Analysis of three-wave coupling in terms of phase and amplitude variations Application to Brillouin-based amplification in the strong-coupling regime

François AMIRANOFF [1], Marco CHIARAMELLO [1], Caterina RICONDA [1], and Stefan WEBER [2]

1) LULI-UPMC Université Paris 06: Sorbonne Université, École Polytechnique, CEA: Université Paris-Saclay, France

E-mail: francois.amiranoff@upmc.fr

2) Institute of Physics of the ASCR, ELI-Beamlines, Prague, Czech Republic

When written in terms of phase and amplitude variations, the envelope equations for three-wave coupling in plasmas give new insight on the evolution of the waves.

This procedure is applied to the Brillouin-based laser amplification scheme, a promising method to reach high intensities without the limitations due to material damage thresholds. This method relies on the energy transfer between a high-energy long-pulse pump and a short-pulse low-energy seed through the coupling with low-frequency ion modulations induced in a plasma.

In the strong-coupling regime, the evolution of the phases of the different waves leads to a simple interpretation of the initial steps of the coupling [1]. It clearly explains the evolution of the energy-flow directionality. It allows to quantify the effect of the frequency chirp of the beams and to understand the role of the plasma density profile.

Analytical calculations of the coupling are completed by numerical solutions of the envelope equations. The results are compared with 1D PIC simulations.

This type of analysis could be useful in other situations of beam coupling in plasmas, such as multi-beam laser-plasma interaction in the context of inertial confinement fusion.

References

[1] M. Chiaramello, *et al.*, Phys. Rev. Lett. 117, 235003 (2016)