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Problems of Stochasticity in Physics and Astronomy

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Introduction

Solar modulation is the method by which the Sun prevents galactic cosmic rays from entering the solar system, changing the cosmic rays' strength and energy spectrum. It is a difficult astrophysical problem to comprehend solar modulation from the ground up because it necessitates knowledge of the heliosphere's magnetic field and turbulence properties as well as accurate theories for deriving particle transport characteristics, like the diffusion tensor, from turbulence characteristics.

We give a thorough explanation of our recently created stochastic method for resolving Parker's transport equation, which, according to us, represents the first attempt to do so in three dimensions while accounting for time dependence. This method evolved from our three-dimensional steady state stochastic method. Although we use the typical Parker field as an example to show how to compute the transport of galactic cosmic rays, our formulation of this method is universal and applicable to any sort of heliospheric magnetic field. Our 3-D stochastic approach differs in a number of ways from other stochastic methods described in the literature. For instance, we immediately integrate using spherical coordinates, which greatly improves the code's efficiency by minimising coordinate transformations.

Modern global climate simulations can only have a spatial resolution of a few hundred kilometres due to finite processing resources. Small-scale processes like convection, clouds, and ocean eddies are not accurately represented in either the atmosphere or the ocean. It is well recognised that the depiction of unresolved processes in the resulting bulk formula affects climate models, sometimes rather strongly. Weather and climate models with stochastic physics schemes have the ability to depict the dynamical effects of unresolved scales in ways that traditional bulk-formula representations cannot. The use of stochastic physics in climate modelling is a quickly developing, significant, and cutting-edge field. The Theme Issue, for which this paper serves as the introduction, compiles the most recent research findings.

The mechanism for the acceleration of cosmic rays through collisions with magnetized clouds in the interstellar medium was first proposed by Fermi (1949), and it has been since discussed extensively in the literature (Davis 1956; Morrison 1961). One of the early difficulties encountered by this theory was that it predicted, contrary to observations, increasingly steeper spectra for the heavier

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cosmic ray nuclei because of their more rapid break up in collisions with interstellar matter. This problem was at that time overcome by Morrison, Olbert, and Rossi (1954) by postulating that cosmic rays leaked out of the galaxy with a time constant much shorter than their nuclear interaction time in the interstellar space. However, yet another difficulty within the theory was pointed out by Hayakawa (1969) who used the first-order term pertaining to monotonie increase in the particle energy to show that the spectrum of the nuclear secondary's. In any case, the interest in the mechanism, in the context of galactic cosmic rays, waned with the accumulation of radio astronomical evidence, showing that the velocities of the interstellar clouds were too small and that their relative spacing too large to accelerate cosmic rays significantly within the short residence time of 106 years-107 years. estimated for cosmic rays in the galaxy.

According to all of this study, galaxies show a wide range of SFHs, including bursts, decreases, and periods of stable star formation. In this study, we suggest modelling the movement of star-forming galaxies around the MS ridgeline and the time-dependence of star production as simply stochastic processes. We specify the features of the Power Spectrum Density (PSD), which is described as a broken power law, in the frequency domain in order to define the stochastic behaviour in very generic terms. How quickly the SFR varies on short time periods is determined by the high-frequency slope of the PSD, which is related to the physical forces that drive star formation. The broken power-law form establishes a time scale on which the SFR can break the correlation.