Singular event excitations in unstable dust acoustic waves: amplitude hole filaments, acoustic vortices, and rogues

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The dust acoustic wave is an acoustic type density wave with longitudinal oscillation of negatively charged dust particles in the dusty plasma, composed of micro-meter sized dust particles suspended in the low pressure gaseous plasma background. The capabilities of direct visualizing particle motion and measuring dust density evolution over a large area through optical microscopy make it a good platform to understand the Lagrangian-Eulerian nonlinear dynamics of unstable acoustic type waves down to the kinetic level. In this talk, we report the first experimental observations of high- and low-amplitude singular event excitations, and their formation mechanisms in unstable dust acoustic waves, self-excited through ion streaming. It is found that the modulation instability leads to waveform undulation when the traveling wave becomes unstable. The formation of a strong kink on a wave crest and the successive rupturing along finite segments and the reconnection with the opposite rupture side of the trailing wave crest leads to the pair generation of low amplitude filaments coinciding with topological defect filaments, winding around which a pair of acoustic vortices with opposite helicities are generated. The particle focusing by the distorted or ruptured waveforms is identified as the key mechanism for the generation of the observed rogue wave events with localized large amplitude.