GAM evolution in L-mode approaching the L-H transition on JET

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The interaction between zonal flows (ZFs) and turbulence is a self-regulating mechanism. Understanding this interaction is crucial to control plasma confinement. The shearing due to ZFs is thought to dominate in regimes when the mean shear flow is modest as before and during the L-H transition [e.g. 1]. This was corroborated by findings in different devices demonstrating the importance of both the oscillating and mean flow shear and their interaction in triggering the transitions [1-4]. While on AUG the sheared flow below the L-H threshold is dominated by Geodesic Acoustic Modes (GAMs) [1], on devices such as DIII-D [2], EAST [3] and HL-2A [4] GAMs do not appear to be important on the way to H-mode. The reported results reveal that no clear picture exists on the relevance of GAMs in the turbulence collapse required for the formation of steep pressure gradients at the transition.

This contribution focuses on the characterization of GAMs in JET L-mode plasmas when approaching the L-H transition aiming at understanding its possible role in triggering the transition. Doppler backscattering has been used to investigate GAMs by measuring oscillations in the E × B flow velocity. Experiments were performed in NBI heated discharges for different values of plasma current ($2.2 < I_p < 3.2$ MA) and line-averaged density ($1.6 < n < 3.1\times10^{19}$ m^{-3}). The dataset also includes variations in toroidal magnetic field, magnetic configuration and hydrogen isotopes.

Results demonstrate that parameters such as plasma current and density have a strong effect on the GAM amplitude. By assessing the importance of critical parameters such as safety factor and collisionality, experimental evidence is found for the different mechanisms determining the GAM amplitude: turbulence drive, collisional and collisionless damping.

GAMs have been studied along the power ramp used to induce the L–H transition, taking advantage of the unique JET dataset. As the heating power increases, the GAM amplitude first increases but then is reduced as the L-H transition is approached. GAMs are either suppressed or have a modest amplitude at the transition. The cause of this reduction is however unclear as the GAM damping rate is expected be reduced along the heating power ramp and density fluctuations levels and the $E \times B$ shear flow display modest changes.

Experimental investigation of isotope effects in hydrogen and deuterium plasmas was also performed. Stronger GAMs were found in D than in H plasmas at low heating power ($P_{NBI} <$ 4 MW) associated with larger edge density fluctuations in H. However, above $P_{NBI} \approx 4$ MW, the GAM amplitude is reduced in D plasmas while increases for H plasmas. Unfortunately, the L-H transition could not be achieved in H plasma due to heating power limitations.

[1] G.D. Conway et al., PRL 106, 065001 (2011)
[2] Z. Yan et al, NF 53 113038 (2013)
[3] G.S. Xu et al, PRL 107, 125001 (2011)
[4] M. Xu et al, PRL. 108, 245001 (2012)