

Kinetic Plasma Waves Carrying Orbital Angular Momentum

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Plasma waves are a fundamental plasma phenomena, and an accurate description of a plasma wave is a necessary for the understanding of many plasma phenomena. It is possible to twist a plasma waves such that in addition to having longitudinal motion, they can possess a quantized orbital angular momentum^[1]. One such type of plasma-wave mode is the Laguerre-Gaussian mode, these twisted plasma waves can be formed in certain laser-plasma interactions involving similar Laguerre-Gaussian twisted laser modes. This particular topic is gaining considerable ground thanks to the advent of new methods of generating these modes at high efficiency for ultra-intense lasers pulses.

3D numerical Particle-In-cell simulations demonstrate the existence of stable long-lived plasma waves with orbital angular momentum^[2]. These waves can be shown to create large amplitude static magnetic fields with unique twisted longitudinal structures^[2].

When twisted plasma waves undergo Landau damping there are several important differences compared to standard planar plasma-wave Landau damping. The first effect is that there is an increased damping rate^[2], which is affected both by the focal width and the orbital mode of the plasma wave. This increase in the damping rate is of the same order as the thermal correction and can be seen, albeit in a non-linear regime, in 3D PIC simulations^[3,4]. The second effect is that by using the plasma wave mode structure the direction of the momentum picked up by resonant particles can be significantly altered^[4].

References

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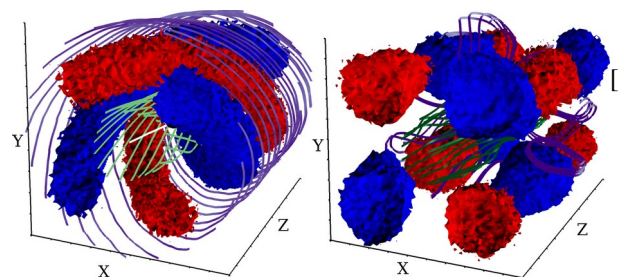


Figure 1. OCEAN PIC: Left: plasmon with $l=2$, right: counter-propagating plasmons with $l=2$. Surfaces show 80% maximum amplitude of density perturbations, (blue negative and red positive perturbations). Magnetic field lines are shown at amplitude maxima/minima.

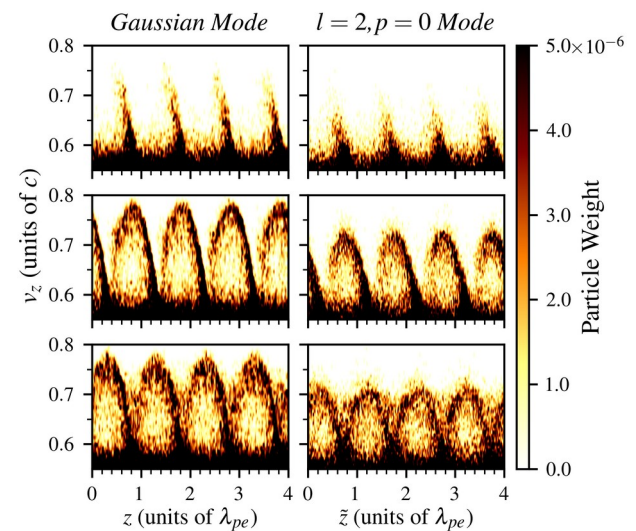


Figure 1. OCEAN PIC: plots of electrons close to phase velocity undergoing phase space rotation. Left Gaussian v_z vs z and right LG ($l = 2, p = 0$) v_z vs. \tilde{z} , where $\tilde{z} = z + t\theta/k$. Top $t \sim 10$ periods, middle $t \sim 20$ periods, bottom $t \sim 30$ periods.