Theory of Cosmic Ray Transport in the Heliosphere

ทฤษฎีการขนส่งของรังสีคอสมิกในฮีลิโอสเฟียร์

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Cosmic rays are energetic particles from space. Most are charged sub-atomic particles, specifically ions and electrons. The main populations of cosmic ray particles are Galactic cosmic rays, from supernova explosions throughout the Galaxy, and solar energetic particles, from solar storms, which can cause "space weather" effects on human activities that rely on space technology or can even cause power outages on Earth. Thus the transport of cosmic ray particles is of scientific and practical interest.

This paper reviews the history and state of the art of theories, computer simulations, and observations of cosmic ray transport in the heliosphere (i.e., the region of space occupied by the solar wind, which extends far beyond the orbits of the planets). We also present new calculations that directly compare the results from different theories or different computational models for the same sets of model parameters and/or inputs (e.g., as shown in the Figure below).

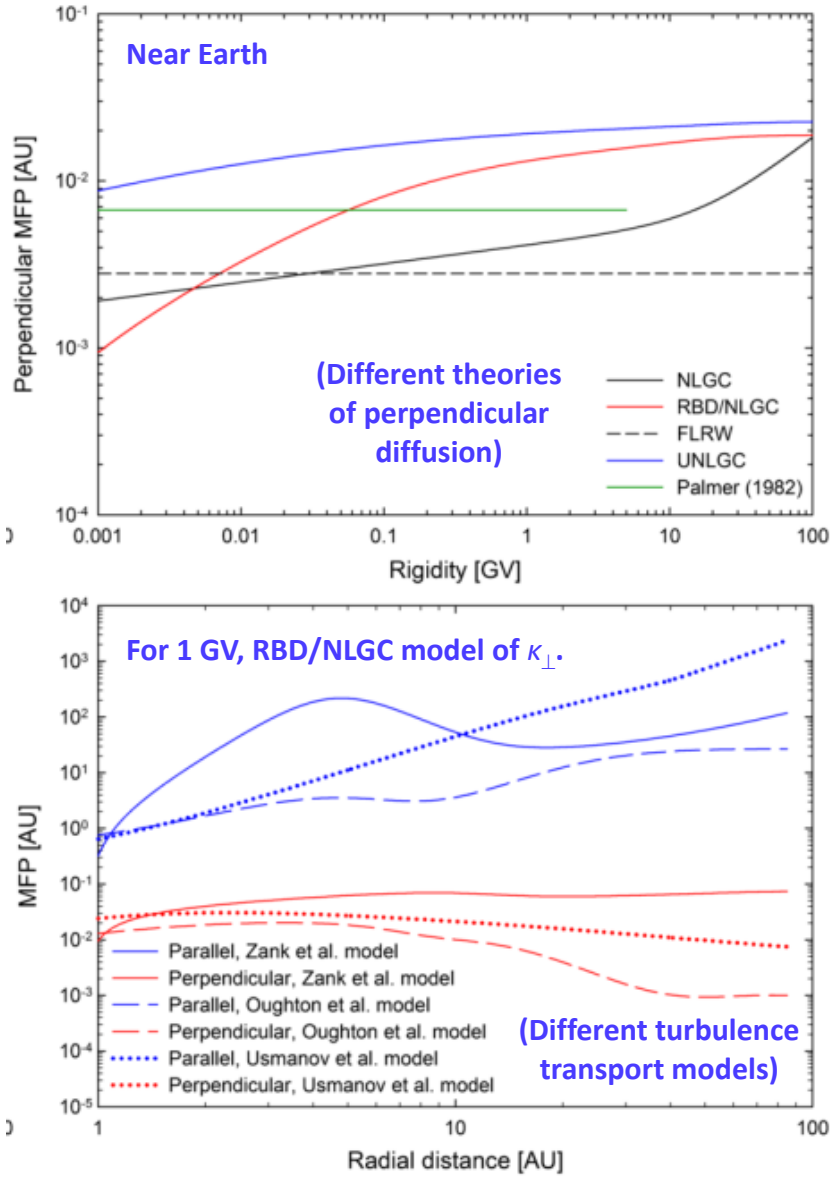

Figure: (Top) Comparison of perpendicular mean free paths near Earth, based on measured parameters of magnetic turbulence, from different theories (NLGC: Matthaeus et al. 2003; RBD/NLGC: Ruffolo et al. 2012; FLRW: Jokipii 1966; UNLGC: Shalchi 2010) and from the consensus value of Palmer (1982). (Bottom) Comparison of mean free paths from different models of turbulence transport, as calculated for particles of 1 GV rigidity, the quasilinear model of parallel transport (Jokipii 1966), and the RBD/NLGC model of perpendicular transport (Ruffolo et al. 2012).