2D Fluid Plasma Echoes

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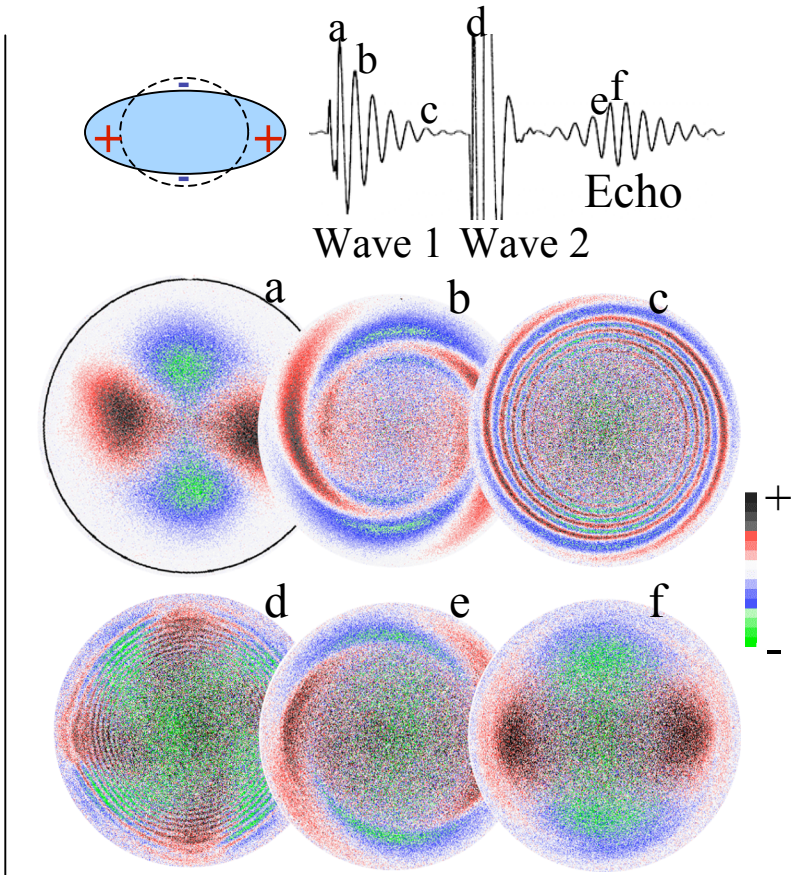
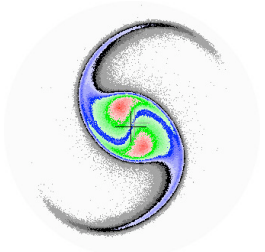
Spontaneous echoes from waves on 2-dimensional vortices have recently been observed, using magnetized electron columns as the "working fluid." Two vortex surface waves are launched and detected (top), using antennas in the circular wall. The launched waves damp away with time, followed by a spontaneous echo, demonstrating a surprising reversibility of the inviscid damping [J.H. Yu et al., Phys. Rev. Lett. **94**, 025005 (2005); and Echo Movie, NNP.ucsd.edu/publications/ .

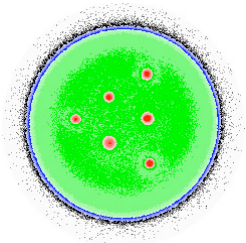
Simultaneously, the variations in vorticity across the vortex are measured (colored data images a-f), directly imaging the "phase space" of theory. The wave damping is readily apparent as spiral wind-up at the resonant layer (b-c), and the echo is a coherent un-winding (e-f). The eventual destruction of echoes provides a sensitive diagnostic of irreversibility due to collisional or non-ideal effects.

Other 2-d fluid processes of interest include the ubiquitous vortex merger with filament creation (lower left), and the rather surprising free relaxation of turbulence to self-organized vortex crystal states (lower right and http://sdphA2.ucsd.edu). All these processes are essentially inviscid, and are important in high Reynolds number flows and turbulence, such as found in planetary atmospheres [D.A. Schecter et al, Physics of Fluids **12**, 2397-2412 (2000)].





Vortex Merger



Vortex Crystals