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Reduced kinetic descriptions of weakly driven plasma waves[1]

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We present a model of kinetic effects in Langmuir wave dynamics using a nonlinear distribution function that includes particle separatrix crossing and self-consistent electrostatic evolution. This model is based on the adiabatic motion of the particles in the wave, and uses the fundamental frequency, its harmonics, and a nearly uniform electric field to describe BGK-type Langmuir waves over a wide range of temperatures ($0.1 \leq k\lambda_D \leq 0.4$). This asymptotic distribution function yields a nonlinear frequency shift of the Langmuir wave that agrees well with Vlasov simulations, and can furthermore be used to determine the electrostatic energy required to develop the phase-mixed, asymptotic state. Energy conservation is used in conjunction with our kinetic theory results to build a simplified model of nonlinear Landau-type damping. The resulting nonlinear, dynamic frequency shift and damping can be used in an extended three-wave type model of driven Langmuir waves, and we discuss comparisons of this model to Vlasov simulations in the context of Raman backscatter.

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