Progress report on quantitative modeling of rf sheaths*

D.A. D'Ippolito[a], J.R. Myra[a], H. Kohno[b] and J.C. Wright[b]
[a]*Lodestar Research Corporation, Boulder, CO 80301 (USA)*
[b]*Plasma Science and Fusion Center, MIT, Cambridge, MA 02139 (USA)*

During ICRF heating, an rf sheath is formed when electrons are accelerated out of the plasma by an rf field component parallel to **B**, which requires a slow wave (SW). There are several ways that an unwanted SW can be launched, e.g. by misalignment of the **B** field with the antenna or with the wall. Over the past twenty years, modeling has shown the importance of rf sheath control in experiments. For high power heating, the rf sheath potential V near the antenna is typically larger than the Bohm sheath potential, $eV/T_e >> 1$. Thus, rf sheaths are important in determining the parasitic power loss in the scrape-off-layer (SOL), hot spots and surface damage, and impurity generation during ICRF heating and current drive experiments, and will be even more important in future long pulse experiments than in present ones.

This talk will describe a new quantitative approach to computing the rf sheath potential, including plasma dielectric effects and the correct geometry of the magnetic field and the material boundaries. The new approach uses a modified boundary condition ("rf sheath BC") [1,2] that couples the rf waves and the sheaths at the boundary. Analytic models using this BC predict a number of general features, including a sheath voltage threshold, a dimensionless parameter characterizing rf sheath effects, and the existence of sheath plasma waves (SPW) with an associated resonance.

Since the sheath BC is nonlinear and dependent on geometry, computing the sheath potential numerically is a challenging computational problem. Numerical results will be presented from a new parallelized finite-element rf wave code for the SOL ("rfSOL") [3]. The code has verified the physics predicted by analytic theory (including the SPW resonance) in 1D, and a number of parameter studies have been carried out in 2D model geometries. Areas for future work will also be discussed.

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[2] D. A. D'Ippolito and J. R. Myra, Phys. Plasmas **13**, 102508 (2006)
[3] Haruhiko Kohno, J.R. Myra and D.A. D'Ippolito, presented at the *52nd Annual Meeting of the APS Division of Plasma Physics*, Chicago, Illinois, November 8 - 12, 2010, paper JP9-92.