ANALYTICAL SOLUTION OF 3-D COSMIC-RAY DIFFUSION IN THE GALAXY WITH BOUBDARYLESS HALO (I) — ONE COMPONENT MODEL —

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We show an analytical solution of three dimensional cosmic-ray diffusion, taking a more realistic structure of our Galaxy into acount, where we assume, i) $D(r,z) = D_0 \exp[r/r_D + z/z_D]$, ii) $n(r,z) = n_0 \exp[-(r/r_n + z/z_n)]$, and iii) $\rho(r,z) = \rho_0 \exp[-(r/r_\rho + z/z_\rho)]$, i.e., three critical parameters, the diffusion coefficient D, gas density n and the cosmic-ray source ρ depending on both radial distance r from the disk center and the perpendicular distance z from the galactic plane.
The solution is expressed by use of the Modified Bessel functions, $I_\nu(\Lambda_r Z_z)$ and $K_\nu(\Lambda_r Z_z)$ with $Z_z = \exp[-z/\bar{z}]$ under the assumption $[r_D, r_n, r_\rho] \gg [z_D, z_n, z_\rho]$, where ν and $\bar{z}$ are related to the critical parameters, z_D and z_n, while Λ_r depends on the radial distance r as well as on the critical parameters, $\bar{z}$, n_0 and D_0.