SPICULES AND MACROSPICULES

W. van Tend
The Astronomical Institute at Utrecht, Sterrewacht,
Zonnenburg 2, 3512 NL UTRECHT, The Netherlands.

ABSTRACT

The transition zone overheating model and the melon seed model are compared with observations of spicules, macrospicules, surges and sprays.

1. Introduction

For about ten years two essentially different models for spicules have existed (Beckers, 1972): Firstly the overheating model of the lower transition zone, and secondly the melon seed model. In this paper we consider these two models in the light of recent observational and theoretical developments.

2. The Overheating Model

In the overheating model a Rayleigh-Taylor like instability occurs, when the lower transition zone receives more energy by heat conduction from the corona than can be radiated away locally. The instability manifests itself as spicules (Kuperus and Athay, 1967).

During spicule generation by overheating of the lower transition zone, the coronal energy content diminishes. The corona thus describes an orbit in the energy balance diagram depicted in Figure 1. The time needed for completing one cycle in this diagram is given by the heating time τ of the corona: $\tau = pH/F$, where p is the coronal base pressure, H is the scale height and F is the energy flux. For the solar corona this time is 1000 sec, which is indeed the observed spicule life time.

In flares a similar time interval is observed between the filament activation and the Hα flash. If the Hα flash is the response of the chromosphere/transition region to excess heating of the corona, this is what is expected, since it takes 1000 sec to heat the corona. The Hα ribbons might then be the base of surges, collimated along field lines as large spicules.

M. Dryer and E. Tandberg-Hanssen (eds.), Solar and Interplanetary Dynamics, 195-197.
Copyright © 1980 by the IAU.

https://doi.org/10.1017/S0074180900067553 Published online by Cambridge University Press

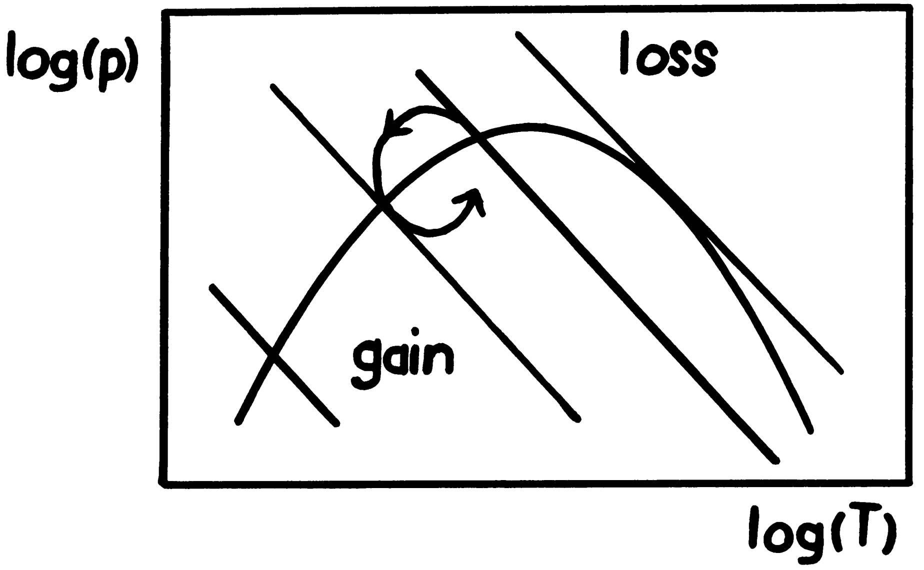

Figure 1
A plot of coronal base pressure against temperature, showing the energy balance curve. Straight lines are contours of constant coronal energy content. A possible orbit of a corona perturbed from energy balance is indicated.

More details on the overheating model are found in Van Tend (1979).

3. The Melon Seed Model

The melon seed model describes spicules as a result of the stretching of field lines after reconnection at the photospheric level. Then a field reversal is required at every spicule. That many field reversals are not observed. The model may apply however to the more recently discovered macrospicules, which are much rarer. Observational evidence for this is the association of macrospicules with small flares (Moore et al., 1977). Flares are always associated with neutral lines, and thus macrospicules would be associated with field reversals, as required.

Also theoretical work (Van Tend, 1980) indicates a possible application of the melon seed model to macrospicules. Magnetic flux leaves flux tubes (like sunspots) during their decay. Only by re-connection at neutral lines does photospheric magnetic flux disappear. The fastest reconnection can be shown to occur at the photospheric level with fields (re)concentrated in flux tubes. Then a configuration as shown in Figure 2 occurs. This field line pattern is stable up to a

https://doi.org/10.1017/S0074180900067553 Published online by Cambridge University Press

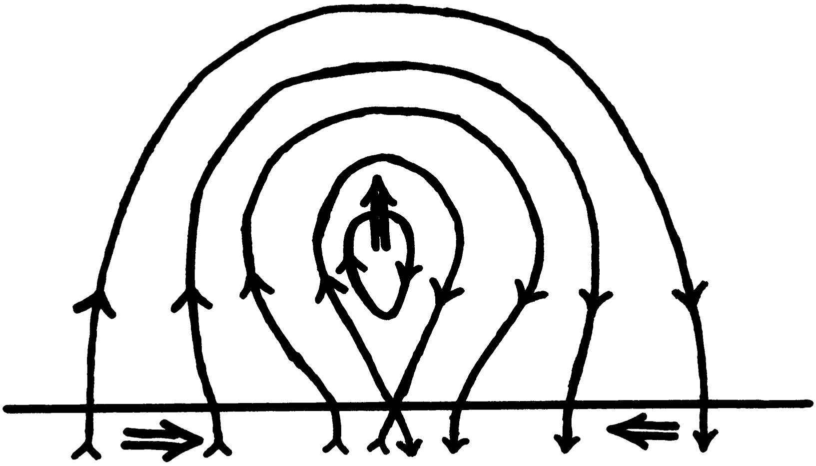

Figure 2
The field line configuration of the melon seed model.

certain threshold height of the coronal O-type neutral point, as shown by the Van Tend and Kuperus (1978) flare build-up model. If the threshold is at a low height, a macrospicule associated with a small flare will result by the reconnection of one pair of flux tubes. If the threshold is high, a larger flare (associated with a spray and prominence eruption) results after several flux tube pairs have reconnected.

Acknowledgement

This work was supported by the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

References

Beckers, J.M.: 1972, *Annual Review of Astron. and Astrophys.* 10, 73.
Kuperus, M. and Athay, R.G.: 1967, *Solar Phys.* 1, 361.
Moore, R.L., Tang, F., Bohlin, J.D. and Golub, L.: 1977, *Astrophys. J.* 218, 286.
Van Tend, W.: 1979, *Solar Phys.*, 61, 89.
Van Tend, W.: 1980, Ph. D. Thesis, University of Utrecht, to be published.
Van Tend, W. and Kuperus, M.: 1978, *Solar Phys.* 59, 115.

https://doi.org/10.1017/S0074180900067553 Published online by Cambridge University Press