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# Dissipative solitary waves in crystalline and amorphous complex plasmas

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A complex plasma is composed of a weakly ionized gas and negatively charged microparticles. In the laboratory, monodisperse particles form a single layer in the (pre)sheath and can self-organize in a triangular lattice with hexagonal symmetry, known as plasma crystal. The crystallization can be suppressed upon cooling in the binary complex plasmas, when two types of microparticles are mixed in a quasi-two-dimensional suspension[1,2]. The majority of such particle suspension exhibits a disordered structure and the dispersion relation of the particle oscillations has distinct features.

Complex plasmas can be externally excited in the experiments. Shear flows, Mach cones, melting and other phenomena can be triggered electrically by the powered wires or optically by the laser beams. As one of the most significant phenomena, the propagation of the solitary waves in the complex plasmas has been extensively studied in the past years.

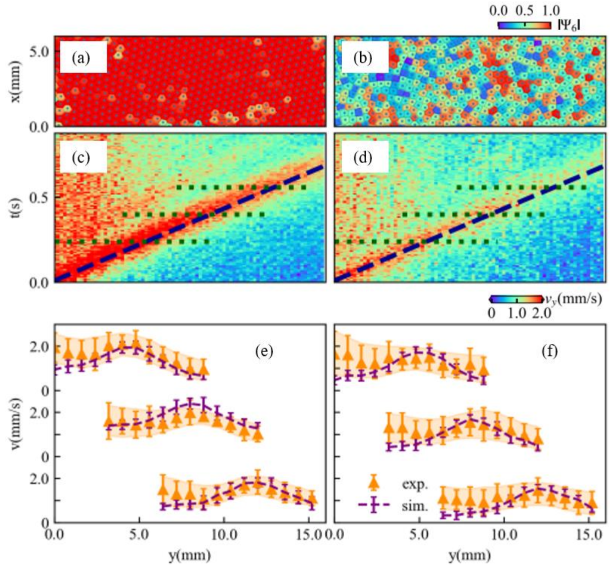


Figure 1. Propagation of solitons in the experiments with the plasma crystal (left) and amorphous binary mixture (right). The structure is characterized by the hexatic order parameter in panels (a) and (b). The propagation of the solitons is shown in panels (c) and (d). The particle velocities at three selected times are fitted by soliton solution for experiments (yellow symbols) and simulations (purple symbols) in panels (e) and (f).

Here, we report on the experimental and numerical investigations on the propagation of the dissipative soliton wave in a disordered quasi-2D binary complex plasma. The soliton is excited by a laser pulse and the amplitude is dissipated by the neutral gas friction. The macroscopic properties of the soliton transport are similar to that in a plasma crystal, as shown in Fig. 1. However, the microscopic structure of the soliton exhibits a tortuous outline due to the disordered local structure, as shown in Fig. 2. Furthermore, as demonstrated by the bond-orientational correlation function, the particles dramatically rearrange themselves, which is not observed in the plasma crystal[3].

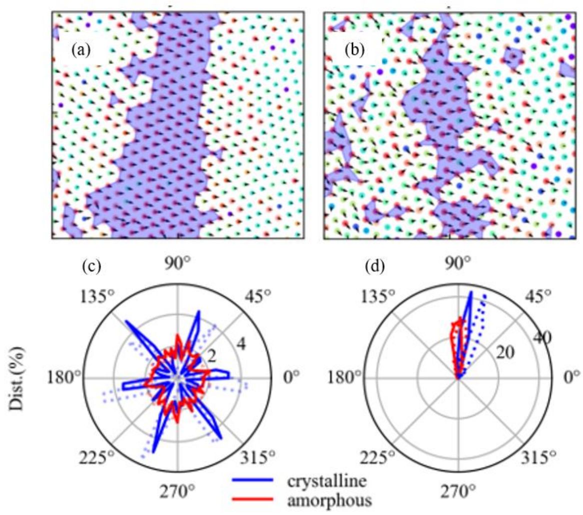


Figure 2. Velocity structure of the solitons in the plasma crystal (left) and amorphous binary mixture (right). The light blue areas in panels (a) and (b) highlight the spatial profile of the solitons, determined by α shape algorithm in the experiments. The nearest-neighbor angle distribution and velocity angle distribution for experiments (solid lines) and simulations (dotted lines) are shown in panels (c) and (d), respectively.

Our results shed light on the wave phenomena and may be important to understand the structural and dynamical properties in a strongly coupled disordered system with soft interactions. This work is supported by the National Natural Science Foundation of China (NSFC), Grants No. 12035003.

References

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