Contribution ID: **45** Type: **Oral**

# Effects of distribution functions in global gyrokinetic simulations of energetic particle driven Alfvénic and EGAM instabilities in ITER and ASDEX Upgrade

*Monday, 6 December 2021 15:40 (20 minutes)*

In recent years, there has been significant progress with global electromagnetic gyrokinetic codes in modelling Alfvén Eigenmodes (AEs) and other energetic particle (EP) driven instabilities in realistic equilibria, for example, simulations with the gyrokinetic code ORB5 [1] of Energetic Particle Modes (EPMs) and Energetic-particle-driven Geodesic Acoustic Modes (EGAMs) in ASDEX Upgrade (AUG) [2,3] and toroidal Alfvén Eigenmodes (TAEs) in ITER [4].

While the previous work addressed the realistic density and temperature profiles and equilibria of the experiments considered, the distribution function of the EPs was typically modelled using a Maxwellian (for AEs) or a Bump-on-tail (for EGAMs). For quantitative predictions or comparisons to experiments, a more realistic distribution for alpha particles in ITER (isotropic slowing down), or for neutral beam injected (NBI) particles in AUG is required.

We report on work done in ORB5 to handle general distribution functions in addition to the analytical choices already implemented. This framework has been used to couple the output from the NBI solver RABBIT [5] to be used as the background distribution in ORB5. The same framework was used to verify the implementations of analytical distribution functions and their gradients, and was used to implement a semi-analytic anisotropic slowing down distribution function.

Also, a comparison for the ITER 15MA scenario between TAEs driven by Maxwellian and slowing down distribution functions, where the mode growth due to EPs with a isotropic slowing down is found to be larger than in the case of a Maxwellian.

In the case of ASDEX Upgrade, following the so-called "NLED-AUG" case (#31213) [6], we focus on EPs from NBI injection. These are taken from RABBIT, but also comparisons have been performed with analytical anisotropic distribution functions, which help to parameterize the observed behaviour.
With these simple analytical distribution functions, we can compare the phase space gradients at the positions of the maximum power exchange in linear simulations.

Finally, we report on efforts ongoing to model AEs in an ITER pre-fusion power operation (PFPO) scenario, and the associated coupling of NBI data from the Integrated Modelling & Analysis Suite (IMAS) database.

[1] E. Lanti, et al., Computer Physics Communications 251, 107072 (2020)
[2] I. Novikau et al., Physics of Plasmas 27, 042512 (2020)
[3] F. Vannini et al., Physics of Plasmas 27, 042501 (2020)
[4] T. Hayward-Schneider et al., Nucl. Fusion 61, 036045 (2021)
[5] M. Weiland et al., Nucl. Fusion 58 082032 (2018)
[6] Ph. Lauber et al, EX1/1 Proc. 27th IAEA FEC (2018)

## Speaker's Affiliation

Max Planck Institute for Plasma Physics

## Member State or IGO

Germany

**Primary author:** HAYWARD-SCHNEIDER, Thomas (Max Planck Institute for Plasma Physics)

**Co-authors:** RETTINO, Brando (Max Planck Institute for Plasma Physics); BOTTINO, Alberto (Max Planck Institute for Plasma Physics); WEILAND, Markus (Max Planck Institute for Plasma Physics); VANNINI, Francesco (Max

Planck Institute for Plasma Physics); LAUBER, Philipp (Max Planck Institute for Plasma Physics); MISHCHENKO, Alexey (Max Planck Institute for Plasma Physics)

**Presenter:** HAYWARD-SCHNEIDER, Thomas (Max Planck Institute for Plasma Physics)

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

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