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P2.4001 Formation and stability of vortex structures in the flute mode turbulence

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Flute oscillations are vortical motions which are highly elongated along the magnetic field. Their characteristic dimensions are much larger than the Larmor radius, and their frequency much smaller than the cyclotron frequency, of the ions. In contrast to the electrostatic drift wave, the flute mode belongs to the reactive system, i.e. the flute mode is linearly unstable even in the absence of any dissipation and is easily excited in a non-uniform plasma if there is an unfavorable ratio of the gradients of the plasma density and the magnetic field. Moreover, for these modes the assumption of adiabatic electrons is not valid and therefore the linear and nonlinear analysis involves the studies of density fluctuations. The oscillations are assumed quasineutral. In this paper we investigate the stationary states which are established under the influence of the nonlinear effects associated with the flute instability. The nonlinearity, which is increased in importance by this instability, give rise to the reduction the characteristic dimension of the initial perturbations, so that the size of a vortex may fall below the critical value which is the threshold for the instability. It can thus be expected that the evolution of the flute instability will terminate in a set of such vortices. The particular interest in these studies is to formulate the conditions for the formation and existence of the infinitely long rows of vortices or vortex streets with finite vorticity associated with flute modes. To perform the analysis, we use the two-field nonlinear model equations for the flute oscillations. The Hamiltonian structurer of these equations has been then identified and used to find the complete set of integral invariants. We focus the discussion on two-dimensional (2-D) vortex flows that are described by the 2-D stationary propagating solutions to the equations for flute modes. These solutions are localized in the direction of the plasma inhomogeneity, periodic in the direction of the translation symmetry and correspond, physically, to so-called "vortex streets" known in fluid dynamics. The knowledge of a full set of integral invariants provides a general characteristic of these stationary solutions and give s tools to investigate their stability. In these studies, we refer to Lyapunov's direct method. First, we form the Lyapunov functional for the stability analysis and then, by varying this functional, we find that the considered 2-D vortex flows are stable to long wave length perturbations.

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