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Effect of Turbulence Intensity, its Dynamics and Roles in Performance Enhancement of Fusion Plasmas

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The role of spatio-temporal evolution of turbulence intensity fluctuations in magnetic confined plasmas has been studied and methodically analyzed using 3-field bifurcation analysis which includes pressure, density, and turbulent intensity as its three component fields. The turbulent intensity is modelled according to the Fisher equation. Also, we consider the plasma to be ELM free which has been found to make a transition to H-mode when the heating is above the threshold value. The turbulent intensity is found to be suppressed by mean flow shear which results in the formation of transport barrier thus facilitating the L-H transition phenomena. It has been found that the pressure, density as well as the turbulence intensity increases at the plasma center with increasing heat source. The pressure increases by 275% whereas the density and turbulence intensity increase by 13% and 140% respectively. A negligible increase in density at the center can be attributed to the flat-top profile.

A contour mapping shows transition of plasma to H-mode with variation in thermal as well as particle sources The transition happens when pressure gradient increases above a critical threshold. Thus, the approximate transition point for pressure has been determined.

The pressure as well as intensity curvature shows an increase at the point of head of the pedestal which also varies with increasing thermal source value. The pedestal head in pressure profile increases with initial increase in thermal source, it also shows a small decrease for higher value of thermal source, showing a steady phase in between where the pedestal head remains constant with increasing thermal source.

It can be noted that the above analysis is performed with a linearized turbulence intensity diffusion equation. However, it has also been found that as the diffusion equation for turbulence intensity shifts towards nonlinearity (while having a linear local growth and nonlinear decay), magnitude of pressure, density as well as the intensity tends to decrease at the center of the plasma.

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