Large scale magnetic field structures in nonuniform unmagnetized plasma

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The generation of large scale flows by underlying small scale turbulence is a well known phenomenon in different areas of current research. Here, we turn our attention to the magnetic electron drift mode turbulence. The corresponding turbulent fluctuations are drift-type modes excited in a nonuniform unmagnetized plasma, characterized by a frequency range in between the electron and the ion plasma frequencies. Our interest in this particular regime is motivated by earlier studies of these modes, which suggest a possibility of spontaneous generation of strong magnetic fields in laser produced plasmas, which have been observed since the 1970's. Within the magnetic electron drift mode turbulence, we address the question of generation of large scale magnetic fields by small scale turbulent magnetic fluctuations in a way similar to the flow generation by electrostatic drift turbulence. We thus deal with a coupled system of two different parts of the same wave spectrum, which cannot be addressed in isolation. Having the spectral model equations in our hand, we focus on the dynamics of interacting magnetic drift wave - large scale field turbulence. First, the stability of such large scale structures is investigated in kinetic and hydrodynamic regime, for which an instability criterion similar to the Lighthill criterion for modulational instability is found. Furthermore, these large scale flows can undergo further nonlinear evolution after initial linear growth, which can lead to the formation of long-lived coherent structures. We show that one possible nonlinear solution is corresponding to a coherent solitary structure, which can be created in-between layers of different magnetic flow velocity. The formation of such coherent structures can be of interest in the context of an electron transport mechanism, which has a smaller characteristic scale and a larger growth rate than the ion turbulence.