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New wave effects in nonstationary plasma[1]

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In plasma undergoing compression, embedded waves can have very unusual and possibly useful properties. For example, part of the mechanical energy of compressing plasma can be transferred controllably to hot electrons by seeding the plasma with plasma waves. Under compression, wherein wave action is conserved, the wave energy grows as its frequency and wavenumber change adiabatically, until, suddenly, the wave damps, resulting in switch-like production not only of heat [1], but also voltage and current [2]. These bursts can be controlled precisely in time by prescribing the compression script. Several classic problems in wave physics, including the bump-on-tail instability, exhibit new effects under compression [3]. In addition, the waves undergoing compression or expansion affect fundamental properties of plasma, such as the plasma compressibility; moreover, and rather remarkably, nonlinear waves, such as BGK modes, affect the plasma compressibility differently [4]. Wave-particle interactions mediated by plasma compression also can enhance the performance of plasma-based particle accelerators. To describe numerically all these effects, novel particle-in-cell simulations were developed. These findings point towards potentially beneficial applications, including in inertial confinement fusion and high energy density plasma physics, where extreme compression is exercised on dense plasma, which could be seeded with waves.

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