

Recent laser-plasma interaction experiments at LLL *

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In order to drive laser fusion targets in an ablative mode instead of an exploding-pusher mode, longer pulse lengths and perhaps shorter laser wavelengths are desirable. Recent experiments at Livermore are aimed at studying laser-plasma interaction issues using longer pulse lengths (0.6 — 2 ns); also, for better laser-target coupling, experiments at frequency doubled light have been conducted.

The issues under consideration are absorption of laser light into the plasma, transport of heat into dense material, scattering of laser light at the underdense plasma, and suprathermal electrons which can cause target preheat; however, hot-electron production can be reduced by using shorter laser wavelengths.

Experimental data indicate that at longer pulses, lower light intensity can be used to increase target absorption. However, longer pulse experiments are characterized by much larger regions of underdense plasma which tend to stimulate Brillouin and Raman scattering. The latter mechanism is especially detrimental because it is capable of generating hot electrons. Measurements show that, contrary to expectations, the angular distributions of suprathermal X-ray emissions are highly anisotropic. Furthermore, at long pulse lengths, time-resolved sub-Kev X-ray emission data from targets indicate that there may be a Z dependence of the laser intensity threshold for inhibited heat transport.

The results of the experiments generally agree with calculations, but there are still experimentally observed phenomena which are not fully explained. Further experiments are planned to elucidate these complex physical processes.

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劳伦斯·利佛莫尔实验室目前的 激光-等离子体相互作用实验

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为采用烧蚀方式而不采用爆炸推进方式驱动激光聚变靶,需要使用长激光脉冲,如又能用短激光波长可能就更好。目前利佛莫尔的实验目标是使用长脉冲(0.6~2毫微秒)研究激光与等离子体的相互作用问题;此外,为了加强激光与靶耦合,进行了二倍频激光方面的实验。

正在考虑中的问题是:激光为等离子体所吸收,热输运进入稠密靶材,激光为低密度等离子体所散射以及可能使靶预热的超热电子。然而使用较短的激光波长可以减少热电子的产生。

实验资料表明,在长脉冲情况下,低光强可增加靶的吸收。然而长脉冲实验的特点是易于产生受激布里渊和喇曼散射的低密度等离子体的区域大得多。后一机制特别有害,因为它能产生热电子。与预期相反,测量表明,超热X射线辐射的角分布是高度各向异性的。而且在长脉冲情况下,靶的时间分辨低于千电子伏的X射线数据表明,对于禁戒的热输运,激光强度阈值可能依赖于Z。

实验结果一般与计算相符,但仍观察到不能完全解释的实验现象。为阐明这些复杂的物理过程,进一步安排了实验。