Current sheets in the Sun's corona

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Abstract Current sheets play an important role in the Sun's atmosphere, especially in coronal heating events and solar flares. They may form in response to motions of the magnetic footpoints in the solar surface or following a loss of equilibrium.

In two dimensions, X-type null points may collapse to current sheets, as described by nonlinear self-similar solutions and by complex-variable theory. Magnetic diffusion resolves the sheets and allows fast reconnection to take place. There are many ways in which such reconnection can occur, depending on the boundary conditions, including one family of *almost-uniform* regimes and another family of *non-uniform* regimes.

In three dimensions, nulls may also collapse to give a growing current along the *spine* or the *fan* of the null. (These are, respectively, isolated field lines or surfaces of field lines that approach or recede from the null point.) Dissipation can then occur by either *spine reconnection* or *fan reconnection*, or also by *separator reconnection* when the current concentrates along, respectively, the spine, the fan or a separator (which is a field line that links one null point to another).

Coronal heating may be produced by reconnection in the following ways: by converging photospheric motions at X-ray bright points; by binary reconnection when pairs of magnetic sources interact; by separator reconnection in complex fields due to tertiary flux interactions; by braiding of field lines; and by coronal tectonics heating at separatrix surfaces between intense flux tubes. Solar flares may occur when a magnetic catastrophe causes the slow eruption of a flux tube, which in turn drives the formation of a current sheet under the flux tube. As the sheet dissipates and reconnects, the overlying field lines holding down the flux tube are released so that rapid eruption and energy release can take place.

The magnetic field of the Sun
Engenders a whole lot of fun;
There's nothing to beat
Collapse to a sheet,
And that's how the heating's begun.

1. Introduction

The Sun's atmosphere has three layers. The surface, called the photosphere, is only 6000K in temperature and it possesses sunspots, dark areas of very strong magnetic field. Images of the line-of-site compo-