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TH/P3-34: Development of a Predictive Capability for Fast Ion Behaviour in MAST

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A recent focus of the programme at MAST has been upon the development of tools to interpret and understand the fast ion driven instabilities observed with a view to developing a predictive capability for the future: In particular, which modes will be unstable, how will they behave, and what will be the consequences? The drive arises from gradients in the fast ion distribution, and the calculation of smooth high resolution 6D distributions (recently made possible using a GPU-based approach) has allowed much more realistic simulations of the wave-particle interaction taking place. For the resonant neutral beam ions in MAST, dynamical friction dominates over pitch-angle scattering and facilitates a complex nonlinear wave evolution through the formation of structures in the fast ion distribution. Dynamical friction has been captured within the HAGIS code by treating the collisional terms as a combination of drag and a phase-space dependent Krook-like relaxation rate. Since fusion-born alpha-particles are also slowing down in nature, this physics is expected to be important in describing the behaviour of alpha-driven modes in future burning plasmas. Two new fast ion diagnostics have been installed and commissioned on MAST: A 4-chord scanning neutron camera and a FIDA system with toroidal and vertical views. Experiments have quantified the changes in the fast ion distribution associated with the presence of internal n = 1 chirping modes. Simulations of the coherent redistribution due to these modes has been described by diffusive and convective terms. Subsequent simulations using only these transport coefficients reproduce the modifications to the fast ion profile arising from the full wave-particle simulations motivating their adoption within more global transport codes. As a further aid to experimental interpretation, synthetic forms of the MAST neutron camera and FIDA views have been developed allowing a direct comparison between the measurements and simulations, and providing confidence that the processes responsible for the fast ion redistribution are correctly understood. This work was funded by the RCUK Energy Programme under grant EP/I501045 and the European Communities under the contract of Association between EURATOM and CCFE. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

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