General Physics Seminar

Rijnhuizen Seminar Room

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Fast ions in fusion plasmas measured by Collective Thomson Scattering

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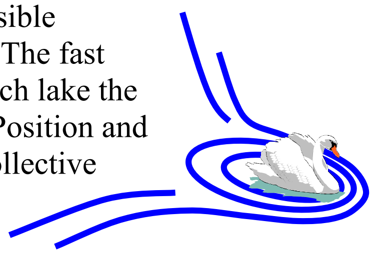
Fast ions in magnetically confined fusion plasmas are notoriously illusive to experimental observation. They do not interact strongly with electromagnetic radiation and it is very difficult, in flight, to place electrons on them to make them visible through line radiation or to permit them to escape as neutrals. The fast ions do, however, draw a wake in the electron distribution much lake the wake a swan draws in the water when it glides across a lake. Position and velocity of the swan is evident from the wake. Similarly in Collective Thomson Scattering (CTS), where the fast ion distribution is inferred by detecting the wakes the ions draw.



Why the interest? Well, magnetically confined fusion plasmas contain highly non-thermal populations of energetic ions resulting from fusion reactions and plasma heating. These populations typically carry 1/3 of the plasma energy and significantly affect the plasma dynamics. It is essential that these energetic ions remain confined while they slow down and heat the thermal bulk plasma. Non-linear wave particle interaction is important for the fast ion dynamics and can lead to catastrophic loss of confinement. This interaction is also the basis of Ion Cyclotron Resonance Heating (ICRH); one of the main plasma heating schemes relying on the absorption of radio waves. In both cases the wave particle interaction depends critically on the phase space distribution of the energetic ions.
Theoretical models have led to conflicting results and lack challenges from experiments. We are seeking to provide such a challenge by measuring the phase space distribution of the confined energetic ions with Collective Thomson Scattering. Following an outline of the physics of CTS, we will present results from JET demonstrating the feasibility of energetic ion diagnosis by CTS, and new results from the fast ion CTS at TEXTOR showing for the first time the temporal evolution of the fast ion distribution. The physics issues we are pursuing included the vexed question of whether energetic ions are expelled from the core by the ever present magneto-hydro-dynamic relaxations (sawteeth).