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MATHEMATICAL SIMULATION OF IONOSPHERIC PLASMA DIAGNOSTICS BY ELECTRIC CURRENT MEASUREMENTS USING AN INSULATED PROBE SYSTEM

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The goal of this work is to theoretically substantiate the possibility of determining the charged particle density in the ionospheric plasma by separately measuring the electric currents of an insulated probe system in the electron saturation region. The ionospheric plasma composition is modeled by two ion species with significantly different masses and electrons to keep the plasma quasi-neutrality. The probe system, which is electrically insulated from the spacecraft structure, consists of cylindrical electrodes: a probe and a reference electrode. The reference electrode to probe current-collecting area ratio can be significantly less than required by the single cylindrical probe theory. The electrodes are oriented transversely to a supersonic flow of a collisionless plasma. In addition to the main plasma with two ion species, a model plasma with a single ion species is considered. The mass of the model ions is such that the ion saturation current to the cylinder is the same for both plasma models.

Based on a previously obtained asymptotic solution for the electron saturation current in a plasma with a single ion species, computational formulas are found for determining the ion mass composition and the electron density by probe current measurements. The errors of the formulas are estimated numerically and analytically as a function of the probe system geometry, the bias potential of the probe relative to the reference electrode, and the accuracy of potential and current measurements. It is shown that a proper choice of the probe system settings and the accuracy of probe measurements assures a reliable determination of the charged particle densities in a plasma with two ion species. A priori estimates are presented for the effect of the current bias potential measurement errors on the reliability of determining the ion mass composition and the electron density of the ionospheric plasma.

Keywords*: two ion species plasma, probe system with cylindrical electrodes, model single-species ions, mathematical model of current collection, reliability of ion composition and electron density determination.*

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