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The Effect of Single Particle Charge Limits on Particle Charge Distributions in Dusty Plasmas[1] STEVEN GIRSHICK, ROMAIN LE PICARD, Dept. of Mechanical Engineering, University of Minnesota, Minneapolis, MN — There is a limit to the number of electrons that can coexist on a dust particle in a plasma. This limit depends on the particle's surface potential, electron affinity and the inter-electron Coulomb repulsion. We conducted numerical simulations that examine the effect of charge limits on steady-state particle charge distributions, as well as on the time required to reach steady state. Attachment of electrons to a cloud of nanoparticles can severely deplete the electron density and increase the ion density, causing the electron-to-ion density ratio to be much less than unity. At sufficiently high values of the density ratio, e.g. above about 0.1 for 80-nm-diameter Si particles, the charge limit strongly constrains particle charge. At lower values of the density ratio, e.g. around 0.01, particles are much less negatively charged even in the absence of a charge limit, and therefore the limit makes only a small difference. However, in this regime the charge distribution still deviates from the Gaussian form predicted by previous work that neglects charge limits. For the case of Maxwellian electron velocity distributions, we find that whether or not particle charge distributions are significantly affected by charge limits depends on the dimensionless asymmetry charging factor p and on particle size. The factor p in turn depends on the ratios of electron-to-ion density, temperature and mass.

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