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Chromospheric evaporation via Alfvén waves

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Abstract. We summarize a scenario for the chromospheric evaporation during solar flares. For details we refer to Haerendel (2009).

Key words. Waves – Sun: chromosphere – Sun: flares – Sun: magnetic fields

1. Chromospheric evaporation during solar flares

The paper (Haerendel 2009) presents a scenario for the chromospheric evaporation during solar flares, which is inspired by the chain of events leading to the formation of auroral arcs and ionospheric evacuation during magnetospheric substorms. Plasma, ejected from high coronal altitudes during a flare reconnection event, accumulates at the tops of coronal loops by braking of the reconnection flow, possibly by fast shock formation. A high-β layer forms and distorts the magnetic field. Energy contained in magnetic shear stresses is transported as Alfvén waves from the loop-top towards the chromosphere. It is shown that under these conditions the Alfvén waves carry enough energy to feed the chromospheric evaporation process. The second subject of this investigation is identifation of the most effective energy dumping or wave dissipation process. Several processes are being analyzed, ion-neutral collisions, classical and anomalous field-aligned current dissipation, and critical velocity ionization. All of them are being discarded, either because they turn out to be insufficient or imply very unlikely physical properties of the wave modes. It is finally concluded that turbulent fragmentation of the Alfvén waves entering the chromosphere can generate the required damping. The basic process would be phase mixing caused by a strongly inhomogeneous distribution of the Alfvénic phase speed and laminar flow breakup by the Kelvin-Helmholtz instability. The filamentary (fibril) structure of the chromosphere thus appears to be essential for the energy conversion, in which the K-H instability is the first step in a chain of processes leading to ion thermalization, electron heating and neutral particle ionization. Quantitative estimates suggest that a transverse structure with scales not far below 100 km suffices to produce strong wave damping within a few seconds. Nonthermal broadening of some metallic ion lines observed during the pre-impulsive rise phase of a flare might be a residue of the turbulent breakup process.

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References

Haerendel, G. 2009, ApJ, 707, 903