SPECTRAL METHOD FOR RESOLUTION OF THE FOKKER-PLANCK EQUATION

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A specialized spectral method has been developed to solve the steady state Fokker-Planck equation describing the diffusion and upward bulk motion of H^+ ions through a background of O^+ ions. This method was developed to study the escape of H^+ ions in the polar wind and can be adapted to study the escape of different species of ions of the atmosphere of other planets and stars. Assuming azimuthal symmetry, the velocity distribution function of the H^+ ions is a function of the radial distance r, the velocity v and $\mu = \cos\theta$ where θ is the angle between the velocity vector and the magnetic field direction. To solve the partial differential Fokker-Planck equation, we expand the solution in orthogonal polynomials for each variable: Legendre polynomials for the variable μ, speed polynomials for the velocity of the particles, and modified Legendre polynomials for the dimensionless altitude defined as the ratio of the altitude and the mean free path of the particles.
The velocity distribution function of H^+ ions is determined as a function of the altitude for realistic boundary conditions. A correct choice of the boundary conditions at $v = 0$ is needed to obtain regular mathematical solutions. The solution has been compared to the velocity distribution function determined by a DSMC (Direct Simulation Monte Carlo) code and the solution obtained with an hydrodynamic model.