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RESEARCH ARTICLE

MAGNETIC RECONNECTION MODEL FOR CORONAL HEATING.

Chandra Mohan S. Negi.
Department of Applied Science, Nanhi Pari Seemant Engineering Institute Pithoragarh, Uttarakhand.

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Abstract

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Sun is a most important star in our universe. The solar corona is the strange place. Its heating is highly complex with many different facts in Astrophysics. It is likely that different heating mechanism is at work in solar corona. Reconnection is a fundamental process in plasma. In this paper I describe Magnetic reconnection model for solar coronal heating.

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Introduction:-

The Solar corona is a strange place. There are some dues to help us how the temperature changes as we go higher in solar atmosphere-

(1) All energy from sun is produced in the solar core for below the solar atmosphere.
(2) The laws of thermodynamics suggest that heat energy from a gas of high given temperature cannot be used to heat another gas to a higher temperature.

From the above discussion it is clear that the temperature of corona require energy to corona by non-thermal processes because simple laws of physics prevents heat from flowing directly from solar surface photosphere at 6,000 kelvin to much hotter million kelvin.

Two classes of model have been proposed, namely, magnetic waves[1][2]and magnetic reconnection[3] to explain the coronal heating.

Magnetic reconnection model for solar coronal heating:-

Reconnection is a fundamental process in a plasma. It changes

- Changes the topology,
- Converts magnetic energy to heat/ kinetic energy,
- Accelerates fast particles

Magnetic reconnection theory too has progressed greatly.

Magnetic reconnection is a mechanism for heating the sun's corona and may operate in several ways. It may be driven by photospheric motion and produce x-ray bright points and transient brightening. It occurs as binary reconnection when pairs of source interact. It takes place by separator reconnection in complex magnetic field or by braiding.

Corresponding Author:- Chandra Mohan S. Negi.
Address:- Department of Applied Science, Nanhi Pari Seemant Engineering Institute Pithoragarh, Uttarakhand.

A new idea is that reconnection “by coronal tectonics” may be heating the corona. The aim here is to determine the effect on coronal heating of the magnetic carpet.

Reconnection can be driven at many of the separatrix that separate from each other all the tiny narrow elementary coronal loops whose foot points are the intense flux tubes[4].The driving will be by the lateral relative motion, the driving will be by the lateral relative motion, the fragmentation and the cancellation of the minute magnetic fragments in the photosphere. The formation and dissipation of current sheets on separatrix surfaces are referred as “flux-tube tectonics”. The behavior of majority of the photospheric magnetic flux in the quiet Sun is that it emerges as ephemeral regions, which split into network elements. Each network consisting of about 10 unresolved intense flux tubes, and that the flux then migrates to the boundaries of super granule cells and moves along them, fragmenting, merging and canceling.

The shearing motions of flux elements at the photosphere cause current sheets to grow at the separatrices of the magnetic cells in the corona. These current layers either are very thin (two-dimensional case) or grow straight away as singularities (three dimensional case). Therefore, even ohmic dissipation will soon become very active, possibly enhanced by anomalous resistivity or reconnection in these sheets[5].

In order to calculate average heating rate per unit solar surface area we assume the following :

1. The simplified dissipation model is one dimensional and we do not consider the escape of matter from the diffusion region.
2. We consider dissipation as simple ohmic diffusion is a driven one dimensional current sheet.
3. Our approach is some what similar to the Sweet-Parker with a long Sweet-Parker current sheet except for the fact that the sheet current is not driven by converging flows but by field shearing in the region exterior to the sheet.

Let σ be the effective electrical conductivity of the coronal plasma and η (=$1/\mu\sigma$) the corresponding magnetic diffusivity. The dissipation is concentrated in the coronal parts of the separatrices. The volume rate of the Joule heating is given in terms of the current density $\vec{J}$ by h=j^2/σ. For a surface current density J at the separatrix and a sheet thickness (δ_∞) in the coronal region, the heating power delivered by the coronal segment of the loop of length 2L and width of order of the transverse size (2w) of a magnetic cell is

$$H_{\text{loop}}=\frac{4Lw\delta_\infty}{\sigma}\left(\frac{J_S}{\delta_\infty}\right)^2=\frac{4LwJ_S^2}{\delta_\infty\sigma} \qquad \text{….(1)}$$

In the carpet region, at a distance r from the flux element, the width of the current channel scales as r/w and the contribution to the heating of the region that carries the surface current J from loop to the flux source element scales as

$$H_{\text{carpet}}=\int_0^w 2\pi dr\,\frac{\delta_\infty r}{w}\frac{1}{\sigma}\left[\frac{J_S}{\delta_\infty({}^{r}/_{w})}\right]^2=\frac{8\pi w^2J_S^2}{\delta_\infty\sigma} \qquad \text{….(2)}$$

Comparison of equations (1) and (2) shows that the current density in the carpet region is larger, whereas the average heating per unit length is the same in the carpet and the corona.

Conclusion:-

Priest, Heyvaerts and Title (2002) suggested that simple lateral motions of magnetic flux fragments in the photosphere drive the formation and dissipation of currents along the separatrix surfaces in the corona. Each coronal loop will form between the fingers connecting a loop to the surface and between individual loops. Simple motions of the flux fragments will then drive the formation of current sheets at these separatrix surfaces and will drive reconnection For Coronal heating.

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