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Angular distribution of energetic particles scattered by strongly anisotropic MHD turbulence: understanding Milagro/IceCube results

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Both the acceleration of cosmic rays (CR) in supernova remnant shocks
and their subsequent propagation through the random magnetic field
of the Galaxy deem to result in an almost isotropic CR spectrum. Yet
the MILAGRO TeV observatory and the IceCube discovered sharp
(~10 deg)
arrival anisotropies of CR nuclei. We suggest a mechanism for producing
such a CR beam which operates en route to the observer. The key assumption
is that CRs are scattered by a strongly anisotropic Alfven wave spectrum
formed by the turbulent cascade across the local field direction.
The strongest pitch-angle scattering occurs for particles moving almost
precisely along the field line. Partly because this direction is also
the direction of minimum of the large scale CR angular distribution,
the enhanced scattering results in a weak but narrow particle excess.
The width, the fractional excess and the maximum momentum of the beam
are calculated from a systematic transport theory depending on a single
scale l which can be associated with the longest Alfven wave,
efficiently
scattering the beam. The best match to all the three characteristics
of the beam is achieved at l~1 pc. The distance to a possible
source of the beam is estimated to be within a few 100pc. Possible
approaches to determination of the scale l from the characteristics
of the source are discussed. The beam related
large scale anisotropic CR component is found to be energy independent
which is also consistent with the observations. The beam splitting
mechanism to explain the combined Milagro and IceCube observations is
suggested.

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