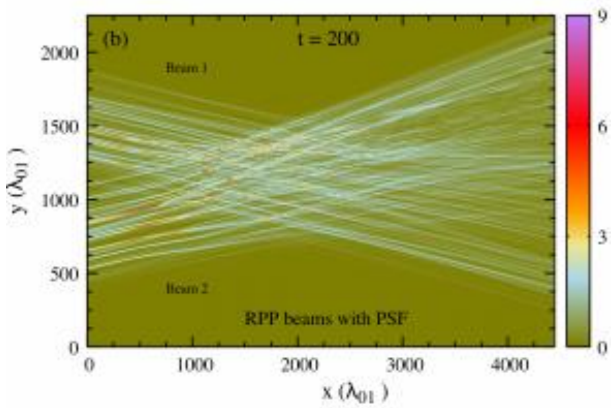

Figure :

Snapshot of the light intensity contours of two intense « smooted » laser beams entering from the left into a hot inhomogeneous plasma with flow in the y direction. Collective processes provoke energy exchange between the laser beams due to nonlinear wave-wave coupling, such that the light beam energy is redistributed at the rear of the plasma.

References :

[1] “Experimental investigation of the collective stimulated Brillouin and Raman scattering of multiple laser beams in inertial confinement fusion experiments” S Depierreux, C Neuville, et al., A. Héron, S. Hüller, et al., Plasma Physics and Controlled Fusion 62, 014024 (2019) hal-02376822, v1

[2] 'Experimental Investigation of the Collective Raman Scattering of Multiple Laser Beams in Inhomogeneous Plasmas', S. Depierreux, C. Neuville, et al., *Phys. Rev. Lett.* **117**, 235002 (2016).

[2] “*Crossed beam energy transfer between optically smoothed laser beams in inhomogeneous plasmas.”* S. Hüller, G. Raj, M. Luo, W. Rozmus, D. Pesme; Philosophical Transactions of the Royal Society A 378, 20200038 (2020); https://royalsocietypublishing.org/doi/10.1098/rsta.2020.0038, hal-02880936, v2