Abstract for an Invited Paper
for the GEC11 Meeting of
The American Physical Society

Application of Nonlocal Electron Kinetics to Plasma Technologies[1]

IGOR D. KAGANOVICH, Princeton Plasma Physics Laboratory

Partially ionized plasmas are typically in a highly non-equilibrium thermodynamic state: the electrons are not in equilibrium with the neutral particle species or the ions, and the electrons are also not in equilibrium within their own ensemble, which results in a significant departure of the electron velocity distribution function (EVDF) 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. Significant progress in understanding the formation of non-Maxwellian EVDF in the self-consistent electric fields has been one of the major achievements in the low-temperature plasmas during the last decade. This progress was made possible by a synergy between full-scale particle-in-cell simulations, analytical models, and experiments. Specific examples include rf discharges, dc discharges with auxiliary electrodes, Hall thruster discharges. In each example, nonlocal kinetic effects are identified as the main mechanisms responsible for the surprising degree of discharge self-organization. These phenomena include: explosive generation of cold electrons with rf power increase in low-pressure rf discharges; abrupt changes in discharge structure with increased bias voltage on a third electrode in a dc discharge with hot cathode; absence of a steady-state regime in Hall thruster discharges with intense secondary electron emission due to coupling of the sheath properties and the EVDF.

[1]In collaboration with Y. Raitses, A.V. Khrabrov, M. Campanell, V. I. Demidov, D. Sydorenko, I. Schweigert, and A. S. Mustafaev. Research supported by the U.S. Department of Energy.