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ELM-induced energy and momentum transport in ASDEX Upgrade

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Heat and momentum transport play a key role in achieving high confinement in fusion plasmas. Recent advances in the diagnostic capabilities at AUG now allow us to measure the edge profiles on a sub-ms to ms time-scale and with a spatial resolution of less than 5 mm, making it ideal to study the profile recovery after an ELM crash. Here, we present the dynamic behaviour of the energy and momentum transport during edge localized mode cycles at the plasma edge of AUG by combining a comprehensive set of pedestal measurements with interpretive and predictive modelling.

The main ion temperature and toroidal rotation profiles were measured in helium plasmas with unprecedented temporal resolution of 250 mus. A local increase of Ti close to the separatrix is observed at the ELM onset, thus reducing the gradient in the pedestal, similar to the behaviour in D plasmas [1]. Shortly after the initial separatrix increase, the whole profile drops and then the pedestal starts to build up again. The pre-ELM profile is fully recovered 3-4 ms after the ELM crash. Transport analysis of the ion energy reveals that the ion heat transport is at the neoclassical level before the ELM crash in the region where the edge ion temperature gradient is maximal. Further inwards, the ion heat transport is about a factor of 4-5 above the neoclassical level. The dynamics of the edge ion heat transport during the pedestal build-up after the crash is also consistent with neoclassical theory [2].

Helium plasmas provide the unique opportunity to measure both main ion and impurity flows simultaneously. Compared to the impurity (here nitrogen) toroidal rotation, which exhibits a local minimum at the plasma edge during the inter-ELM phase [3], the edge main ion toroidal rotation has a much less pronounced dip and is rather flat. During the ELM the main ion toroidal rotation in the pedestal drops by about 5-10 km/s. This is in contrast to the behaviour of the impurity toroidal rotation, which shows a flattening of the toroidal dip feature [1]. TRANSP simulations and predictive modelling with ASTRA solving the toroidal momentum balance including diffusion, pinch and external sources are used to quantify how much momentum is transported during the ELM and will be presented.

[1] M. Cavedon et al PPCF 59 105007 (2017)
[2] E. Viezzer et al NF 58 026031 (2018)
[3] T. Pütterich et al PRL 102 (2009)

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Primary author: Dr VIEZZER, Eleonora (University of Seville)

Co-authors: Dr KAPPATOU, Athina (Max Planck Institute for Plasma Physics); Dr ANGIONI, Clemente (Max Planck Institute for Plasma Physics); Mr CRUZ-ZABALA, Diego José (University of Seville); Dr WOLFRUM, Elisabeth (Max Planck Institute for Plasma Physics); Dr FABLE, Emiliano (Max Planck Institute for Plasma Physics); Dr LAGGNER, Florian (Princeton University); Dr RYTER, Francois (Max Planck Institute for Plasma Physics); Mr HARRER, Georg (Institute of Applied Physics, TU Wien); Dr CAVEDON, Marco (Max Planck Institute for Plasma Physics); Ms CANO-MEGIAS, Pilar (University of Seville); Dr MCDERMOTT, Rachael (Max Planck Institute for Plasma Physics); Dr DUX, Ralph (Max Planck Institute for Plasma Physics); Dr PÜTTERICH, Thomas (Max Planck Institute for Plasma Physics); Ms PLANK, Ulrike (Max Planck Institute for Plasma Physics)

Presenter: Dr VIEZZER, Eleonora (University of Seville)

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