EIGHTEENTH FUSION ENERGY CONFERENCE

SESSION EX9/TH6

Tuesday, 10 October 2000, at 11:10 a.m.

Chair: W. MORRIS (UK)

SESSION EX9/TH6: Energetic Particles (provided by K. McCLEMENTS, UK)

Paper IAEA-CN77/EX9/1 (presented by M. Sasao)

DISCUSSION

M. ONO: The slowing-down time of ICRF-generated high energy ions is a critical parameter for future stellarators. I am happy to see relaxation times of up to 200 ms, which is a very nice result. My question concerns the points in your plot of measured versus classical relaxation time showing that the experimental decay time is saturating or even declining when the calculated slowing-down time goes above 200 ms. This is an indication of some “anomalous” loss. Do you have any possible explanation for those points, particularly the one showing a significant decrease?

M. SASAO: The decay time of 100-200 ms is not very short, compared to the alpha particle slowing-down time in a burning plasma (~300 ms). The anomalous losses are due to ripple-induced transport, as explained in the second part of my talk.

H. L. BERK: In what fraction of phase space do prompt losses occur? Are improved designs available to minimize these prompt losses?

M. SASAO: The prompt loss region is expected to be very small (less than a few percent) in the inward-shifted configuration, although this depends very much on the energetic particle birth profile. The stability of transition particles and their transport into the loss region is our main concern. Further studies of the inward-shifted configuration will be carried out in the next campaign, to look for further improvement.

Paper IAEA-CN-77/EX9/2 (presented by H. Tamai)

DISCUSSION

G. MARTIN: Where do the runaway electrons go after the termination? Do they go to the divertor?

H. TAMAI: During the runaway termination, spikes in hard X-ray emission are observed. These are due to interactions of runaway electrons with the surface wall. The runaway electrons are thus considered to be deposited on the first wall, including the divertor plates. The measured heat loads on the divertor plates are some fraction of the total heat loads deposited by runaway electrons.

R.D. GILL: I am confused about cause and effect here. Do the magnetic fluctuations cause the runaway loss, or vice versa?

H. TAMAI: We think that magnetic fluctuations are the cause of the runaway current termination, since the appearance of fluctuations with n=1 is closely correlated with the termination runaway electrons. Repeated, small-amplitude magnetic fluctuations are essential for the termination. Detailed analysis of these fluctuations will be carried out in the near future in order to clarify the termination mechanism.

Paper IAEA-CN-77/EX9/3 (presented by H. K. Kawashima)

DISCUSSION

A.W. MORRIS: Did you correct the poloidal field detectors and the plasma position and shape control system for the effect of the steel boards?

H.K. KAWASHIMA: No we didn't. As I showed in my presentation, the magnetic effects of ferritic boards (FBs) are very small. However, after FB insertion some position control is required in order to produce discharges similar to those obtained before.

Paper IAEA-CN-77/TH6/1 (presented by N. N. Gorelenkov)

DISCUSSION

K. LACKNER: Do you have, or plan to develop, tools to study the interaction of fast particles with neoclassical tearing modes?

N.N. GORELENKOV: In principle NOVA-K can be used to study interactions between tearing modes and fast particles, but it would need to be modified for this. We do not plan to work on this in the near future.

H.L. BERK: I have two questions. (i) Why do Alfvén instabilities occur in NSTX at high β, when the Alfvén speed is relatively low? (ii) To what do you attribute frequency sweeping of energetic particle modes?

N.N GORELENKOV: (i) This is due to the global structure of the modes, which makes it possible for the resonance condition to be satisfied. (ii) In TFTR we found that frequency sweeping was due to evolution of the q-profile, while in JT-60U it occurs because the total pressure (background pressure plus fast particle pressure) is increasing.

Paper IAEA-CN-77/TH6/2 (presented by Y. Todo)

DISCUSSION

A. JAUN: Comparisons between different models suggest that the electrostatic component needs to be taken into account to explain the beam ion losses in DIII-D, given the measured level of magnetic fluctuations ($\delta B/B \sim 10^{-5}$). How large are the magnetic fluctuations in your calculations? If I understand correctly, they neglect the electrostatic character of Alfvén eigenmodes.

Y. TODO: In the simulations presented here the maximum amplitudes are $\delta B/B \sim 10^{-3}$.

H.L. BERK: Have you observed any secondary flows due to the TAE activity?

Y. TODO: Not in these simulations, but the possibility of such flows cannot be excluded. The viscosity used in the simulations may be suppressing flows.

R.J. GOLDSTON: I am fascinated by why these systems burst. It seems to me that the explanation in this case must be related to the fact that your integrated fast ion loss is delayed with respect to the mode amplitude. Do you have a physical explanation for this observation? Also, you say that you get a burst repetition period of 0.6 ms, while in the experiment it is 2.0 ms. By how much did you increase the drag rate in the simulation, compared with experimental values?

Y. TODO: Particle motion in the electromagnetic field of overlapping modes is stochastic. Particles interact with many modes, and the free energy for each mode increases rapidly. Therefore, the burst must be related to the generation of stochasticity. On the other hand, this stochasticity transports particles, leading to particle loss, with some time delay. It is misleading to compare the slowing-down time in the simulation with the experimental value. It is better to consider the heating time, which we define as the stored fast ion energy divided by the heating power. This is shorter by a factor of seven in the simulation than it is in the experiment.

Paper IAEA-CN-77/EX9/4 (presented by K. Ida)

DISCUSSION

K. LACKNER: Can the electron root also solve the problem of fast ion (in particular alpha particle) losses? My feeling would be that the electric fields you quoted are too small to affect alpha particles.

K. IDA: The radial electric field in these experiments is typically only about 10 kVm^{-1}. This is not high enough for alpha particles to be significantly affected. But these experiments are only a first step.

M. ONO: Do you see hysteresis behaviour in the transition to the electron root? For example, can you go to higher density after the transition?

K. IDA: No hysteresis has been observed in the experiments so far. This is because the time resolution of the radial electric field measurement using charge exchange spectroscopy is relatively poor. The time resolution will be improved when a Heavy Ion Beam Probe (HIBP) is installed. We may then observe hysteresis behaviour, as in the Compact Helical System (CHS).

R.J. GOLDSTON: It seems that there is some disagreement between the Japanese and German groups as to whether suprathermal electrons from ECH are needed to access the electron root. Was any ECH used in the discharges you report here?

K. IDA: No. The discharges reported here are neutral beam-heated, and there was no ECH. Our results thus confirm that suprathermal electrons are not necessary for the transition from ion root to electron root.