Contribution ID: **63** Type: **Oral**

Modeling of the nonlinear resonant interaction between ELMs and fast-ions in tokamaks using MEGA

Monday, 6 December 2021 15:20 (20 minutes)

Edge localized modes (ELMs) are periodic magnetohydrodynamic (MHD) instabilities driven by sharp pressure gradients and current densities at the plasma boundary that will likely lead to transient, and intolerable, energy and particle losses in ITER. Although the ELM nature is still under intense investigation, their behavior and their consequences in a burning plasma with a significant fraction of energetic (supra-thermal) ions is completely missing. Recent experimental observations have shown the ejection and acceleration of energetic ions during ELM crashes [1, 2], indicating a strong interplay between the energetic particle population at the plasma edge and the electromagnetic perturbation developed during an ELM crash. A good understanding of the interaction between energetic ions and ELMs is mandatory to develop ELM control techniques for burning plasmas as well as to be able to predict their impact on the plasma, including fast-ion confinement.

In this work, the nonlinear hybrid kinetic-MHD MEGA code [3] has been used to study the interaction between energetic particles and ELMs in an ASDEX Upgrade H-mode plasma [4]. The simulations show, for the first time, the strong impact that energetic particles kinetic effects have on the spatio-temporal structure of ELMs in tokamaks. Energetic ions kinetic effects modify the ELM linear growth rate, crash timing, frequency pattern, and spatial structure. In the nonlinear phase, energetic ions impact the shear and tend to extend the ELM radial ballooning structure to regions deeper in the plasma. Strong energetic ion transport is observed during the ELM crash. The results presented here may help explaining the frequency pattern and fast-ion losses observed during ELMs in several tokamaks worldwide [5] and, thus, may help improving our predictive capabilities and control techniques for future fusion devices. The implications of our simulation results for ITER will be discussed.

References
[1] M. Garcia-Munoz et al., Nucl. Fusion 53, 123008 (2013).
[2] J. Galdon-Quiroga et al., Phys. Rev. Lett. 121, 025002 (2018).
[3] Y. Todo et al., Phys. Plasmas 5, 1321 (1998).
[4] A.F. Mink et al., Nucl. Fusion 58, 026011 (2018).
[5] F.M. Laggner et al., Nucl. Mater. Energy 19, 479 (2019).

Speaker's Affiliation

University of Seville, Faculty of Physics, Department of Atomic, Molecular and Nuclear Physics

Member State or IGO

Spain

Primary authors: DOMINGUEZ-PALACIOS, Jesus (University of Seville); FUTATANI, Shimpei (Department of Physics, Universitat Politècnica de Catalunya (UPC), Barcelona); Prof. GARCIA-MUNOZ, M. (University of Seville); GONZALEZ-MARTIN, Javier (University of Seville); Mr TOSCANO-JIMENEZ, Manuel (University of Seville); Prof. VIEZZER, E. (University of Seville); OYOLA, Pablo (Universidad de Sevila); TODO, Yasushi (National Institute for Fusion Science); SUZUKI, Yasuhiro (National Institute for Fusion Science); Dr SANCHIS, Lucia (Aalto University); Dr CHEN, Haotian (University of Seville); GALDON-QUIROGA, Joaquin (University of Seville); Dr RIVERO-RODRIGUEZ, J. Francisco (University of Seville); Mr JANSEEN VAN VUUREN, Anton (University of Seville); ASDEX UPGRADE TEAM; EUROFUSION MST1 TEAM

Presenter: DOMINGUEZ-PALACIOS, Jesus (University of Seville)

Session Classification: Effects of Energetic Particles in Magnetic Confinement Fusion Devices

Track Classification: Effects of Energetic Particles in Magnetic Confinement Fusion Devices