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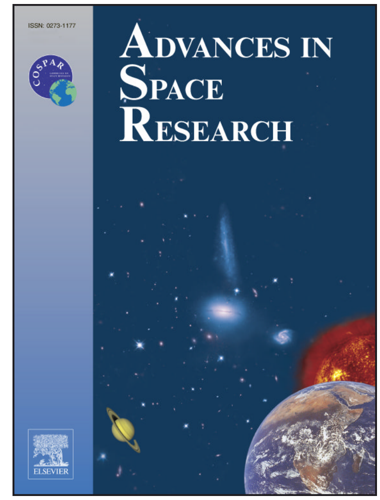

Solutions of the Cosmic Ray Velocity Diffusion Equation

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Solutions of the Cosmic Ray Velocity Diffusion Equation

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Abstract

In order to describe the propagation and acceleration of cosmic rays, one usually uses a diffusive transport equation. The most fundamental equation is the pitch-angle dependent diffusion equation which is usually called the Fokker-Planck equation. In the current paper we solve the position integrated equation numerically and analytically. For a constant pitch-angle Fokker-Planck coefficient we derive an exact solution of the corresponding transport equation and compare it with numerical solutions. We show that even if the scattering coefficient is assumed to be constant, the solution behaves well. As a second example we consider the case of a linear pitch-angle Fokker-Planck coefficient. Again we solve the corresponding transport equation numerically and analytically. In all cases considered, we find similar distribution functions. We also compute the corresponding velocity correlation functions and parallel diffusion coefficients. Our results are relevant for improving analytical theories of perpendicular diffusion, for code tests, and for different astrophysical applications where a pitch-angle dependent description of the particle motion is required.

Key words: magnetic fields, turbulence, energetic particles

1 Introduction

A fundamental problem in astrophysics is to understand the origin and dynamics of cosmic rays. Due to complicated interactions between such energetic particles and astrophysical plasmas, their motion is usually of diffusive nature. Therefore, the propagation and acceleration of cosmic rays is described by a diffusive transport equation (see, e.g,. Schlickeiser 2002 and Zank 2014). It has

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