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Cosmic ray small-scale anisotropies in quasi-linear theory

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The paradigm for wave-particle interactions in cosmic ray physics, quasi-linear theory, cannot describe the small-scale anisotropies observed with high-precision observatories like IceCube and HAWC. This can be traced back to the loss of two-particle correlations when only the ensemble-averaged phase-space density is modelled.

After a brief review of standard quasi-linear theory, we consider two-particle correlations in a systematic and perturbative approach. We determine the angular power spectrum as the steady state of a differential equation describing the correlated transport of pairs of particles. As an example, we consider a toy model of isotropic turbulence and verify our result with numerical simulations. Our angular power spectrum compares favourably with data from the IceCube and HAWC observations.

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