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Energy generation, transport and dissipation in a coronal loop

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Various processes have been proposed to explain the heating of loops to coronal temperatures, from braiding of magnetic flux tubes to waves. The relative contribution of different heating mechanisms is yet to be determined.

We study the coupling of a coronal loop to the solar surface and the transport and deposition of energy in different atmospheric layers.

Using 3D MHD simulations with the MURaM code, we model a coronal loop as a straightened-out magnetic flux tube. At each footpoint, the loop is rooted in a shallow convection zone layer, leading to self-consistent heating by magnetoconvection.

Energy transport may occur through slow, relative motions of magnetic flux tubes or by small-scale motions within magnetic flux concentrations. We compare the contribution of flows on various spatial and temporal scales to the energy transport.
We find that a large part of the energy injected into the loop is generated by internal coherent motions within strong flux tubes.
Small-scale vortices are ubiquitous in the intergranular lanes in the photosphere. These structures extend through the chromosphere into the corona and transport a significant fraction of the Poynting flux into the upper atmosphere and show enhanced heating rates.

The energy deposition in the corona gives rise to a clear substructure in the emission showing strands with widths of a few hundred km.

Our model allows us to follow the energy from its origin in the convection zone to dissipation in the corona and the resulting synthetic emission.

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