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Mode-coupling instability of monolayer complex (dusty) plasmas

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Strongly coupled complex (dusty) plasmas give us a unique opportunity to go beyond the limits of continuous media and study various generic processes occurring in liquids or solids, in regimes ranging from the onset of cooperative phenomena to large strongly coupled systems at the most detailed kinetic (atomistic) level. On the other hand, there is certain peculiarity of the interparticle interactions in complex plasmas. This can be easily understood if we divide the complete set of elementary charges in complex plasmas into two distinct categories - a subsystem of charges bound to the microparticles, and a subsystem of free plasma charges in the surrounding wakes. Plasma wakes play the role of a "third body" in the mutual particle-particle interaction and, hence, make the pair interaction nonreciprocal. We carried out rigorous theoretical investigation of the DL wave mode coupling occurring in 2D complex plasmas due to particle-wake interactions. The analysis of the mode coupling shows that if the strength of the vertical confinement is below a certain critical value, then resonance coupling between the longitudinal in-plane mode and out-of-plane mode sets in. This results in the emergence of a hybrid mode and drives the mode-coupling instability. The universal dependence of the critical confinement frequency on plasma parameters is calculated, which allows us to specify the conditions when stable 2D highly ordered complex plasma can be formed in experiments.