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Nonlocal effects in a bounded low-temperature plasma with fast electrons[1]

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Effects associated with nonlocality of the electron energy distribution function (EEDF) in a bounded, low-temperature plasma containing fast electrons, can lead to a significant increase in the near-wall potential drop, leading to self-trapping of electrons in the plasma volume, even if the density of this fast group is only a small fraction ($\sim$0.001%) of the total electron density. If self-trapping occurs, the fast electrons can substantially, increase the rate of stepwise excitation, supply additional heating to slow electrons and reduce their rate of diffusion cooling. Altering the source terms of these fast electrons will, therefore, alter the near-wall sheath and, through modification of the EEDF, a number of plasma parameters. This could have technical applications. Self-trapping of fast electrons is especially important in an afterglow plasma, which is a key phase of any pulse-modulated discharge. In the afterglow, the electron temperature is less than a few tenths of an eV, and the fast electrons will have energies typically greater than an eV. It will be shown that in the afterglow plasma of noble gases, fast electrons, arising from Penning ionization of metastable atoms, can lead to the above condition and significantly change the plasma and sheath properties. Similar effects can be important in technologically relevant electronegative gas plasmas, where fast electrons can arise due to electron detachment in collisions of negative ions with atomic species. Following a brief overview of nonlocality, both experimental and modeling results will be presented to illustrate these effects.

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