The charging of two conducting spheres by a flow of weakly ionized collisional plasma

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We study the charging process of two fixed conducting sphere by a weakly ionized collisional plasma flow. Plasma is assumed to consist of positive and negative ions, the spheres are aligned with the flow; external electric field, the flow of neutral gas, molecular diffusion and ionization-recombination processes are taken into account. The interaction of spheres and plasma is described by motion and continuity equations for ion components, Poisson equation, and charging equations for both conducting spheres. It is assumed that there is no particle emission from the sphere surface. The non-stationary problem (initial conditions correspond to spheres appearing in plasma and the flows being turned on) is solved numerically in bispherical coordinate system by the finite differences method.

The dependences of the stationary values of the sphere charges as well as the spatial distributions of space charge density on the distance between the spheres and other plasma parameters are studied. The results are as follows. For ions with equal mobilities $\mu_-/\mu_+ \sim 1$, far-spaced spheres don't acquire a charge; if the spheres are close enough they acquire equal charges of opposite sign. For the case of $\mu_-/\mu_+ > 1$ (<1) far-spaced spheres charge negatively (positively). In both cases with decreasing of distances between spheres the charge on the upstream/downstream sphere with respect to the electric field direction increases/decreases, respectively. For sufficiently small distance between the spheres they also acquire charges of opposite sign; the value of such distance is determined by the plasma parameters.

In the surrounding plasma a positively charged area is formed to the left of the upstream sphere, and a negatively charged one is formed to the right of the downstream sphere. The charge density in the area between the spheres changes sign; absolute values of minimum and maximum of the charge density in this region decreases with decreasing distance between the particles. Starting with a certain distance of the same order of magnitude as sphere's radii, space charge in the region between the spheres is almost absent.

In the case of far-spaced spheres the results are in accordance with solution, obtained earlier for the case of solitary sphere. The results can be important in understanding intergrain interactions in weakly ionized highly collisional anisotropic dusty plasmas.