Novel free boundary equilibrium and transport solver with theory-based models and its validation against ASDEX Upgrade current ramp scenarios

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Abstract

Tokamak scenario development requires understanding of the properties that determine the kinetic profiles in non–steady plasma phases, and of self–consistent evolution of the magnetic equilibrium. Current ramps are of particular interest since many transport–relevant parameters explore a large range of values and their impact on transport mechanisms has to be assessed. To this purpose a novel full–discharge modeling tool has been developed, which couples the transport code ASTRA and the free boundary equilibrium code SPIDER [1], utilizing a specifically designed coupling scheme. The current ramp–up phase can be accurately and reliably simulated using this scheme, where a plasma shape, position, and current controller is applied, which mimics the one of ASDEX Upgrade. Transport of temperature and density is provided by theory–based models (e.g. GLF23, TGLF [2]). A recipe based on edge–relevant parameters [3] is proposed to resolve the low current phase of the current ramps, where the impact of the safety factor on microinstabilities could make quasi–linear approaches questionable in the plasma outer region [3]. Current ramps scenarios, selected from ASDEX Upgrade discharges, are then simulated to validate both the coupling with the free–boundary evolution and the prediction of profiles. Analysis of the underlying transport mechanisms is presented, to clarify the possible physics origin of the observed L–mode empirical energy confinement scaling. The role of toroidal micro–instabilities (ITG, TEM) and of non–linear effects is discussed.

References

[1] A. A. Ivanov *et al.*, 32nd EPS Conf. on Plasma Phys., ECA Vol.29C, P-5.063 (2005)

[2] G. M. Staebler *et al.*, *Phys. Plasmas* **14**, 055909 (2007)

[3] B. D. Scott, *Phys. Plasmas* **7**, 1845 (2000)

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