Title: Diffusion of energetic charged particles in turbulent magnetic fields

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Abstract:

A fundamental problem in astrophysics is the interaction between space plasmas and energetic particles. Plasmas can be found in any astrophysical scenario. This could be the plasma of the solar wind or the interstellar medium. Solar energetic particles, pickup ions, and cosmic rays are among the key energetic particle populations in the Heliosphere for example. While those particles propagate through the interplanetary or interstellar space, they experience scattering due to magnetic turbulence. Describing those scattering effects theoretically is important to understand different processes in space and astrophysics. Examples for such applications are the acceleration of particles at interplanetary shocks, solar modulation and space weather studies, the motion of cosmic rays through galaxies, and diffusive shock acceleration in supernovae remnants. We have developed a test-particle code to simulate the interaction of charged particles with turbulent magnetic fields. Diffusion coefficients along and across the mean magnetic field are calculated and compared with different analytical theories. Different turbulence models where considered such as models with reduced dimensionality and full three-dimensional models. We have also included wave propagation and dynamical effects. We also considered particle diffusion in unique turbulence setups such as noisy hydrodynamic models. A number of conclusions were reached. Some are related to the influence of turbulence properties on diffusion parameters where it is shown that such influence is not strong as originally thought, and others concern the applicability of certain theories such as the unified nonlinear transport theory. In addition, we were able to reproduce solar wind observations by employing a more realistic turbulence approach.

"The purpose of computing is insight, not numbers"
-Richard Hamming (1962)