# Experiments in a basic plasma device in support of the comparison with linear and nonlinear theories of electrostatic instabilities

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Basic plasma physics experiments in toroidal geometry offer the possibility of investigating the properties of low frequency instabilities in well-diagnosed scenarios. The development of instabilities, from a linear to a nonlinear character, and the related turbulence and its implications for anomalous particle transport, are investigated on TORPEX, a toroidal device with toroidal magnetic field ≤100 mT and a small vertical component (≤4 mT). Plasmas from noble gases are produced and sustained by low field side injection of microwaves (P≤20 kW) with f=2.45 GHz, in the EC frequency range. Density and potential fluctuations are measured over the whole plasma cross-section, and their properties investigated for a large range of variation of control parameters, including the ion mass, the neutral gas pressure and the vertical magnetic field. For the different experimental scenarios, the maximum of fluctuations is measured where the pressure gradient and the magnetic field gradient are co-linear. From the comparison of the measured spectral properties, including the dispersion relation in the directions perpendicular and parallel to the magnetic field, with a kinetic dispersion relation for drift waves in slab geometry, the observed instabilities are identified as drift-interchange. The spectrum exhibits coherent features where the unstable modes are excited. At this location, the bicoherence spectrum is dominated by nonlinear interactions between the fundamental and higher order harmonics. The degree of turbulence increases as the modes are convected away from their source region by the underlying **E**×**B** drift, the spectral regions between harmonics are progressively filled in and nonlinear interactions between modes are measured in an extended frequency range. The quadratic non-linear coupling coefficients and the energy transfer function are estimated at different locations over the plasma cross-section. Features such as the characteristic scale range involved, the spectral index and the direction of energy cascade are consistent with a nonlinearity induced by the **E**×**B** convection of density fluctuations. In real space, large-scale coherent structures are detected in the fluctuating density, originating in the region of high fluctuation level and propagating in the **E**×**B** direction. The relation between statistical space-time properties of the structures and local spectral properties of fluctuations will be discussed.