Contribution ID: **95** Contribution code: **P1.29** Type: **Poster**

Advanced modelling of heavy impurity tokamak transport in rotating 3D magnetic fields

Tuesday 3 October 2023 16:08 (4 minutes)

Tungsten divertors in tokamaks are designed to withstand and evacuate the excess heat coming from the hot plasma. Some of the tungsten divertor can melt, enter the plasma, and itself become a high-Z impurity plasma. If it enters the core, it can emit enough radiation to cause a loss of thermal plasma energy and degrade or terminate tokamak operation [1]. Thus, it is crucial to develop a theoretical and numerical framework to understand the transport processes for heavy impurities such that high performance scenarios can be developed. Present day tokamaks are often heated with unbalanced neutral beam injection, which in turn causes the plasma to rotate toroidally. The associated rotation of the tungsten plasma is typically super-sonic. Another common feature of tokamak plasmas is the existence of long-living non-axisymmetric magnetic fields –which can be due to saturated plasma instabilities –and/or symmetry breaking magnetic coils. The combination of a strongly rotating plasma in 3D magnetic fields is particular to tokamaks (heavy impurities in stellarators would rotate sub-sonically).

For heavy impurity simulations we use a δf PIC code called Venus-Levis [2]. To accurately trace the tungsten particles, one needs to consider the interaction with the background plasma. For this, a custom collision operator is used which relies on the calculation of neoclassical transport coefficients. These coefficients have presently been been calculated analytically [3-4]. To extend the work beyond ideal MHD, one needs to find these coefficients numerically. Current on-going work is being done to:
• develop a new numerical scheme based on Venus-Levis for these coefficients,
• port Venus-Levis to GPUs for a fast code which can take advantage of modern supercomputers.

References:

[1] T Pütterich, et al., the ASDEX Upgrade Team, and JET EFDA Contributors. Observations on the w-transport in the core plasma of jet and asdex upgrade. *Plasma Physics and Controlled Fusion*, 55(12):124036, nov 2013.
[2] D. Pfefferlé, W.A. Cooper, J.P. Graves, and C. Misev. Venus-levis and its spline-fourier interpolation of 3d toroidal magnetic field representation for guiding-centre and full-orbit simulations of charged energetic particles. *Computer Physics Communications*, 185(12):3127–3140, 2014.
[3] M Raghunathan, J P Graves, T Nicolas, W A Cooper, X Garbet, and D Pfefferlé. Heavy impurity confinement in hybrid operation scenario plasmas with a rotating 1/1 continuous mode. *Plasma Physics and Controlled Fusion*, 59(12):124002, oct 2017.
[4] E Lascas Neto, J P Graves, M Raghunathan, C Sommariva, D Pfefferlé, and JET Contributors. Heavy impurity transport in tokamaks subject to plasma rotation, NTV and the influence of saturated ideal MHD perturbations. *Plasma Physics and Controlled Fusion*, 64(1):014002, nov 2021.

Author: KOERFER, Joachim Jacques (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC))

Co-authors: Dr LASCAS NETO, Eduardo (Fédérale de Lausanne (EPFL), Swiss Plasma center (SPC))); Prof. GRAVES, Jonathan (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma center (SPC))

Presenter: KOERFER, Joachim Jacques (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC))

Session Classification: Poster session: 01

Track Classification: 3. Plasma confinement, neoclassical and turbulent plasma transport