Transport of Cosmic Rays in Chaotic Magnetic Fields Fabien Casse
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abstract The transport of charged particles in disorganised magnetic fields is an important issue which concerns the propagation of cosmic rays of all energies in a variety of astrophysical environments, such as the interplanetary, interstellar and even extra-galactic media, as well as the efficiency of Fermi acceleration processes. We have performed detailed numerical experiments using Monte-Carlo simulations of particle propagation in stochastic magnetic fields in order to measure the parallel and transverse spatial diffusion coefficients and the pitch angle scattering time as a function of rigidity and strength of the turbulent magnetic component. We confirm the extrapolation to high turbulence levels of the scaling predicted by the quasi-linear approximation for the scattering frequency and parallel diffusion coefficient at low rigidity. We show that the widely used Bohm diffusion coefficient does not provide a satisfactory approximation to diffusion even in the extreme case where the mean field vanishes. We find that diffusion also takes place for particles with Larmor radii larger than the coherence length of the turbulence. We argue that transverse diffusion is much more effective than predicted by the quasi-linear approximation, and appears compatible with chaotic magnetic diffusion of the field lines. We provide numerical estimates of the Kolmogorov length and magnetic line diffusion coefficient as a function of the level of turbulence. Finally we comment on applications of our results to astrophysical turbulence and the acceleration of high energy cosmic rays in supernovae remnants, in super-bubbles, and in jets and hot spots of powerful radio-galaxies.