MAGNETIC CONFIGURATION EFFECTS ON TURBULENCE DRIVEN TRANSPORT FROM LHD AND W7X IDENTICAL EXPERIMENTS

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ABSTRACT

Characteristics of the turbulence driven transports are investigated in LHD and W7-X. The gyrokinetic non-linear simulation with identical input gradient shows lower ETG driven transport in W7-X and lower ITG driven transport in LHD. The configuration scan experiments in LHD shows that reduced transport associated with reduction of ion scale turbulence at inwardly shifted configuration, where effective helical ripple is low. The identical experiment between W7-X and LHD with similar density and heating power shows clear different density and temperature profiles. Total transport is lower in W7-X at most of the radial location, however, anomalous contribution is lower in LHD. The reduced ion transport in LHD qualitatively agree with gyrokinetic simulation. The effective helical ripple is not ruling parameter to reduce anomalous transport among stellarator/heliotron configuration.

CONFIGURATION COMPARISON

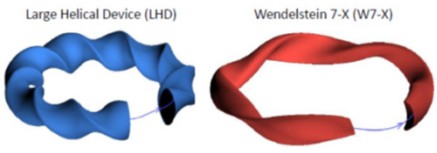

FIG1 LHD and W7-X

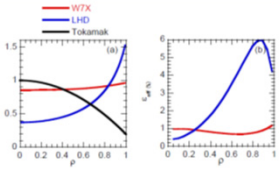

FIG2 Comparison of ι and ε_{eff}

LHD high ι shear and high ε_{eff}., W7-X low ι and low ε_{eff}. Neoclassical transport is around one order magnitude lower in W7-X than in LHD [1] . How about anomalous transport?

GYROKINETIC INVESTIGATIONS IN LHD AND W7X

Configuration dependence was investigated using same input parameter.

Q_{ITG} LHD < W7X

This is due to stronger generation of zonal flow in LHD

Q_{ETG} LHD > W7X

This is due to the more effective break of streamer. Positive I shear works to break radial streamer [2].

For identical $a/L_{Ti} = a/L_{Te}$ (realized in outer radius region), Q_{ETG} is negligibly small in W7-X and factor two small in LHD

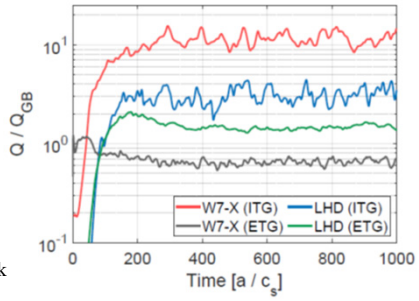

FIG3 Non-linear heat flux driven by ITG and ETG in LHD by GKV and in W7-X by GENE . ($a/L_{Ti} = a/L_{Te} = 3$; $a/L_n = 0$) Adiabatic electron for ITG and adiabatic ion for ETG are used.

CONCLUSION

- Although neoclassical transport is much lower in W7X than in LHD, GK NL simulation shows ITG driven transport is lower in LHD. This is due to the larger generation of zonal flow.
- Among LHD configuration, lower ε_{eff} results in reduced transport, however, this dependence cannot be applicable for W7-X, because anomalous contribution of ITG in W7-X, with low ε_{eff} is higher than in LHD.
- Transport comparison experiments shows lower ce and ci in W7-X than in LHD. Ci exp-ci neo as a proxiy of anomalous contribution shows reduced anomalous contribution in LHD. This results qualitatively agree with GK NL simulations.

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CONFIGURATION SCAN IN LHD

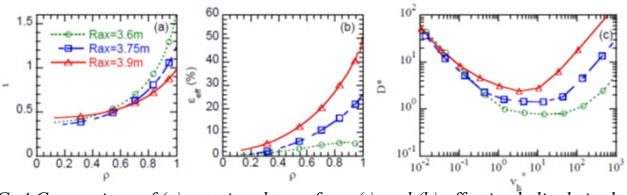
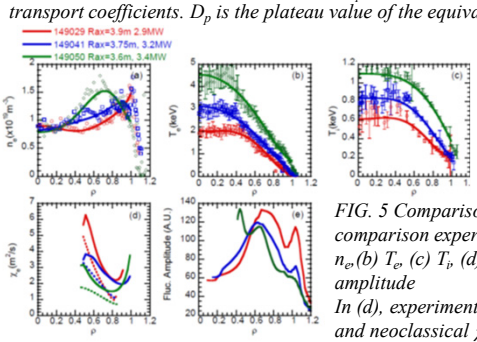


FIG. 4 Comparison of (a) rotational transform (ι) and (b) effective helical ripple (ε_{eff}) and (c) neoclassical diffusivities. In $D^*=D_{neo}/D_p$, The D_{neo} is monoenergetic neoclassical transport coefficients. D_p is the plateau value of the equivalent tokamak [3]



3.4MW at Rax=3.6m,
3.2MW at Rax=3.75m
2.9MW at Rax=3.9m

FIG. 5 Comparisons of profiles in transport comparison experiments of ECRH plasma. (a) n_e,(b) T_e, (c) T_i, (d) χ_e and (d) fluctuation amplitude
In (d), experimental χ_e were shown by plain line and neoclassical χ_e were shown by dashed line

For almost identical heating power, profiles are complete different.
More hollowed density profile at more outwardly shifted configuration. This is due to the larger neoclassical thermo-diffusion [4].
Lower temperature at more inwardly shifted configuration.
Both χ_{exp} and χ_{neo} is higher at more inwardly shifted configuration.
Ion scale turbulence is larger at more inwardly shifted configuration.
Lower neoclassical transport coincident with lower anomalous transport supporting theoretical investigation [5].
In W-7X, configuration dependence in high-iota, high-mirror and standard configurations are relatively small [6].

TRANSPORT COMPARISON EXPERIMENTS IN LHD AND W7-X

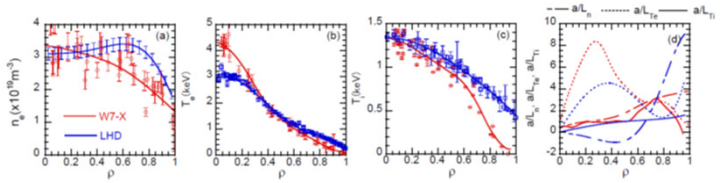


FIG.6 Comparisons of profiles (a) n_e, (b) T_e (c) T_i and (d) normalized gradient ECRH ~2MW central heating

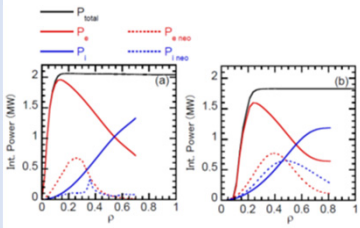


FIG.7 Integrated deposition power (a) W7-X and (b) LHD

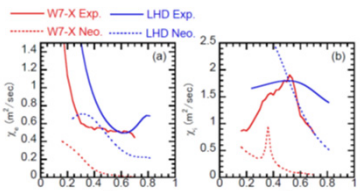


FIG.8 Comparisons of (a) χ_e and (b) χ_i

Peaked density profile in W7-X and hollowed profile in LHD.
Steeper telepicture in W7-X than in LHD
Neoclassical contribution is much higher in LHD than in W7-X

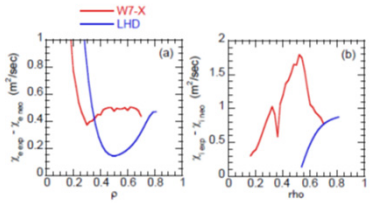


FIG.9 Possible contribution of anomalous transport (a) electron channel and (b) ion channel

Experimental χe and χi are lower in W7-X at most of the radial location.
Anomalous contributions were compared by χ_{exp}-χ_{neo} as a proxy.
χ_{exp}-χ_{neo} is lower in LHD at most of the radial locations.
Both ITG and ETG can contribute to electron transport because $a/L_{Ti} < a/L_{Te}$ at ρ <~0.6
TEM is probably ruled out due to non steep density gradient at ρ <0.8 in both devices.
Ion transport can be governed by ITG in both device.
Lower ITG driven ion trasnport in LHD qualitatively agree with GK NL simulation.
However, lower ε_{eff} in W7X does not results in reduced transport observed in LHD.