NONLOCAL COLLISIONLESS AND COLLISIONAL ELECTRON TRANSPORT IN LOW TEMPERATURE PLASMAS*

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A distinctive property of partially ionized plasmas is that such plasmas are always in a non-equilibrium state: the electrons are not in thermal equilibrium with the neutral species and ions, and the electrons are also not in thermodynamic equilibrium within their own ensemble, which results in a significant departure of the electron velocity distribution function from a Maxwellian. These non-equilibrium conditions provide considerable freedom to choose optimal plasma parameters for applications, which make gas discharge plasmas remarkable tools for a variety of plasma applications, including plasma processing, discharge lighting, plasma propulsion, particle beam sources, and nanotechnology. Typical phenomena in such discharges include nonlocal electron kinetics, nonlocal electrodynamics with collisionless electron heating, and nonlinear processes in the sheaths and in the bounded plasmas. We report on recent advances in nonlocal electron kinetics in low-pressure plasmas, in the Hall thruster discharges[1,2], and dc discharges with auxiliary biased electrodes for plasma control[3]. We show on specific examples that this progress was made possible by synergy between full scale particle-in-cell simulations, analytical models, and experiments.

1. D. Sydorenko, A. Smolyakov, I. Kaganovich, and Y. Raitses, Phys. Rev. Lett. **103**, 145004 (2009) , IEEE Trans. Plasma Science **34**, 895 (2006); Phys. Plasmas **13**, 014501 (2006); **14** 013508 (2007); **15**, 053506 (2008).
2. I. D. Kaganovich, Y. Raitses, D. Sydorenko, and A. Smolyakov, Phys. Plasmas **14**, 057104 (2007).
3. V.I. Demidov, C.A. DeJoseph, and A.A. Kudryavtsev, Phys. Rev. Lett. **95**, 215002 (2005); V.I. Demidov, C.A. DeJoseph, J. Blessington, and M.E. Koepke, Europhysics News, **38**, 21 (2007).

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