Particle In Cell code and Backward Raman Amplification

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To perform studies on laser plasma interaction in the high-intensity domain, we have recently developped a new "Particle In Cell" (PIC) [1] code OCEAN [2]. This code models the laser plasma interaction, in the classical and relativistic domains, by simultaneously solving the Maxwell equations for the electric and magnetic fields and the Vlasov Equation for each species. The particularity of PIC code consists in modeling plasma with macro-particles, i.e. numerical particles which have the same physical characteristics than the physical particles (mass, charge...) but with an additional statistical weight. Then, the distribution function $f_i(\vec{r},\vec{p},t)$ for each species i writes as :

$$f_i(\vec{r},\vec{p},t) = \sum_{j=1}^{N} w_j^i \times \delta(\vec{r}-\vec{r}_j^i) \times \delta(\vec{p}-\vec{p}_j^i) \tag{1}$$

with w_j, $\vec{r}_j$ and $\vec{p}_j$ are the weight, position and momentum of each macro-particle, respectively. The particle resolution of the Vlasov equation consists in following the N macro-particles trajectories by solving the equations of motion.

The code OCEAN is able to model the laser plasma interaction in one and two dimensional geometries, and it has been parallelized on a spatial decomposition domain in order to model large scale plasmas. Moreover, we have implemented three different Maxwell solvers in order to control the numerical dispersion and the electromagnetic fields accuracy. We will present in details these Maxwell solvers and their characteristics.

The code OCEAN has been adapted to model the Backward Raman Amplification [2, 3] by giving the possibility to insert laser from both numerical box boundaries. An excellent agreement has been found between the linear theory for the 3-waves coupling and the numerical results. We will show how it is important to control the numerical noise generated by PIC codes in order to do not enhance the Backward scattering.

References

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