Implicit Hybrid Simulation Techniques for the Modeling of Intense Laser-Matter Interactions*

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Implicit hybrid simulation codes such as the ANTHEM model[1] were used in the earliest studies[2] of intense laser-matter interaction in application to the Fast Ignitor approach to ICF. The basic approach treats the background plasma in a laser target as a pair of collisional ion and cold electron fluids. Laser energy is propagated across the computational mesh to the critical surface, where it converts some of the background electrons into a third, relativistic hot electron component. The hot electrons spread throughout the target, scattering off the ions and dragging against the electrons. They draw a resistive cold electron return current through resultant self-consistent electromagnetic fields. Electromagnetic fields are calculated implicitly by the Moment Method[1]. This enables the practical study of super-compressed plasmas (10^3 $\times$ critical) with no time-step limits from the plasma period. We will report on recent model refinements, including the mixed use of fluid and particle ion and electron components. The particles permit a more accurate treatment of relativistic effects. Implicit Moments[1] can continue to form a basis for the electromagnetic field solve with a relativistic Lorentz factor γ for electrons determined with the particle moment accumulations. Ponderomotive effects can be included as a simple gradient of a mesh propagated intensity. Near Gigagauss magnetic fields at critical have been predicted through the action of the ponderomotive forces at laser intenstites[2] exceeding 10^{19} W/cm^2. Weibel instability leading to electron transport filamentation can be studied as a function of the hot electron source distribution. In application to transport in dense (200 x critical) thin foils, ANTHEM shows strong magnetic field generation on the foil's back side surrounding a directed column of the hot electrons, correlated with the strongly focused emission of fast ions.

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2. Tabak, M. et al., Phys. of Plasmas **1**,1626(1994); Mason, R. J, and Tabak, M. Phys. Rev. Lett. **80**, 524 (1998); Mason, R. J., ICENES 2002, Albuquerque, NM, 29 Sept-4 Oct., *Proceedings*, P. 284.

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