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The effect of resonance manifold shrinking under zonal flow shear at the TJ-K experiment

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In magnetically confined fusion plasmas the dynamics at the edge of the confinement region, in particular turbulent cross-field transport determines the quality of plasma confinement. Shear flows are considered to be involved in the reduction of turbulent transport. At the stellarator experiment TJ-K Langmuir probe arrays are employed to experimentally access turbulent perpendicular dynamics, which has a two dimensional character giving rise to the transfer of energy along an inverse cascade into macroscopic zonal flows. Those constitute an energy sink for microscopic turbulent scales. In the plasma edge region the dynamics are governed by drift waves and the energy transfer is determined by resonant non-linear three-wave interactions under the constraints of the drift-waves' dispersion relation. Under these constraints the coupling space is limited. Theoretically this manifold is reduced in the presence of shear flows [1]. As a persisting contribution within the shrinking manifold, zonal flows (ZF) gain relative importance in the turbulence's three-wave interactions, which may be reflected in an enhanced efficiency in turbulence-flow energy transfer. In this contribution an experimental approach to address the influence of shear flows on resonant manifold is presented. To this end, multiple Langmuir probes are aligned to the complex 3D magnetic field structure of the stellarator TJ-K. The data is analyzed by means of a combined conditional wavelet-based bispectral analysis method. Fig. (1) shows the effective width of the resonant manifold, calculated in wavenumber space from effective wavenumbers in the positive and negative wavenumber space. Effective width and occuring ZF are anti correlated, showing the contraction of the resonant manifold under flow shear.

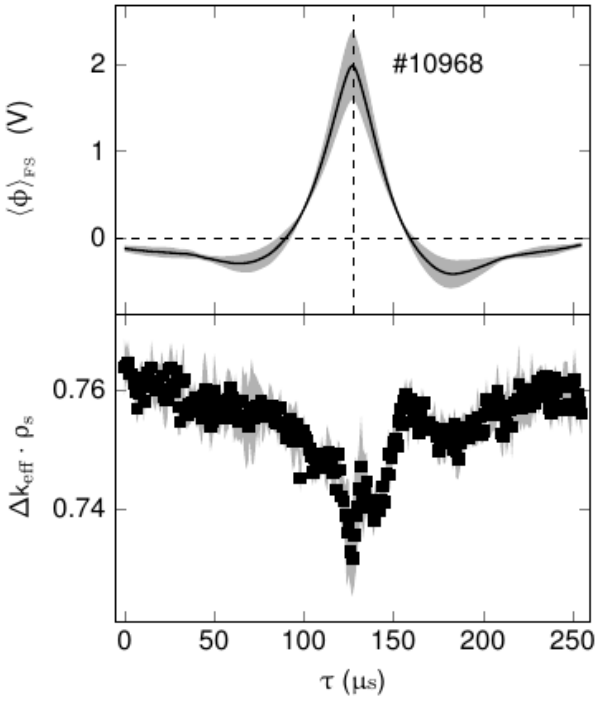

Figure [1]: Measurement of the effective extent of the resonant manifold during ZF occurrence. *(Top)*: Conditionally averaged ZF potential with uncertainty (grey), whose evolution can be regarded equivalent to the radial shear. Below: Time evolution of difference between the effective wavenumbers in positive and negative coupling space, which can be interpreted as an effective width of the manifold, shown as filled squares with uncertainties as shaded area. The time trace exhibit a drop of the effective width when the shear increases.

References:

[1] Ö.D. Gürcan: Phys. Rev. Lett. **109**, 155006 (2012)