# Spacecraft and non-Maxwellian plasma interactions at GEO altitudes

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The spacecraft and its environment interaction, effects on its structure due to plasma environment and radiations and the charge mitigation techniques are required to be investigated with more realistic models.

Space plasma particles and space weather conditions greatly affect spacecrafts and satellites at geosynchronous Earth orbit (GEO) and their charging occurs due to incoming (primary) and outgoing (secondary and backscattered) electron flux [1-2]. It has been observed that the space plasma environment in GEO orbit is sometimes better modeled by non-Maxwellian distribution functions than Maxwellian distribution. At GEO altitudes a spacecraft will encounter a tenuous, collisionless and relatively cool plasma. However, when substorm arises, the inclusion of high-energy plasma with a mean energy of the order of keV makes the GEO plasma to deviate from the equilibrium that could be better modeled by non-Maxwellian distribution functions. Due to the presence of highly energetic (superthermal) electrons [3] at GEO altitudes, a generalized power law q-nonextensive particle distribution is employed to evaluate the modified current-balance equation for spacecraft charging both analytically and numerically.

Specifically, within the framework of Whittaker function technique, a more generalized q-nonextensive energy distribution function is employed to model high energetic superthermal electrons and obtained a modified current-balance equation for spacecraft charging at the GEO altitudes [4-5]. The impact of extensivity is discussed for plasma systems to analyze more pronounced energy tails and charging onset associated with q-distribution in comparison to standard Kappa distribution function.

Furthermore, numerical estimation for identifying the current and charging onset due to various space grade materials will be discussed. Some results of anti-critical temperatures for typical surface materials in non-extensive plasmas would be presented.

References

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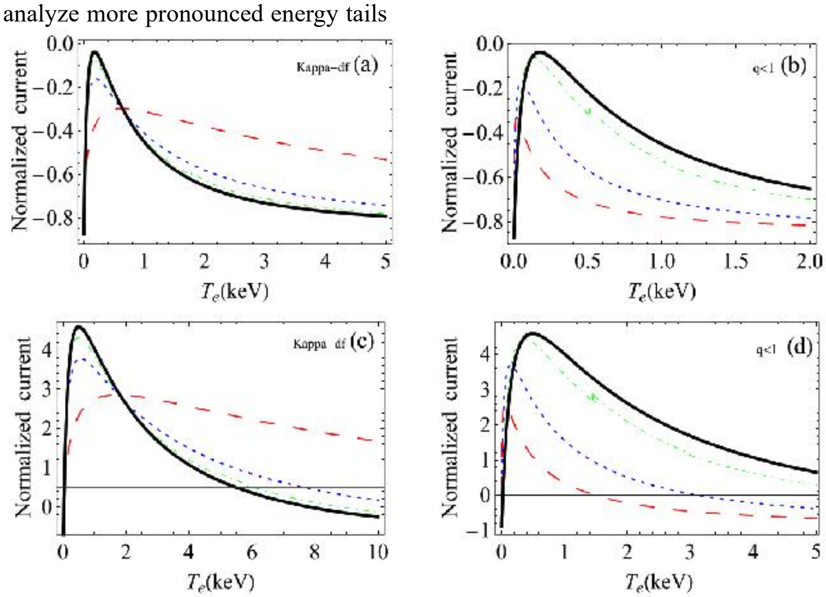


Figure: Normalized current curves are shown against the electron temperature for different values of (a) $\kappa$ = 1.6 (large dashed red curve), $\kappa$ =2.5(small dashed blue curve), $\kappa$ = 5.5 (dash-dotted green curve), and Maxwellian (solid black curve), (b) q = 0.6, 0.7, 0.9, Maxwellian, (c) $\kappa$ = 1.6, 2.5, 5.5, Maxwellian, and (d) q = 0.6, 0.7, 0.9, Maxwellian. Figures (a–b) and (c–d) correspond to Al and MgF2 materials, respectively.