Reynolds stress and fluctuation measurements with Langmuir and ball-pen probes in the vicinity of the L-H transition on COMPASS

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The Reynolds stress force due to the Reynolds stress tensor has been identified in recent models and experiments \cite{1} as a likely driver of poloidal zonal flows which are expected to play a key role in the L-H transition and the associated limit cycle oscillations (LCO) \cite{2} in the predator-prey-like interaction of zonal flows with turbulence.

This contribution presents a comparison and an analysis of simultaneous Reynolds stress profile measurements with both Langmuir and ball-pen \cite{3} probes in similar geometric configurations using a new probe head installed at the COMPASS tokamak \cite{4}. The Reynolds stress profiles calculated from the floating potential measured with Langmuir probes are found to be lower than those calculated from the plasma potential measured with ball-pen probes. Spectral analysis of the Reynolds stress suggests that this is due to negative contributions from higher frequency fluctuations possibly associated with electron temperature fluctuations.

The same probe head was used to measure fluctuations of the density $\delta n_e$ and the electric field $E_r$ during oscillations observed near the L-H transition, originally discovered with an ELM-detection algorithm. This candidate for the limit cycle oscillations regime (cLCO) modulates $\delta n_e, E_r$ and $D_\alpha$ emission with a frequency 2-5 kHz. Preliminary results show that the cLCO have a magnetic mode number $n = 0$ which indicates an axisymmetric structure. The phase shift between $\delta n_e$ and $E_r$ is close to $\pi/2$ which points to a limit cycle behavior. These findings are consistent with LCO characteristics observed in other devices \cite{2}.

References

\begin{enumerate}
\item J. Cheng, J. Dong, K. Itoh, et al., Nuclear Fusion \textbf{54} 114004 (2014)
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