SESSION EX7

Friday, 23 October 1998, at 2 p.m.

Chairman: V.E. Golant (Russian Federation)

TRANSPORT

Paper IAEA-CN-69/EX7/1 (presented by J.G. Cordey)

DISCUSSION

T.C. LUCE: You cannot simultaneously match ρ^*_i, ρ^*_e, and T_e/T_i when the ion mass changes. Are you implicitly assuming that the electron ρ^* scaling is Bohm-like?

J.G. CORDEY: Yes, I am assuming that ρ^*_e is an unimportant parameter in the transport. This would certainly be the case if the turbulence scale length is proportional to the ion Larmor radius.

R.J. GOLDSTON: If your model of core and pedestal is extrapolated from JET up to ITER, it has a modest effect on τ_E - but this may not be so bad, since the profile will be more peaked. It seems to me that, if it is extrapolated down from JET to JFT-2M or Compass, almost all of the stored energy would be in the pedestal. In fact, relative pedestal stored energy is more or less constant in our experience for fixed ELM behaviour. This is presumably why $\tau_{E,H}/\tau_{E,L} \leq 2$ for almost all machines, no matter how small or large.

J.G. CORDEY: I have not yet checked the expression against the full multimachine database. Following this check there may well be a need for some refinement of the expression for the scaling of the pedestal. In this paper, I am merely trying to establish the principle that the scaling of the pedestal and the core will be very different. From equation (6) of the paper, one can see that the pedestal term is proportional to ρ^{*2}/β^2 and, as you say, one would expect the pedestal to become larger in small devices at high ρ^*. However, this is partially offset by the fact that the smaller devices tend to operate at higher β.

F. WAGNER: If it can be generalized that the global ion mass scaling of τ_E is determined by the Bohm-like edge in H-modes, whereas the core is gyroBohm with slightly reversed A_i scaling, then the local A_i scaling could be used as a tracer for Bohm versus gyroBohm. Maybe the H-mode analyses where a positive A_i scaling was also found for the core will have to be revisited. On the other hand, there are clear confinement modes with positive A_i scaling in the core. Therefore the question arises as to why the H-mode core can be gyroBohm. Do you think that it could be the reduced core gradients (thanks to the edge pedestal), specifically those of the density profile, which make the H-mode core gyroBohm?

J.G. CORDEY: Yes, I believe you are correct. The main difference between the ELMy H-modes on JET and the supershots in TFTR is the strongly peaked temperature, density and rotational profile. These together result in a strong gradient in the ExB flow term which is mass dependent. The higher mass isotope flows affect the turbulence more strongly. As a consequence, the simple weakly negative mass dependence of gyroBohm transport is modified into having a positive mass dependence.

Papers IAEA-CN-69/EXP2/03 and 02 (rapporteured by F. Ryter)

DISCUSSION

R. AMROLLAHI: You state that the global result $B_T\tau_E$ = constant. Do you have any idea what that constant is or might be?

F. RYTER: In saying $B_T\tau_E$ = constant, we mean that $B_T\tau_E$ takes the same value for a pair of shots matched in two devices. $B_T\tau_E$ depends on the transport model. We have not assumed any transport model here; we simply assume that the transport mechanism is the same in both devices, which leads to $B_T\tau_E$ being the same when all the dimensionless parameters as well as geometry are matched.

C.S. CHANG: Definition of ν^* near the last closed flux surface is not a simple matter since it includes the connection length which goes to infinity. In your comparative study between JET and AUG, how did you define ν^*? I believe it means you will suffer from a large error bar in the definition of ν^*. Thus, your conclusion that L-H transition is insensitive to ν^* may not be conclusive at all.

F. RYTER: We are aware of the difficulties in calculating ν^* at the edge. We took the data on the 95% poloidal flux surface where we think that the geometry is still well determined by our equilibrium. In addition, the results shown here are obtained for the same geometry and so, even if the absolute value of ν^* has a large error bar, the relative variation of ν^* from shot to shot has a much smaller error. Our conclusion is motivated by the variation of ν^* and not by the absolute value.

Paper IAEA-CN-69/EX7/3 (presented by G. Kuang)

There was no discussion.

Paper IAEA-CN-69/EX7/4 (presented by N.J. Lopes Cardozo)

DISCUSSION

K. IDA: Have you tried the heat pulse propagation experiment with ECH modulation to check your heat transport model? Did you observe the slow-down of heat pulse propagation at the transport barrier, which you predict from the steady-state T_e profile?

N.J. LOPES CARDOZO: We observed the strongest barriers - between $q = 1$ and 1.5 - with modulated ECH in various conditions, including ohmic (with only low power ECH to induce heat pulses) [G.M.D. Hogeweij et al. Nucl. Fusion 36 (1996) 535]. We also observed the formation of the barrier near $q = 3$ with modulated ECH in a discharge that made a spontaneous transition from level "E" to level "D" (see Fig. 2). I refer you to M.R. de Baar et al., Phys. Rev. Lett. 78 (1997) 4573. Finally, evidence for the existence - and "strengthening" - of two transport barriers between $q = 1$ and $q = 2$ was found with modulated ECH in experiments on the so-called "non-local" central T_e-rise, induced by edge cooling (P. Mantica et al., submitted to Phys. Rev. Lett.).

C.C. PETTY: You show a simulation of the electron temperature profile (Fig. 6) using your numerical model for a case of off-axis ECH where the simulated profile was hollow. How can a purely diffusive model produce a hollow temperature profile in steady state?

N.J. LOPES CARDOZO: We do include power sinks in the model: radiation and energy loss to the ions. However, these are not sufficient to explain the hollow - sometimes extremely hollow - T_e profiles we obtain in steady state with off-axis ECH. Therefore, outward heat convection is used in the model. This convection goes out to the ECH deposition radius, and is kept constant for all simulated plasmas.

J.P. CHRISTIANSEN: The barriers in the electron transport which you have determined experimentally should also affect ion transport, plasma transport and resistive diffusion (i.e. χ_i, D, η). Do you think this is possible and, if so, how can we determine these effects experimentally?

N.J. LOPES CARDOZO: If the layered structure resulted from the magnetic topology, the ions would be far less sensitive to it than the electrons. Similarly, fast electrons should be more sensitive to the barriers than slow electrons. I do not know how the barriers would affect resistive diffusion, but this would certainly be very difficult to assess experimentally. I should add that the barrier near $q = 1$ has been very clearly seen in impurity transport, also in JET.

Y. NAGAYAMA: Your χ_e model challenges traditional understanding that χ_e is infinite at the rational surface where the magnetic islands develop as a result of the tearing mode. Is the minimum χ_e region really at the rational surface, or next to the rational surface.

N.J. LOPES CARDOZO: If you think of the magnetic topology as the physics underlying the alternation of layers with “good” and “bad” confinement, you would indeed expect the “good” layers to be not at but just next to the rational q surfaces. However, “at” and “next to” are difficult to distinguish experimentally. In fact, in the model I presented the barriers are adjacent to the rational q values. I do not agree that X_e is infinite where magnetic islands are present. A chain of islands does represent an impedance to the heat flux, even if the T_e gradient vanishes inside the island. In this situation, the system is no longer one-dimensional.

Paper IAEA-CN-69/EX7/5 (presented by V. A. Vershkov)

DISCUSSION

M.C. ZARNSTORFF: Do you see a difference in the transport between plasmas with and without the quasi-coherent mode?

V.A. VERSHKOV: Yes, we see a strong connection between quasi-coherent turbulence and plasma diffusion. In IOC mode, for example, diffusion decreases by a factor of three.

B. COPPI: Did you explore regimes where the direction of the phase velocity changes, as the theory of the toroidal ITG-collisionless trapped electron mode indicates?

V.A. VERSHKOV: So far, we have investigated only one regime in detail but we are planning to conduct further studies of other regimes in the future.