SESSION EX4

Thursday, 22 October 1998, at 8.50 a.m.

Chairman: I.C. Nascimento (Brazil)

INNOVATIVE CONCEPTS, REVERSED FIELD AND MIRROR EXPERIMENTS

Papers IAEA-CN-69/ICP/01-05, 09-10 (rapporteured by D.C. Robinson)

DISCUSSION

H. TOYAMA: What are the critical issues needing to be tackled in experiments on second generation spherical tori, such as NSTX, MAST and Globus-M, to ensure the success of ST reactors? Please give quantitative indications where possible.

D.C. ROBINSON: The key issues for the further development of spherical tori are: the extrapolation of confinement to more collisionless plasmas at large size and currents, the scaling of the SOL width which is key to the exhaust problem, demonstration of quasi-steady-state operation with a large fraction of pressure driven currents and, linked to this, further increase in the β value at higher elongations ($\kappa > 2$).

Papers IAEA-CN-69/ICP/06-08, 11-12 (rapporteured by M.C. Zarnstorff)

DISCUSSION

D.D. RYUTOV: I am intrigued by your indication that the configuration of the quasi-omnigenous stellarator is not dependent on beta. When we studied omnigenous configurations in the late 70s-early 80s in conjunction with non-axisymmetric mirror systems, we found that quasi-omnigeneity falls apart at higher betas (we were interested in betas ~ 50%). I presume that there would be a similar effect in a quasi-omnigenous stellarator. Can you comment on that?

M.C. ZARNSTORFF: The quasi-omnigenous configurations are optimized at the MHD β-limit (~ 2-3% so far). The configurations are approximately invariant for lower β values owing to balancing of the effects of plasma currents (diamagnetic, Pfirsch-Schlüter, and bootstrap). Higher β values have not been examined.

Paper IAEA-CN-69/EX4/3 (presented by R. Bartiromo)

DISCUSSION

R.J. GOLDSTON: Perhaps you could tell us the absolute confinement time in the turbulent state, and in the quieter states. How close do the quieter states come to β = constant scaling?

A. BUFFA: In our standard case we have a relatively wide mode spectrum and, correspondingly, the transport in the core region is consistent with stochastic diffusion. In this case, our typical $\tau_E \sim 1$ ms. In our enhanced confinement regimes we have measured reduced core transport and a correspondingly narrow mode spectrum. In this case τ_E increases by a factor of ~ 2-3. At currents up to 0.6 MA these values fit the $\beta \simeq$ constant scaling.

M.E. MAUEL: As you may know, in tokamak plasmas, when magnetic islands are made to rotate with respect to the background plasma by rotating magnetic perturbations, the island size decreases until the island locks to the rotating perturbation. In your experiment, do you see the size of the magnetic instability decrease when you apply rotating fields and do you see evidence of "mode-locking" to the rotating perturbation?

A. BUFFA: Our results are still preliminary. However, we do see a reduction of the amplitude and coupling between the internal modes and the applied rotating perturbation.

J.D. CALLEN: Could you give us some indication of the conditions under which the alpha-mode enhanced confinement regime occurs? In particular, does it occur for large pinch parameter Θ where the Taylor theory indicates a helical structure can be the lowest energy state?

A. BUFFA: The main conditions so far identified for the occurrence of the alpha-mode are a slightly decreasing current (which corresponds to reduced MHD dynamo) and a low Z_{eff} (≤ 1.5). These quasi-single helicity states occur at low Θ (~ 1.4) and are not the Taylor helical states, which occur at higher Θ (~ 1.56) and have a pitch resonant outside the field reversal, whereas the observed states correspond to modes resonant inside the field reversal surface.

F. WAGNER: The density profile is flat in the core and has a local maximum at the edge. How is this variation consistent with transport analysis? Is it reasonable that the radial electric field in the core along with stochastic field and the strong E_ϕ do not play a role at the high turbulence level in the core?

A. BUFFA: The analysis of the density profiles is consistent with diffusion in stochastic fields and corresponds to an outward pinch velocity (~ 10's m/s). The contribution of the toroidal electric field is relatively less important.

Paper IAEA-CN-69/EX4/4 (presented by Y. Hirano)

DISCUSSION

S. ORTOLANI: Congratulations on achieving such interesting results during initial operation of TPE-RX. Have you made any measurements of Z_{eff}?

Y. HIRANO: No, we have not measured Z_{eff} spectroscopically. Estimation from the conductivity temperature indicates that the Z_{eff} could be very high, possibly more than 5.

M.E. MAUEL: Are you considering using special wall conditioning techniques, such as boronization?

Y. HIRANO: Yes, we are going to use some kind of wall conditioning, like boronization or titanium gettering. We are considering which type would be best for our machine.

Paper IAEA-CN-69/EX4/5 (presented by G. Fiksel)

DISCUSSION

E.B. HOOPER: Do you have a measurement of the phase difference between velocity fluctuations and the corresponding magnetic field fluctuations? Does this phase depend on S?

G. FIKSEL: We do not have well-resolved measurements of the phase scaling, but in general it is weak. The strong scaling of the dynamo product is mainly a result of decrease in the coherence.

D. ESCANDE: A recent study of improved confinement regimes in RFPs by P. Martin at Padua has shown that quasi-single helicity is, as expected theoretically, related to high Prandtl number, i.e. high viscosity. The S number is then no longer active for the scaling of magnetic fluctuations. Therefore, the future of the RFP line could be more related to setting the plasma in the single helicity basin than to decreasing the amplitude of fluctuations.

G. FIKSEL: The scaling was done in "standard" RFR with a multiple number of modes.

D.E. BALDWIN: When you cite improved energy confinement with externally driven current, do you count the power required to input that current? Also, is external current drive more efficient than using diffusion of central current to the edge?

G. FIKSEL: The input power from both toroidal and poloidal circuits is included in the calculation of the global energy confinement time.

T.R. JARBOE: How does the confinement scale with S?

G. FIKSEL: The scaling is weak - probably because of weak scaling of magnetic fluctuations.

D.D. RYUTOV: When performing the S-scan, you probably have to vary some other important dimensionless parameters, in particular, plasma beta. How do you know that the observed changes in fluctuation and transport are solely attributable to the changes in S?

G. FIKSEL: We do not know. As a matter of fact, some observations, like dependence of scaling on density, indicate that parameters other than S might be important.

Paper IAEA-CN-69/EX4/6 (presented by K. Yatsu)

DISCUSSION

E.B. HOOPER: What was the central cell electron temperature, and was it affected by the application of ECRH in the end cells?

K. YATSU: The electron temperature was 60 eV for the ICRF sustained plasma. It increased to 80 eV through the application of ECRH and the stored electron energy doubled in accordance with the density increase.

D.D. RYUTOV: In the experiments with conducting plates, have you tried placing them on one side of the plasma only?

K. YATSU: The conducting plates were installed on both sides of the plasma. However, we plan to apply a different potential to each one of a pair of conducting plates.

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