DPP07-2007-000240

Abstract for an Invited Paper
for the DPP07 Meeting of
the American Physical Society

Experimental Studies of Zonal Flow and Field in CHS Plasma

AKIHIDE FUJISAWA, National Institute for Fusion Science

Turbulence is a fundamental phenomenon ubiquitously observed in nature. In the fusion and plasma research, the drift-wave turbulence has been extensively studied to clarify the anomalous transport that degrades plasma confinement properties. Recently, a new paradigm for plasma turbulence has come up: the turbulence is regarded as a system of drift waves and the zonal flows. This paper provides full reports on the pioneer works in CHS, which have propelled the paradigm shift by dual heavy ion beam probes (HIBPs) and by modern data-processing techniques (wavelet, bicoherence, etc). In the experiments up to date, I) zonal flow was identified for the first time with the oscillatory branch of zonal flow, geodesic acoustic modes. II) The coupling between zonal flow and turbulence was confirmed. III) The difference in the energy partition between zonal flow and turbulence is found to be a cause of the confinement improvement for the states with and without a transport barrier. Very recently, the experiments have evolved into a new stage by exploring the potentiality of HIBP, that is, the ability to measure local magnetic field perturbation. The application resulted in discovery of zonal magnetic field and the coupling with turbulence. Similarly to the zonal flow, the zonal field is a symmetric structure around the magnetic axis with a finite radial wavelength in meso-scale. The discovery presents clear evidence that turbulence can generate the structured magnetic field, giving an insight into the field generation like geomagnetism. The works provide a modern framework for a fundamental understanding of the turbulence and its related structural formation. The observations of structured electric and magnetic fields generated by turbulence in laboratory are important for fluid mechanics and astronomy as well as the plasma physics.