PHYSIOLOGY OF QUIESCENT FILAMENTS

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Abstract: The paper represents a preliminary account of the formation and evolution of quiescent filaments. Both large-scale and small-scale points of view are considered. The conclusions of earlier papers about the subject are confirmed and completed. The concept of filament motions is analysed.

Introduction

Filaments are the most common solar phenomenon. More than 1300 papers have been written about filaments and their limb counterpart-prominences, about their structure, spectroscopy, distribution, statistics, etc. In this paper we are concerned with the evolution of quiescent filaments. From the publication of the fundamental treatise about the problem by d'Azambujas (1948), extensive new data, bearing observational evidence on and better theoretical insight into the behaviour of solar activity and in particular of quiescent prominences, have been gained.

The Material

The following sources of information have been used in the present paper:

Photographic Journal of the Sun (Osservatorio Astronomico di Roma).

Maps of the Sun (Freiburg).

Solar Geophysical Data (Boulder).

Cartes Synoptiques de la Chromosphère Solaire (Meudon).

Quarterly Bulletin on Solar Activity (IAU).

Selected Spectroheliograms (Mt. Wilson).

From the Cartes synoptiques de la chromosphère a movie has been copied, in order to follow better the large-scale pattern of the filaments and their large-scale evolutionary changes.

The Quarterly Bulletin has been used as a source of synoptic charts of the solar magnetic fields. From the first, second and third publications information on the structure and evolution of the filaments has been used. The authors are fully aware of the fact that the good quality of the original material has been partly lost by reproduction and that our conclusions would be more reliable if based on the original material.

Large-Scale Properties

Solar prominences in general and quiescent filaments in particular are closely connected with magnetic fields. In their hierarchy one may find: bipolar active regions, extended UM regions lasting many rotations (Howard, 1967; Newkirk, 1971), polar regions and the large-scale sector fields 60—90° in longitude (Ness and Wilcox, 1965; Wilcox and Howard, 1968).

We have also traced the *large-scale pattern* in the quiescent filament distribution. For this purpose we have photographed the Cartes Synoptiques de la Chromosphère Solaire and then projected them as a movie. Some distribution and evolutionary features could be clearly seen in the movie which are lost when inspecting individual maps. Especially the concentrations of filament activity into clearly separated, largescale regions may be seen, analogously to the magnetic field distribution. Often, two main longitudinal regions may be seen. Another distinct feature in the quiescent filament distribution and evolution are the so-called wakes (see Fig. 1). The wakes are formed on the front side (i. e. western boundary) of the above mentioned regions and they represent a relatively stable channel, lasting for more than 6 months through which many filaments migrate polewards. The shape of the wake is a parabolic sector. It seems to follow the high latitude tail of the large magnetic structure.

The change of the background field geometry and of the grad H across the dark lane leads to the observed *changes of the shape* and of the overall *structure of the quiescent filaments,* and possibly to their disappearance or appearance.

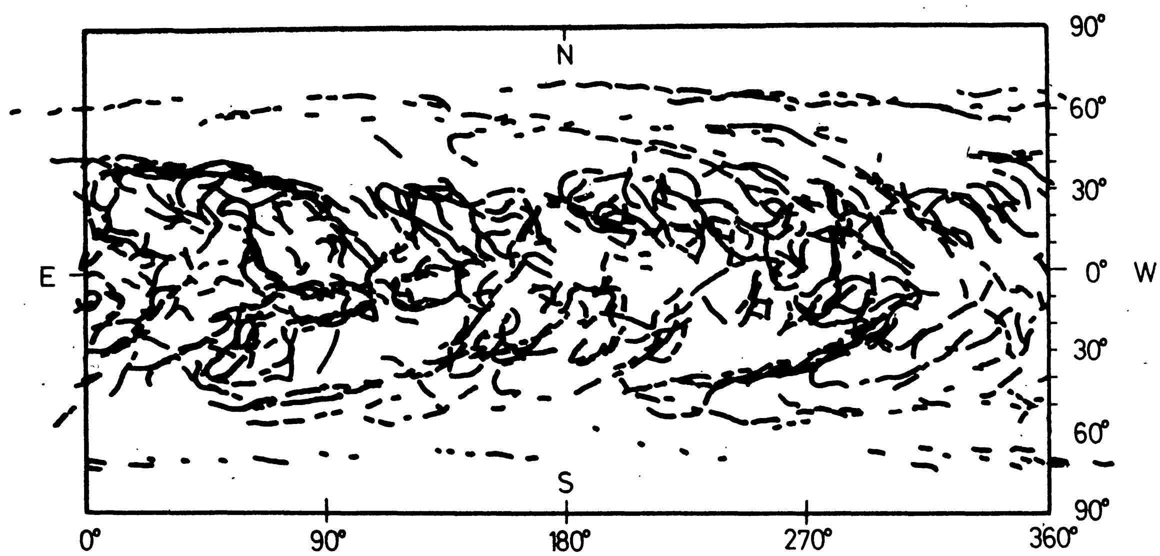

Fig. 1. All filaments that occurred during a half year are represented in the figure. It represents a superposition of six synoptic charts of the chromosphere for rotations 1557—1562. Two filament wakes may be seen in the southern hemisphere (starting around 180 and 300° heliographic longitude) and two wakes in the northern hemisphere (starting at about 90 and 270°).

The *reverse side* (i. e. the eastern boundary of the large scale region) is much less stable, its shape changes, often in wiggling meanders and its filaments sometimes drift towards the equator. This is in contradiction to the general tendency of filaments, mentioned by d'Azambujas (1948). In the early phases of the region the leading (wake) and the following boundaries are interconnected by a *poleward arch of filaments.* It is just in this early archy feature where filaments are usually most intense (dark). In later phases the interconnecting filament arch breaks.

Filaments of circular form developed in a few cases, when a new opposite polarity had merged in the background field.

Filaments develop in *dark lanes* (seen in H_α pictures) which in turn follow neutral lines. Whether and when the filament appears in the pre-existing dark lane, is an open question. We are under the impression that the filaments appear at a critical interval of values of grad H (high values for sharp regular filaments in active regions and low values for quiescent filaments outside active regions).

Small-Scale Properties

We have further examined the H_α chromosphere from our material to find some pre-existing features in the dark lanes, preceding the formation of quiescent filaments. In a few cases we have found small dark mottles along the lane axis. As they precede the appearance of filaments in that lane, we call them *embryonal elements.* They are circular, or slighty elongated, and oriented along the lane axis.

In some cases (when the material was of very good quality) one could see very fine dark *dashes* between the embryonal elements. They are located along the lane axis.

A *plage emerging* near a dark lane pushes it away and eventually part of the lane is destroyed completely. If the filament already exists, the appearance of an active region leads (analogously) to its deformation, activation and eventually to sudden disappearance. This is one example of how the changes of shape and grad H influence the physiology of the quiescent filaments (see end of the Section 3).

The *growth of quiescent filaments* (at least in some cases) consists of two phases:

a) the appearance of a number of embryonal elements (e. g., 8) at the axis of the pre-existing dark lane, and

b) the darkening of the space between the elements (eventually broadening and darkening of the interelement dashes). This kind of filament growth, consisting in the darkening of the interelement intervals, is not a continuous growth in length, but rather proceeds in jumps.

Concluding Remarks

The authors are aware of the fact that the material at their disposal is not homogeneous (as regards angular resolution, passband and the setting of the filters used, photographic material and method of treatement), that the original material should be used (by copying, information may be lost) and that, due to the short time for our communication, more details and numerical data specifying individual features of filament growth could not have been given.

A full discussion is being prepared for publication in the Bulletin of the Astronomical Institutes of Czechoslovakia.

References

AZAMBUJA, de M. et M[me] L. (1948): Ann. Obs. Paris, Section Meudon, Tome VI, fasc. VII.

BUMBA, V. and HOWARD, R. (1965): Astrophys. J., *141,* 1.

HOWARD, R. (1967): Ann. Res. Astron. Astrophys., *5,* 1.

NESS, N. F. and WILCOX, J. M. (1965): Science, *152,* 161.

NEWKIRK, G. A. Jr. (1971): In: R. Howard (Ed.), Solar Magnetic Fields, p. 547. IAU Symp. 43.

WILCOX, J. M. and HOWARD, R. (1968): Solar Phys., *5,* 564.