HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Helmholtz Call for Chinese Applicants Interested in Running for CSC 2021 Fellowship

Helmholtz Centre: Forschungszentrum Jülich GmbH – www.fz-juelich.de

Department/Institute: Institute of Energy and Climate Research, Plasmaphysics (IEK-4)
https://www.fz-juelich.de/iek/iek-4/EN/Home/home_node.html

Supervising scientist: Dr. Sven WIESEN

University for registration or for a future degree: -

Research Field: Energy; Plasma physics

Position open for: **PhD Student** □ **Sandwich PhD Student** ☑

Title of the research: Combined fluid-kinetic treatment of W transport in JET ELMy H-mode dicharges

More description of research topic:

The next step fusion experiment ITER is equipped with a combination of beryllium (Be) main wall and tungsten (W) divertor. The understanding of high-Z W material erosion and transport is essential for performance predictions of a future fusion device (e.g. CFETR). Too large concentrations of high-Z materials (like W) in the main plasma must be avoided not to dilute the core plasma. As no scaling for the W source and transport exists, the prediction of W core influx is based on multi-physics multi-scale edge plasma codes. Most nowadays simulations of W transport in edge transport analyses assume W to be treated as a fluid, an assumption which is not always plausible. To improve on this, a hybrid approach of a kinetic description of separate (low) W charge states and a treatment of higher charge states by a fluid approximation is proposed. To avoid artefacts in the solution (e.g. numerical viscosity), higher charge states can be partly bundled with adequate physics model assumptions.

The workplan for the PhD candidate contains modelling of W for tokamaks in both, kinetic and fluid description of the W charge states. For the latter, reliable bundling schemes for the higher fluid-like charge states are to be developed based on existing ADAS database. The hybrid W transport models are to be applied and tested, e.g. based on existing SOLPS-ITER simulations for JET H-mode discharges. As the source of W is mainly given by large particle and heat influx into the W divertor during ELMs, a proxy-model for an ELM is to be setup in SOLPS-ITER. The results are to be compared to JET data.

The Institute of Energy and Climate Research (IEK-4) is leading in the field of plasma edge modelling using edge codes (namely SOLPS-ITER in 2D and EMC3-EIRENE in 3D) and plasma-wall interaction (PWI). At IEK-4 the EIRENE Monte-Carlo code has been developed that contains a trace impurity model to describe kinetically W ions. In the past decades, IEK-4 has delivered major contributions to JET, AUG, ITER and W7X physics database that led to validated predictions for exhaust and PWI for both devices and beyond. IEK-4 has a long history of collaboration with Chinese fusion science groups.

Specific requirements:

A very good knowledge of mathematical and modelling skills, and good experiences of plasma transport physics on tokamak or stellarator are a prerequisite, as well as a very good level in spoken and written English. Experience in data analysis using standard tools (python, MatLab, etc) is an advantage.

Working Place: Forschungszentrum Jülich, Germany (near Cologne)

Earliest Start: September 2021

Language Requirement: Very good knowledge of English language, written and spoken. German language courses are organised in the context of our in-house training program and are free of charge.

Name and Address of the Supervisor: Dr. Sven Wiesen, Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research (IEK-4), 52425 Jülich, Germany; Email: s.wiesen@fz-juelich.de