THE EVOLUTION OF THE PHOTOSPHERIC NETWORK*

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Abstract. A time-lapse sequence of spectroheliograms in the bandhead of CN at \( \lambda 23883 \) reveals the following behavior of the photospheric network with time:

1. There is a steady flow of bright 'points' (\( \approx 1000 \) km in diameter) laterally outward from sunspots at speeds on the order of 1 km-sec\(^{-1}\). After traveling about 10 000 km from a sunspot they either conglomerate to form fragments of the photospheric network or disappear.

2. Spatial changes in the network pattern seem to take place by means of the shifting of network fragments laterally on the solar surface. Although most small-scale details are recognizable after 5–10 minutes, within 30 minutes nearly all the details have changed completely. In contrast to this, the large-scale network pattern seems relatively unchanged after 2½ hours.

3. Occasionally 'new' network, not resulting from the lateral motion of bright features from either previously existing network or sunspots, appears on the solar surface. This process consists of the formation in approximately 10 minutes of bright points and a darker-than-average feature between them. The dark feature disappears in another 5–10 minutes and the bright points separate at a relative speed of a few km-sec\(^{-1}\). If the event is of a sufficiently large magnitude, a sunspot will appear.

These observed changes of the photospheric network with time are interpreted as formation and motions of photospheric magnetic fields. It is suggested that these motions reflect the presence of both short-lived small-scale and long-lived large-scale photospheric currents such as one might expect from the granulation and the supergranulation.

1. Introduction

In recent years there has been considerable effort to determine the way in which solar magnetic fields change with time. Most studies have been made with photoelectric magnetographs but have lacked sufficient temporal or spatial resolution (or both) to permit a confident understanding of more than the grossest of magnetic field changes. Although several developments to improve the quality of these observations are under way (Ramsey, 1969; Livingston et al., 1969; Mayfield et al., 1969), another technique of studying the spatial changes of photospheric magnetic fields is presently available. Namely, in view of the observed cospatiality between the pattern of photospheric magnetic fields and the photospheric network (Chapman and Sheeley, 1968), one may suppose that a time-sequence of spectroheliograms in any one of a number of temperature-sensitive photospheric lines will reveal positional changes of magnetic fields. This paper describes a time-lapse sequence of spectroheliograms taken in the CN bandhead at \( \lambda 23883 \) using the 82 cm image at the Kitt Peak National Observatory during a 2½ hour period of very good seeing conditions.

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2. Observational Techniques

The Boller-and-Chivens spectroheliograph at the Kitt Peak National Observatory has two exit slits so that pairs of spectroheliograms can be taken simultaneously. Exit slit #1 was centered 0.18 Å violetward of the CN bandhead at λ3883.4. Exit slit #2 was centered on the continuum at λ3883.9. Both slits were 150 μ wide corresponding to a band pass of 0.14 Å at the dispersion of 0.91 Å·mm⁻¹. The positions and widths of these slits relative to the spectrum are shown in Figure 1, taken from the Utrecht Atlas (Minnaert et al., 1940). Starting at 7:00 MST on August 13, 1968 simultaneous pairs of spectroheliograms were taken on 8" × 10" glass plates. To take into account the different intensities in slits #1 and #2 the CN spectroheliograms were taken on II-0 emulsions while the λ3884 continuum spectroheliograms were taken on the relatively less sensitive III-0 emulsions. The spectroheliograph ran at a rate of 3.5 sec·cm⁻¹ for a scan length of approximately 14 cm × 23 cm near the center of the 82 cm disk. Pairs of spectroheliograms were repeated as often as it was possible to reload plates into the spectroheliograph – about 6.5 minutes per frame. Exposed plates were marked and placed in boxes for later development. This was continued until the seeing had deteriorated to such an extent that sharp granular structure was no longer visible on the white light image. The final frame ended at 9:22 giving a