Coulomb collisional processes in space plasmas; Relaxation of suprathermal particle distributions

Bernard Shizgal[1]; Hiroyuki Shinagawa[2]

[1] Dept Chemistry, Univ British Columbia; [2] STEL, Nagoya Univ.

Nonequilibrium distributions of space plasmas are often characterized by extended high energy tails. There are also numerous situations in aeronomy that are characterized by distributions of energetic neutral species. This paper provides a detailed analysis of the relaxation of such isotropic nonequilibrium systems; ionized or neutral. In the first case, we consider an energetic charged species dilutely dispersed in a fully ionized plasma, which acts as a heat bath at equilibrium. The minor constituent is referred to as a test particle and collisions between test particles are not included. We study the approach to equilibrium with a finite difference method of solution of the Fokker-Planck equation appropriate for collisions between charged particles. The main objective is the calculation of the energy dependent relaxation times of the distribution function. A strong energy dependence for these relaxation times is anticipated since, for Coulomb collisions, the Rutherford cross section varies with relative speed g as g^(-4). Some potential applications to modelling of the solar and polar wind expansions will be discussed.

For the relaxation of isotropic nonequilibrium distributions of neutral species, we consider a hard sphere cross section for the collisions of the test particles and the heat bath particles. Collisions between test particles are not included in the analysis. We study the approach to equilibrium with a finite difference method of solution of the Boltzmann equation. The main objective is the calculation of the energy dependent relaxation times for the distribution function. It is anticipated that these relaxation times will not exhibit a strong energy dependence owing to the energy independent hard sphere cross section. The results are compared with the previous analysis for Coulomb collisions.