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On Excitation of Zonal Structures by Kinetic Alfv´en Waves

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Zonal flow (ZF) and zonal current (ZC) in fusion devices are manifestations of ,respectively, electrostatic (ESCC) and magnetostatic (MSCC) convective cells in uniform plasmas. Similarly, kinetic Alfv´en waves (KAW) appear as kinetic Alfv´en eigenmodes (KAE) due to the presence of Alfv´en continuum. Employing this paradigm, we have investigated the spontaneous excitation of CC via modulational instabilities induced by a finite-amplitude pump KAW both analytically and by numerical simulations. Our results demonstrate that kinetic finite ion Larmor radius (FILR) effects play crucially important roles in the excitation mechanism. More specifically, we have found that (i) spontaneous excitation only sets in when both the pump KAW and the CC have perpendicular wavelengths comparable to the ion Larmor radius, and (ii) both ESCC (ZF) and MSCC (ZC) are excited simultaneously. Results of fluid-electron and Vlasov-ion hybrid simulations show good agreements with analytical predictions. Implications to ZF/ZC excitations by KAEs in laboratory fusion devices will also be discussed.

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