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ATOMIC AND MOLECULAR PROCESSES IN NUCLEAR FUSION PLASMA SCIENCE

DETLEV REITER

Institute for Laser and Plasma Physics,
Heinrich-Heine-University, D-40225 Düsseldorf, Germany
E–mail reiterd@uni-duesseldorf.de

Abstract. Fusion plasma science combines plasma physical challenges from the highly un-isotropic and turbulent plasma in electromagnetic fields, with a rich plasma chemistry due to the presence of nearby material surfaces and plasma surface interactions at the reactor vessel. It was recognized as early as 1968 by Bo Lehnert that a zone of powerful gas–plasma interaction, formed near fusion reactor vessel components, can be the key to solving the plasma surface interaction issues for sustainable nuclear fusion reactor operation.

Hydrogen - in the form of deuterium and tritium - is the fuel of fusion energy plasma devices. One might have hoped that the first element in the periodic table might behave in a simple way in this context. But in fact, see Janev 1984, a great variety of complexities arises. Ratko Janev certainly was the most influential and respected bridgehead, world wide, between the fusion plasma and atomic physics communities, for nearly four decades. Today the chemically rich "divertor detachment" plasma regime in tokamaks, anticipated in Janev 1984, is regarded as the feasible technical solution for a nuclear fusion power plant, e.g. also underlying the current construction of the ITER fusion reactor in Cadarache, France, in a joint world wide effort. Historically fusion research had not developed very far before it was recognized that it is essential to quantify and fully understand these processes. In the mid eighties, a quantum step occurred in this field: the first comprehensive atomic and molecular database for complex fusion analysis codes appeared, including all the important physics and chemistry involved, see Figure 1, Janev, 1987. We will present this development, the prominent role of Ratko Janev in it, and current knowledge on collision processes involving fuel (H), ash (He), wall material (e.g., C, Be, W) and seeding particles (e.g., N_2).

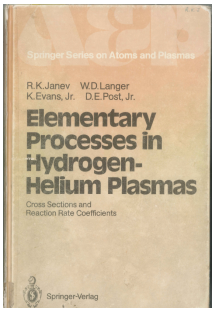

Figure 1: Three decades the unchallenged standard reference for atomic and molecular physics in fusion plasmas: Janev, R.K., et al, 1987, Springer Verlag.

References

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