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EX/P3-31: Scalings of Spontaneous Rotation in the JET Tokamak

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Intrinsic rotation levels measured in JET plasmas are generally lower than expected from scaling laws that predict that rotation increases with normalised beta. Several factors have been observed to influence intrinsic rotation, such as fast ion losses and toroidal field (TF) ripple, suggesting that different physics mechanisms are at play to drive intrinsic rotation and that these should be taken into consideration when extrapolating to future devices. TF ripple, in particular, was found to have a significant effect on the rotation of plasmas without momentum input. JET results suggest that ITER intrinsic rotation may be substantially less than what was predicted by the multi-machine rotation scaling of ref. [1].
The JET intrinsic rotation database includes plasmas with Ohmic heating, ion-cyclotron radio-frequency (ICRF) heating (in two scenarios: minority heating and mode conversion) and, lower hybrid current drive. Typical C6 toroidal velocities are less than 30 km/s. JET data from ELMy H-modes not previously included in a multi-machine database were compared with a scaling for the Alfven-Mach number, and a scaling for the velocity change from L-mode into H-mode [1]. These two scalings do not reproduce well the JET data, where rotation can be lower for the same beta normalized. At JET no significant difference between H-mode and L-mode rotation is observed. In either L-mode or in H-mode, core counter-rotation is a common observation in JET plasmas. Velocity profiles often change sign from co-rotation in the edge to counter-rotation in the core. Factors clearly influencing the direction of rotation are heating details, such as ICRF resonance position, plasma current and MHD activity. In view of models of turbulent momentum transport that predict that changes in rotation might be correlated to gradients of bulk plasma parameters, the possible correlation of JET core rotation with electron and ion temperatures and plasma density has been investigated. The effect of TF ripple on intrinsic rotation was studied by varying the ripple from 0.08% to 1.5% in Ohmic and in ICRF heated plasmas. In both cases ripple causes counter rotation, indicating a strong torque due to non-ambipolar transport of thermal ions and in the case of ICRF also fast ions. At ITER relevant ripple levels of 0.5% JET plasmas were hardly rotating.
[1] J.Rice et al, N F 47 1618 2007

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Collaboration (if applicable, e.g., International Tokamak Physics Activities)

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