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Solitary electrostatic structures observed in a laboratory experiment

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Solitary electrostatic pulses interpreted as phase-space holes have been observed in numerous places of the magnetosphere such as the vicinity of reconnection current sheets, shocks or auroral current layers. They are thought to affect plasma resistivity and heating, and may play a role in particle acceleration. However these roles have not been fully clarified, and this is particularly so in magnetized plasmas where some of their basic properties such as their stability remain poorly understood.

Here we present the first results of a series of experiments conducted at the UCLA plasma device (LAPD). Solitary waves were generated by injecting a weak electron beam into a cold (with a large beam velocity compared to thermal speeds), weakly collisional (large mean free path compared to experiment size) and magnetized background plasma. Beam energies varied from 30 to 120 eV, and magnetic fields from 75 ($\omega_{pe} \gg \omega_{ce}$) to 750 G ($\omega_{pe} \ll \omega_{ce}$). A set of electric field probes separated by approximately a Debye length ($\sim$60 μm) allowed us to estimate propagation characteristics and scale size of the structures. The velocity of the structures was found to be a fraction of the beam velocity and their sizes of the order of few tens of Debye lengths. A stronger magnetic field was found to be a stabilizing factor for the solitary structures.