

Radiation-condensation instability: a driver for up-down or in-out asymmetry of divertor plasma

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A spontaneous break of the up-down symmetry of the divertor plasma parameters in a symmetric transport model (symmetric double-null divertor configuration and boundary conditions, as well as the absence of drifts) in the presence of impurity seeding was found in computational modelling [1], [2]. The effect was attributed to the radiation-condensation instability (RCI) that amplifies the perturbations of the plasma temperature and drives the radiating impurity to the colder divertor. The behavior of the seeded impurity in a single-null divertor sometimes resembles this pattern, showing sharp re-distribution of the radiation intensity between the inner and outer divertors [3].

In the present paper, development of the RCI in the SOL and the divertors that it connects is studied by means of SOLPS4.3 [4] modeling. The code is set up to describe the parallel transport only (a 1D approximation) in order to simplify the model and to exclude possible interference of mechanisms other than RCI. The results show that the RCI can be the principal mechanism driving the asymmetries in the SOL and divertor plasmas.

[1] A. S. Kukushkin, "Spontaneous Break of up-down Symmetry in a Symmetric Double-Null Divertor Configuration," Plasma Phys. Reports, vol. accepted, 2019.

[2] A. S. Kukushkin and S. I. Krasheninnikov, "Bifurcations and oscillations in divertor plasma," Plasma Phys. Control. Fusion, vol. 61, no. 7, p. 74001 (8pp), 2019.

[3] H. D. Pacher et al., "Impurity seeding and scaling of edge parameters in ITER," J. Nucl. Mater., vol. 390–391, pp. 259–262, 2009.

[4] A. S. Kukushkin, H. D. Pacher, V. Kotov, G. W. Pacher, and D. Reiter, "Finalizing the ITER divertor design: The key role of SOLPS modeling," Fusion Eng. Des., vol. 86, no. 12, pp. 2865–2873, 2011.

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