7P42 Statistical analysis of the effect of geodesic curvature of magnetic field lines on turbulent transport characteristics

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The zonal flow reduces the turbulent transport. Theoretical research has shown that the zonal-flow intensity may depend on the geodesic curvature of the magnetic field line [1]. Controlling the zonal-flow intensity is essential for the turbulent transport reduction in nuclear fusion plasma.

We scanned the geodesic curvature by checking the magnetic axis of the Large Helical Device (LHD). In previous research, we have experimentally investigated the geodesic curvature dependence of the transport reduction effect of zonal flow with a reduced transport model [2], assuming that the amount of plasma parameters is the same. The result showed that the geodesic curvature dependence of the zonal flow effect was consistent with the theoretical prediction (refer the figure 1) [1].

The heat transport coefficient's geodesic curvature dependence with other parameters was investigated with statistical analysis. The statistical analysis was conducted with JMP ver.16 (SAS Institute, Cay, NC, USA). We chose the critical parameters for Akaike Information Criterion (AIC) [3] from geodesic curvature $\langle \kappa_g \rangle$, density fluctuation $\tilde{n}_e/n_e$, temperature ratio T_e/T_i, normalized collisionality $\nu_{ii}{}^*$, normalized electron temperature gradient R/L_{T_e}, and normalized ion pressure gradient $R/L_n + R/L_{T_i}$. Based on the AIC, the essential parameters are geodesic curvature, temperature ratio, normalized electron temperature gradient, and normalized pressure gradient. We evaluated the scaling of the heat transport coefficient of the parameters with multi-regression analysis. The result is shown in equation (1), and the result is consistent with the measured heat transport coefficient (shown in figure 2).

$$\frac{\chi_i}{\chi_i^{GB}} = 10^{6.80\pm0.35}\langle \kappa_g \rangle^{1.85\pm0.06}\left(\frac{T_e}{T_i}\right)^{1.64\pm0.11} \left(R/L_{T_e}\right)^{-0.960\pm0.135}\left(R/L_n + R/L_{T_i}\right)^{-0.469\pm0.040} \quad (1)$$

The geodesic curvature effectively improves the confinement through the zonal flow activation in ITG-turbulence.

[1] M. Nakata and S. Matsuoka, Plasma Fusion Research in press.
[2] M. Nunami et at., Physics of Plasmas **20**, 092307 (2013)
[3] H. Akaike, IEEE Transactions on Automatic Control **19**, 716 (1974)

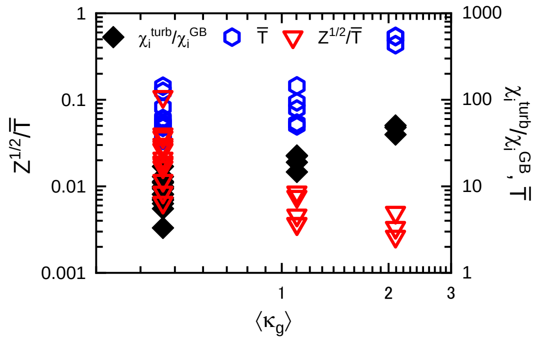

FIG. 1 Geodesic curvature dependence of zonal flow effect

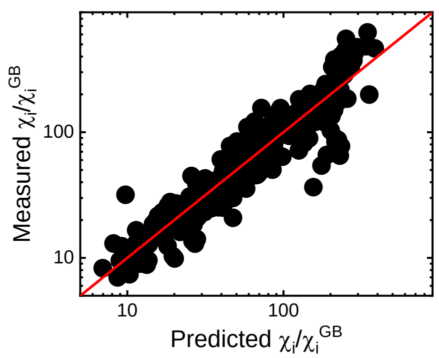

FIG. 2 Measured heat transport coefficient as a function of predicted heat transport coefficient.