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Fusion Ignition Simulations using a Particle Code

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A molecular dynamics (MD) particle simulation code has been developed to study inertial fusion ignition physics including effects of a non-Maxwellian ion velocity distribution. 10,000 DT ions at density 100 g/cm3 and temperatures of several keV are followed for 10 to 20 psec. The simulation includes ion-ion collisions, electron-ion coupling and emission and absorption of radiation. Fusion reactions produce energetic alphas; the alphas deposit energy to electrons and have Coulomb collisions with ions and the plasma self-heats to 20-30 keV.

`This simulation using realistic particles and interactions poses the scientific challenge of including qua`

The most important new physics in MD simulations is the possibility to describe a non-Maxwellian ion velocity distribution f(v); fusion reaction rates are very sensitive to the high-energy tail of f(v), which depends delicately on plasma transport and equilibration processes.

Although equilibrium ion-pair correlation is not strong in multi-keV plasmas we find dynamical correlations caused by alpha-particle energy transfers. It is found that calculations starting from a variety of initial conditions evolve to follow a unique self-heating trajectory, an ignition attractor.

Calculations starting with 3 keV DT heat to ignition within a few psec after a pulse of energetic ions are injected; this shows that fast ions are quite effective for fast ignition of pre-compressed DT. A series of such calculations help identify the threshold ion deposition heating required to ignite DT fuel within a short time of peak target compression.

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