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Mechanisms of Coronal Heating

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Abstract. The Sun is a mysterious star. The high temperature of the chromosphere and corona present one of the most puzzling problems of solar physics. Observations show that the solar coronal heating problem is highly complex with many different facts. It is likely that different heating mechanisms are at work in solar corona. Recent observations show that Magnetic Carpet is a potential candidate for solar coronal heating.

Key words. Magnetic field—corona—Magnetic Carpet—magnetic flux.

Researchers have been searching for the elusive heating of the corona ever since its million-degree temperature was measured more than half a century ago. Some invisible agent is spiriting out energy into the corona, pumping it up and keeping it distended. Magnetism most likely plays a pivotal role. An important realization from Michelson–Doppler Imager (MDI) on Solar and Heliospheric Observatory (SOHO) is that the quiet Sun is covered with small regions of mixed polarity, termed 'Magnetic Carpet' contributing to solar activity on a short time scale. Magnetic loops of all sizes rise far into the solar corona, arising from regions of opposite magnetic polarity in the photosphere. Energy released when oppositely directed magnetic fields meet in the corona is one likely cause for making the solar corona so hot.

The motion of magnetic flux concentrations, along with the continual appearance and disappearance of opposite polarity pairs of fluxes releases a substantial amount of energy. The process of emergence of an ephemeral region will drive reconnection with the overlying field, and the subsequent cancellation of collections of network elements in the network will drive large-scale reconnection between opposite-polarity elements. These processes have been shown convincingly to explain the appearance of X-ray bright points, which however, although important in their own right, make up only a small fraction of the total coronal heating (Priest *et al.* 2002). The second possible way may be the buffeting of the magnetic fragments by granulation on a time-scale of 10–50 s and at a velocity of 2–10 km s^{-1} which will generate magnetic waves that propagate up towards the corona and dissipate efficiently within the fibril coronal magnetic structure. The third reconnection will be driven in several ways in the corona, including braiding by the thrusting of footprints around one another (Parker 1979; Galsgaard & Nordlund 1996), binary reconnection between flux pairs (Priest & Schrijver 1999), and separate reconnection (Priest & Titov 1996; Longcope 1996, 1998) by the interaction of three or more sources at the separation curves that join one null point to another. However, reconnection will also be driven at the myriads of separatix surfaces (Parker 1979, 1994) that separate from each other all the tiny narrow elementary coronal loops whose footprints are the intense flux tubes. The driving will be by the lateral relative motion, the fragmentation, and the cancellation of the minute magnetic fragments in the photosphere. This formation and dissipation of current sheets on separatix surfaces can be referred to as "flux-tube tectonics". The heating is fairly uniform along the separatix so that each elementary coronal flux tube is heated uniformly.

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