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Instabilities and Transport of Fast Ions on MAST

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A systematic and significant recent effort in diagnosing energetic ion driven instabilities and related transport of the energetic ions on MAST is setting a stage for new understanding of such instabilities relevant to the next-step burning plasma experiment. The fast ion-driven Alfvenic instabilities are detected on MAST in the frequency range up to ~5 MHz with magnetic coils and with Doppler backscattering system. The fast ion population on MAST is represented by D NBI injected at Eb ≈ 60-70 keV, and it is studied with a four-channel neutron camera and energetic proton detector measuring the two branches of the beam-thermal DD fusion reactions, and fast ion Dα emission produced by beam ions. The instabilities driven by the beam are seen over a wide frequency range: i) fishbones at 10-50 kHz, ii) TAE at 50-150 kHz, Alfven cyclotron instabilities at 400 kHz-3.8 MHz. Special attention was paid on MAST to establishing the link to NSTX data on beam-driven "avalanches"consisting of several coupled TAEs with strong downward frequency sweep and higher amplitudes than un-coupled TAEs.Based on measurements from the neutron camera, as well as the FIDA and proton detector measurements, the effects of fast ion-driven instabilities on the beam profile are assessed, and modelling is performed with the HAGIS code. A search for plasma scenario minimising the effect of fast ion-driven instabilities on the beam radial profile was performed by scanning plasma density. Together, these studies aim at providing the data base to design experiments on MAST-Upgrade with its higher BT and off-axis beams, which will test extensively theories and models used for ITER and DEMO.

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