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Spontaneous Transport Barriers Quench Turbulent Diffusion in 2 Dimensional and Reduced MHD

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This paper (1) identifies the physical mechanism for the quench of turbulent diffusion — specifically resistivity — in 2D MHD. Without an imposed, ordered magnetic field, a multi-scale, blob-and-barrier structure of magnetic potential forms spontaneously. Magnetic energy is concentrated in thin, linear 'barriers', located at interstices between blobs. Note the blob-and-barrier state resembles that of certain turbulent binary mixtures (2, 3, 4). The barriers quench the transport and decay of magnetic energy. The local transport bifurcation underlying barrier formation is linked to the inverse cascade of $\langle A^2 \rangle$ and negative resistivity, which induce local bistability. For small-scale forcing, spontaneous layering of the magnetic potential occurs, with barriers located at the interstices between layers. The structure is effectively a magnetic staircase, resulting from inhomogeneous mixing of A. The implications for reduced MHD are discussed.

References

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