Study of laser plasma interactions using an Eulerian Vlasov code

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A relativistic Eulerian Vlasov code is presented to simulate laser-plasma interactions. Eulerian Vlasov codes have a very low noise level and allow detailed analysis of low-density regions of phase-space. The code we present is 1D (one space dimension x and one momentum dimension p_x) with a fluid momentum p_y, and includes both ion and electron dynamics. The laser is incident from the left as a transverse electromagnetic wave (k_x, E_y, B_z).

The plasma is initially uniform and neutral with a sharp drop to zero density at the boundaries. The spatial boundary conditions on the distribution function are calculated by separately collecting the current arriving at the left and right boundaries. The electric field at a boundary is given by $\epsilon_0 dE/dt = -J_x$, and is calculated by integrating in time the outflowing current density $J_x = J_{xi} + J_{xe}$. A steady state is reached when this current J_x is zero, i.e. when the sheath structure at the boundary has reached an equilibrium such that the outflowing electron and ion currents are equal.

The boundary conditions allow the simulation to proceed for times much larger than when the laser reaches the right boundary. Results will be presented showing the growth of Stimulated Raman Scattering (SRS) in a quiescent plasma over many laser transit times across the simulation box. No spurious reflection or instability occurs at the right boundary. We also explore a 'semi-infinite' boundary condition where we assume a uniform, nonzero plasma density at the right boundary.

Work is underway on a 2D kinetic description in y and p_y.

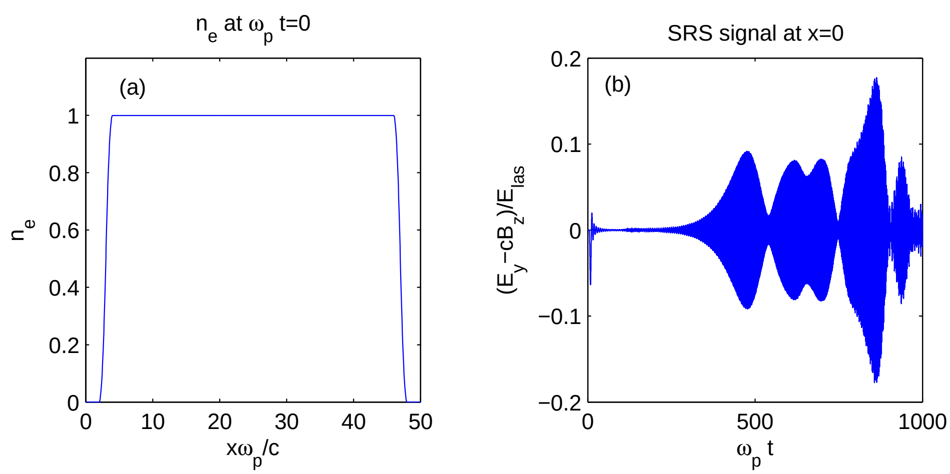

Figure 1: Growth of SRS from a noise-free initial plasma state. (a) Initial plasma density versus position. (b) left-propagating backscattered electromagnetic SRS signal. $T_e = 350$ eV, $\lambda_{las} = 527$ nm, $I_{las} = 10^{16}$ W/cm^2, $n_e/n_{crit} = 0.032$.