Abstract Submitted
for the DPP13 Meeting of
The American Physical Society

Kinematic Constraints on Absorption of Ultraintense Laser Light

MATTHEW LEVY, LLNL; Rice Univ., SCOTT WILKS, MAX TABAK, LLNL, MATTHEW BARING, Rice Univ. — A fundamental property of ultraintense laser interaction with matter is the trend towards increasing absorption with irradiance. Established through simulations and comprehensive experimental data over the years, the theoretical basis to date has remained predominantly heuristic. In this Letter, we propose an explanation for this universal scaling, which we show emerges naturally from a novel mathematical formulation of the laser plasma (LP) interaction. Using constrained minimization techniques, we demonstrate that the LP system is subject to severe restrictions, which become increasingly strict with intensity I_L. We show that the phase volume of states accessible to the LP system, Λ, scales in inverse proportion to the laser intensity and forbids states corresponding to low absorption. We further demonstrate that Λ undergoes rapid contraction in the regime $10^{18} < I_L < 10^{20} W/cm^2$. These key properties suggest that the global trend towards increasing absorption with I_L may be a reflection of the underlying phase volume contraction. This work was performed under the auspices of the U.S. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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Date submitted: 02 Jul 2013

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