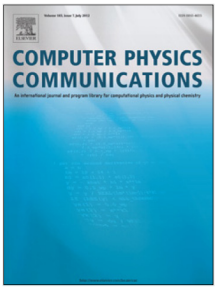
Accepted Manuscript



A hybrid model of laser energy deposition for multi-dimensional simulations of plasmas and metals

Mikhail M. Basko, Ilia P. Tsygvintsev

PII: S0010-4655(17)30022-X
DOI: http://dx.doi.org/10.1016/j.cpc.2017.01.010
Reference: COMPHY 6128

To appear in: *Computer Physics Communications*

Received date : 27 October 2016
Revised date : 6 January 2017
Accepted date : 12 January 2017

Please cite this article as: M.M. Basko, I.P. Tsygvintsev, A hybrid model of laser energy deposition for multi-dimensional simulations of plasmas and metals, *Computer Physics Communications* (2017), http://dx.doi.org/10.1016/j.cpc.2017.01.010.

A hybrid model of laser energy deposition for multi-dimensional simulations of plasmas and metals

Mikhail M. Basko, Ilia P. Tsygvintsev

Keldysh Institute of Applied Mathematics RAS, Miusskaya sq., 4, Moscow, 125047, Russia

RnD-ISAN/EUV Labs, Promyshlennaya Str., 1A, Moscow-Troitsk, 142191, Russia

Abstract

The hybrid model of laser energy deposition is a combination of the geometrical-optics ray-tracing method with the one-dimensional (1D) solution of the Helmholtz wave equation in regions where the geometrical optics becomes inapplicable. We propose an improved version of this model, where a new physically consistent criterion for transition to the 1D wave optics is derived, and a special rescaling procedure of the wave-optics deposition profile is introduced. The model is intended for applications in large-scale two- and three-dimensional hydrodynamic codes. Comparison with exact 1D solutions demonstrates that it can fairly accurately reproduce the absorption fraction in both the s- and p-polarizations on arbitrarily steep density gradients, provided that a sufficiently accurate algorithm for gradient evaluation is used. The accuracy of the model becomes questionable for long laser pulses simulated on too fine grids, where the hydrodynamic self-focusing instability strongly manifests itself.

Keywords: Laser absorption, laser plasmas, ray tracing
PACS: 52.25.Os, 52.38.Dx, 52.38.Mf, 02.60.Lj

1. Introduction

An important ingredient in any large-scale hydrodynamic code, aimed at simulations of laser plasmas, must be a model for propagation and absorption

Email address: mmbasko@gmail.com (Mikhail M. Basko)
URL: www.basko.net (Mikhail M. Basko)