Experimental investigation of the collective Brillouin and Raman scattering of multiple laser beams in ICF experiments

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The direct and indirect drive schemes to ICF make use of a large number of laser beams arranged in a symmetric angular distribution. The preferential decay geometry of the three waves resonant couplings, mainly responsible for backscattered light in single beam experiments, may then be deeply modified in the region of crossing beams where collective laser plasma instabilities could develop [1].Such instabilities can occur for laser beams having a common symmetry axis along which they drive a common daughter wave. The collective coupling results in an increase of the growth gain with the increase of the number of interacting beams. These collective instabilities also produce energy losses in new backward directions. Two categories of experiments have been performed on the Omega facility to study these collective instabilities in the regimes relevant of the direct and indirect drive schemes to ICF.

The first class of experiments [2] was performed in a planar open geometry relevant of megajoule direct drive. They have evidenced the large amplification of stimulated Raman scattering (SRS) electromagnetic waves almost transverse to the density gradient as theoretically predicted 40 years ago [3]. This was achieved in long scale-length high-temperature plasmas in which two beams couple to the same scattered electromagnetic wave further demonstrating for the first time this multiple-beams collective SRS interaction. The collective nature of the coupling and the amplification at large angles from the density gradient increase the global SRS losses and produce light scattered in novel directions out of the planes of incidence of the beams.

The second class of experiments [4] was performed in an indirect drive configuration in rugby ball shaped *Hohlraum* irradiated by 40 beams. Large (>30%) Brillouin sidescattering was evidenced to originate from the collective Brillouin amplification of a shared ion acoustic wave driven along the *Hohlraum* axis by a cone of 10 beams. We further demonstrate and interpret the efficient control of such large Brillouin scattering losses by the temporal incoherence optically imposed on the interacting beams and by the electronic density in the crossing beams domain.

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