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Spontaneous generation of self-organized zonal flows in turbulent plasma

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Drift wave turbulence is ubiquitous in magnetised plasma, in particular on density gradients that can be found in plasma edge configurations. Such configurations arise in both laboratory and space environments, while appropriate scaling the equations governing the drift waves allows them to be applied over a wide range of length and time scales. Therefore, the study of drift wave dynamics has applications ranging from the magnetosphere boundary to small laboratory plasma devices such as CSDX at UCSD [G.R. Tynan et al., J. Vac. Sci. Tech-A **15**, 2885 (1997)]. Recently, it was found that the interaction between drift modes and zonal flows at a plasma edge leads to self-organisation of the drift waves and the formation of solitary zonal flow structures [R. Trines *et al.*, Phys. Rev. Lett. **94**, 165002 (2005)]. The interaction between broadband drift mode turbulence and zonal flows has been studied in numerical simulations based on the wave-kinetic approach. In these simulations, a particle-in-cell representation is used for the quasi-particles, while a fluid model is employed for the plasma. Simulation results show the development of self-organised zonal flow through the modulational instability of the drift wave distribution, as well as the existence of solitary zonal flow structures about an ion gyro-radius wide, drifting towards steeper relative density gradients. These results will be compared to observations made at the magnetopause by the Cluster satellites [R. Trines *et al.*, Phys. Rev. Lett. **99**, 205006 (2007)] and to measurements performed on CSDX. This work is supported by the STFC Accelerator Science and Technology Centre and the STFC Centre for Fundamental Physics.