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P2.4003 Selective excitation of Kelvin-Helmholtz modes with rotating electric fields

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The dynamics of a two-dimensional (2D) inviscid and incompressible fluid can be conveniently studied using a strongly-magnetized pure electron plasma confined in a PenningMalmberg trap, thanks to a mathematical analogy where the fluid velocity is equivalent to the plasma E × B velocity, and fluid vorticity and stream function correspond to plasma density and electrostatic potential, respectively [1]. Experimental investigations have shed light on dynamical features of the fluid flow ranging from the insurgence and decay of diocotron (KelvinHelmholtz) waves to the development of coherent structures and turbulence in conditions of free evolution and more recently also under the effect of an external forcing [2, 3, 4].
Typically, diocotron modes are excited applying multipolar static or oscillating electric fields on an azimuthally-sectored trap electrode, limiting the maximum mode wavenumber to Ns/2, with Ns the number of sectors. We have previously reported on a scheme that removes this limit on the accessible wavenumber, based on the application of suitable multipolar rotating electric fields with a drive frequency closely matching the frequency of the desired mode [5]. These earlier proof-of-principle measurements were affected by experimental limitations related to the plasma generation process [6]. We present now a systematic analysis of the phenomenon based on both theoretical and particle-in-cell simulation studies as well as on improved experiments exploiting an upgraded protocol for the preparation of the initial plasma configuration. We evaluate the mode growth rates, the broadening of resonances, and the presence of unwanted modes depending both on plasma properties like the initial density profile and on the drive amplitude and duration.
References
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