Synchronisation of particle motion induced by mode coupling in a
two-dimensional plasma crystal

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In two-dimensional plasma crystals, wake-mediated interactions between the particles result in the coupling of the crystal in-plane and out-of-plane modes into a hybrid mode of the lattice layer. Localised “hot spots” in the lattice phonon’s spectra are a typical signature of this mode [1]. The theory of mode-coupling instability [2, 3, 4] gives a detailed picture of a plasma-specific melting scenario operating in 2D plasma crystals. The mode coupling induced melting can only be triggered if (i) the modes intersect, and (ii) the neutral gas damping is sufficiently low.

In this study, the kinematics of dust particles during the early stage of mode-coupling induced melting is explored. The formation of the hybrid mode induces the partial synchronisation of the particle vibrations at the hybrid frequency. Phase- and frequency-locked hybrid particle motion in both vertical and horizontal directions (hybrid mode) is evidenced. A rhythmic pattern of alternating in-phase and anti-phase oscillating chains of particles is observed. The spatial orientation of the synchronisation pattern correlates well with the directions of the maximal increment of the shear-free hybrid mode.

References


