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ITR/P1-19: Tokamak Experiments to Study the Parametric Dependences of Momentum Transport

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Momentum transport and plasma rotation have been studied extensively on many tokamaks in recent years. Numerous experimental results have been reported on individual devices –yet no dedicated multi-machine momentum transport experiments have been performed. This paper reports dedicated scans to study momentum transport that have been carried out on JET, DIII-D, AUG, NSTX and C-Mod within the ITPA framework. NBI modulation technique to create a periodic rotation perturbation has been exploited on JET, DIII-D and AUG from which the convective velocity vpinch and diffusion coefficient χ_phi profiles are determined. On NSTX, 50 ms pulses of n=3 non-resonant magnetic fields were applied to extract vpinch and χ_phi profiles. On C-Mod, either ICRH modulation or septum sweeping between the lower and upper null configurations was applied to create the rotation perturbation.
A 3-point collisionality υ*scan by varying collisionality by a factor of 4–5 while keeping the other dimensionless quantities, such as ρ*, βN, q, R/Ln and Ti/Te, as constant as possible (10–20% variation), has been performed independently both on JET and DIII-D in L-mode plasmas. Neither the pinch nor the Prandtl number depends on collisionality on JET or on DIII-D. On NSTX, no clear trend between the pinch number and υ* was found either.
The dependence of the Prandtl and pinch numbers on R/Ln obtained from JET, DIII-D and AUG NBI modulation shots indicates that Pr does not depend on R/Ln although JET plasmas tend to have higher values in general. On the contrary, the pinch number shows a clear dependence on R/Ln in each device separately and also as a joint database. This increase in the pinch number with increasing R/Ln is qualitatively consistent with theory and gyro-kinetic simulations.
Based on the results from these multi-tokamak parametric scans, one can conclude that the inward pinch will have a significant impact on the rotation profile in ITER provided that the density profile is at least moderately peaked (R/Ln≥1) and some rotation source is available at the edge of the plasma. In all these analyses, the possible intrinsic torque has not been taken into account.

Country or International Organization of Primary Author

Finland

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Primary author: Mr TALA, Tuomas (Finland)

Co-authors: Mr SALMI, Antti (VTT); Dr GIROUD, Carine (CCFE); Dr ANGIONI, Clemente (IPP); Dr RYTER, Francois (IPP); Mr CHI, Gao (MIT); Dr TARDINI, Giovanni (IPP); Dr RICE, John (MIT); Mr FERREIRA, Jorge

(IST); Dr YOSHIDA, Maiko (JAEA); Dr MANTICA, Paola (CNR); Dr MCDERMOTT, Rachael (IPP); Dr KAYE, Stan (PPPL); Dr SOLOMON, Wayne (PPPL); Mr PODPALY, Yuri (MIT)

Presenter: Mr TALA, Tuomas (Finland)

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