Contribution ID: **120** Type: **Oral**

Plasma-neutral interaction processes in ITER and medium-sized tokamaks from SOLEDGE3X full-vessel boundary plasma simulations

Tuesday, 8 November 2022 09:15 (20 minutes)

Interactions between plasma and neutrals in the volume and in the vicinity of the divertor and vessel wall surfaces largely determine particle and heat exhaust capabilities of plasma scenarios, especially for reactor-relevant detached regimes. Identifying and understanding the key atomic and molecular processes involved in these interactions is critical to modelling efforts.

In this work, we propose an assessment of the mechanisms at play in a wide range of edge plasma conditions. Discharges for ITER and two current medium-sized tokamaks (JET and AUG) are simulated with the SOLEDGE3X [1] code in 2D transport mode, coupled to the EIRENE kinetic neutrals code, including recently developed detailed output diagnostics for decomposing and studying the contributions from each process included in the plasma-neutral interaction model. Of particular interest here are ion-molecule collisions (elastic and charge-exchange), Molecule Assisted Recombination (MAR), and neutral-neutral collisions. Since the SOLEDGE3X code uses a grid covering the entire vacuum vessel volume with a realistic wall geometry, the produced plasma solutions include the divertor as well as the far Scrape-Off-Layer (SOL) up to the first wall, providing the plasma conditions and fluxes at both locations.

First, a throughput scan is performed for ITER, considering Pre-Fusion Operation Phase 1 (PFPO-1) scenarios with 20 MW of SOL power input. A notable result from this scan is that the molecule charge exchange, while almost negligible in attached cases, plays a key role when partial detachment is reached.

Second, to assess the impact on main chamber recycling of the flattening of the far-SOL density profile observed in current machines under high density detached divertor conditions [2], particle and heat diffusivity coefficients are increased in the far-SOL for 20MW and 60MW cases, mimicking turbulent filamentary transport. Increases in temperatures, particle and heat loads on the first wall of the main chamber are found (e.g. by a factor of up to 4 for the integrated heat load) from additional atom charge exchanges with ions at higher energies. For the cases with the highest far-SOL diffusivity assumptions, even the divertor solution starts being affected and fluxes reduced (e.g. by up to -35% for the total perpendicular heat flux density).

Third, investigation of the differences in the atomic and molecular processes involved in high-throughput simulations on machines of similar geometries but different size is presented, using the AUG and JET devices as examples. This exercise highlights specificities of ITER versus smaller devices, in part due to a change in the ratio of the contribution of the molecular ion H2+ dissociation to the atom ionisation in the particle and electron energy sources near the targets.

[1] H. Bufferand et al., Nuclear Fusion 61 (2021) 116052

[2] N. Vianello et al., Nucl. Fusion 60 (2020) 016001

Speaker's Affiliation

CEA IRFM, Saint-Paul-lez-Durance, France

Member State or IGO

France

Primary author: RIVALS, Nicolas (CEA)

Co-authors: TAMAIN, Patrick (CEA Cadarache); MARANDET, Yannick (PIIM, CNRS/Aix-Marseille Univ., Marseille, France, EU); BONNIN, Xavier (ITER Organization); BUFFERAND, Hugo (CEA); FALCHETTO, Gloria (CEA); Mr YANG, Hao (CEA, IRFM); CIRAOLO, GUIDO (CEA, IRFM); PITTS, Richard (ITER Organization)

Presenter: RIVALS, Nicolas (CEA)

Session Classification: SOL

Track Classification: Scrape-off Layer and Divertor Physics