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TH/P6-26: Nonlinear Ponderomotive Forces with the Consideration of the Spatial Variation of Wave Fields during the Resonant Interaction

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The quasi-linear diffusion theory catches the most important process in plasma-wave interaction, that is, the resonance. Besides basic assumptions on small amplitude and sufficient phase mixing, the quasi-linear theory also requires the damping or growth should be small compared to the real frequency or the wavelength. In practice, the slowly-varying is considered but the space-variation of waves is neglected during the resonance. However, the wave propagates in the plasma and feel the kinetic damping, its amplitude will decay. This effect will induce the ponderomotive force not only on the nonresonant particles, but also on the resonant particles. On the other hand, the conventional concept of ponderomotive force is in the single particle picture. Many previous works have extended this concept to consider the rf nonlinear force on a pack of plasma both in fluid and kinetic theory. However, incomplete treatment on the stress term would result in some fake conclusions. In this work, the generalized rf force is investigated by using the second-order rf kinetic theory. The force inside the magnetic surface, i.e. parallel and tangential force, are especially focused on. Both forces include two parts. The one is proportional to the parallel momentum input, where the relation of the momentum and energy just like a particle. The other component is related to the variation of the wave amplitude; but is also completely the resonant term. Therefore the total force inside the magnetic surface depends on the resonant mechanism. This conclusion indicates again that the quasi-linear EM force is not a good approximation to the rf force since it includes the nonresonant component and results in some fake conclusions such as nonresonant drive by helicity injection in steady status. The components of the rf force due to the spatial-variation of wave fields during the resonant interaction can be reproduced from the single particle picture and the fluid theory. The magnitudes of the forces depend on the spectrum width comparing to the wavelength, the harmonics order and other factors. Special setup may make this kind of force significant so as to drive current/flow.

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