THE BGK BOLTZMANN EQUATION AND ANISOTROPIC DIFFUSION

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In this paper, we study a model of cosmic ray diffusion based on a gyro-phase, and pitch-angle dependent BGK Boltzmann model, involving two collision time scales $\tau_\perp$ and $\tau_\parallel$ associated with scattering perpendicular and parallel to the background magnetic field $\mathbf{B}_0$. The time scale $\tau_\perp$ describes the ironing out of gyro-phase anisotropies, and the relaxation of the full gyro-phase distribution f to the gyro-averaged distribution f_0. The time scale $\tau_\perp$ determines the diffusion coefficient $\kappa_\perp$, perpendicular to the mean magnetic field, and the corresponding anti-symmetric diffusion coefficient κ_A associated with particle drifts. The time scale $\tau_\parallel$ describes the relaxation of the pitch angle distribution f_0 to the isotropic distribution F_0, and determines the parallel diffusion coefficient $\kappa_\parallel$. The Green function solution of the model equation is obtained, for the case of delta function initial data in position, pitch angle and gyro-phase, in terms of Fourier-Laplace transforms. The solutions are used to discuss non-diffusive and diffusive particle transport. The gyro-phase dependent solutions exhibit cyclotron resonant behaviour, modified by resonance broadening due to $\tau_\perp$.