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Turbulent Transport of Emerging Magnetic Flux in Partially Ionized Solar Atmosphere

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The magnetic flux emerging from below the solar convection zone traverses the partially ionized region lying between the photosphere and the chromosphere. Additionally the region is turbulent as revealed by the phenomena of granulation and supergranulation.

In a partially ionized plasma the magnetic induction is subjected to the Hall effect and the ambipolar diffusion in addition to the usual resistive dissipation. The Hall effect arises from the treatment of the electrons and the ions as two separate fluids and the ambipolar diffusion due to the inclusion of neutrals as the third fluid. In this paper we study the transport of the emerging magnetic flux in a partially ionized turbulent plasma.

It is shown that these nonideal effects modify the advective transport rate as well as the turbulent diffusion coefficient in a rather substantial way. The Hall effect may enhance or reduce the advection rate. The ambipolar diffusion introduces a nonlinear field dependent advection and diffusion. The new correlations embodying the coupling of the charged fluids and the neutral fluid appear in a decisive manner. The turbulence is necessarily magnetohydrodynamic with new spatial and time scales. The nature of the new correlations is demonstrated by taking the Alfvénic turbulence as an example.