CHAPTER 4

ISOPHOTAL CONTOUR MAP OF THE LOW QUIET CHROMOSPHERE

4-1 INTRODUCTION

Spicules which are the chromospheric spikelike structures have been observed and studied since 1868. From photographs of the chromospheric limb, taken both during total eclipses and by using H_{α}-filter, a number of characteristics of spicules have been studied. On his best photographs, Dunn (1960) get an average half-width of the intensity profile of spicules of 1.1 seconds of arc. The average heights, as measured by Lippincott (1957) are of the order of 10 seconds of arc at the equator and about 13 seconds of arc at the pole. Their average lifetimes are found to be about 10 minutes. Bhavilai (1965) suggested, and this was later confirmed by Mouradian (1967), the movement of the matter in the spicules does not change in sign. Mouradian (1967) found a broadening phenomena due to the diffusion of spicular matter into corona.

In recent years, many observers have identified the spicules seen at the chromospheric limb, as dark features on the solar disk. However, Bhavilai (1965) concluded that spicules originate in bright features and this was recently confirmed by Beckers (1964, 1966) whose works previously identified spicules as dark features.

In this report, the extensions of the dark features from the inner limb (on the disk) to the outer limb and the connection of spicules to the bright features on the disk are studied.

4 - 2 MATERIALS AND METHODS

Data

A good quality film of the chromospheric limb of the sun on 3 April 1964, taken at 10h 26 min 28 s was selected from the data of one of the authors (R.B.). It was obtained through a 5-in. chromospheric telescope of the CSIRO Division of Physics at Fluers, New South Wales, Australia through a $\frac{1}{8}$ Å tunable birefringent filter centred at H_{α} + 0.75 Å. By the optical system of the telescope, a solar image of about 100 mm. diameter at the final image plane was obtained and it follows that 0.1 mm. on the film was equivalent to about 2 seconds of arc on the sun.

Instrumentation

The tracings were made by the spectroscanner at the Department of Science, Ministry of Industry, Bangkok. Since the 75 x 1000 μ slit of the scanner was not suitable for this project, a circular slit of about 75 μ diameter was used in its place. This circular slit was constructed by simply piercing a thin Al-foil with a sharp needle. The Al-foil was then attached to a wooden base, the height of which was nearly equal to that of the 75 x 1000 μ slit.

Two images of the chromospheric limb were projected simultaneously onto two positions in the scanner, one onto the screen with magnification of about 14.6 and other onto the slit with magnification of about 5. On the sereen, the interesting region to be scanned was selected. The knob, used to move the film in the direction perpendicular to the scanned direction along the limb, was fitted with a long indicator moving over a rather fine scale to measure the height of the level being scanned.

As the scannings were made along the limb, the recorder turned and the transparencies of the film were recorded on the moving paper. The rate of the film's motion was about 0.39 mm. per minute and that of the recording paper was 12.5 small spaces per minute, hence 3.4 small spaces on the recording paper correspond to 0.1 mm. or 2 seconds of arc on the film.

Reduction

The scanning was made along the chromospheric limb of about 18 seconds of arc in length. Since the transparencies of the film change rapidly with height at the limb of the solar image, it is not possible to use only one setting of gain adjustment. To overcome this difficulty a level on the inner edge of the limb (on the disk) was chosen as the base level, and the intensity of light and sensitivity of the instrument along this level were recorded on the chart recorder paper. The higher levels, of approximately equal interval, were then scanned one after the other until the deflection of the recorder was just out of scale.

The sensitivity of the instrument was then readjusted and the recording of the transparencies of the higher levels continued. Four adjustments were made during the scanning of 60 levels in this region. It included about 16 seconds of are in height from the selected base level.

Four sets of curves have been plotted (Figure 1), with the abscissae representing the positions along the limb and the ordinates representing the height levels. Each curve shows the isophotal contour (equal brightness contour on the sun). The smaller numbers on the curves of each graph indicate the isophotal contours of the brighter intensities on the chromosphere. For convenience, the four sets of curves are numbered as 1, 2, 3, 4 starting from the one showing the lowest level.

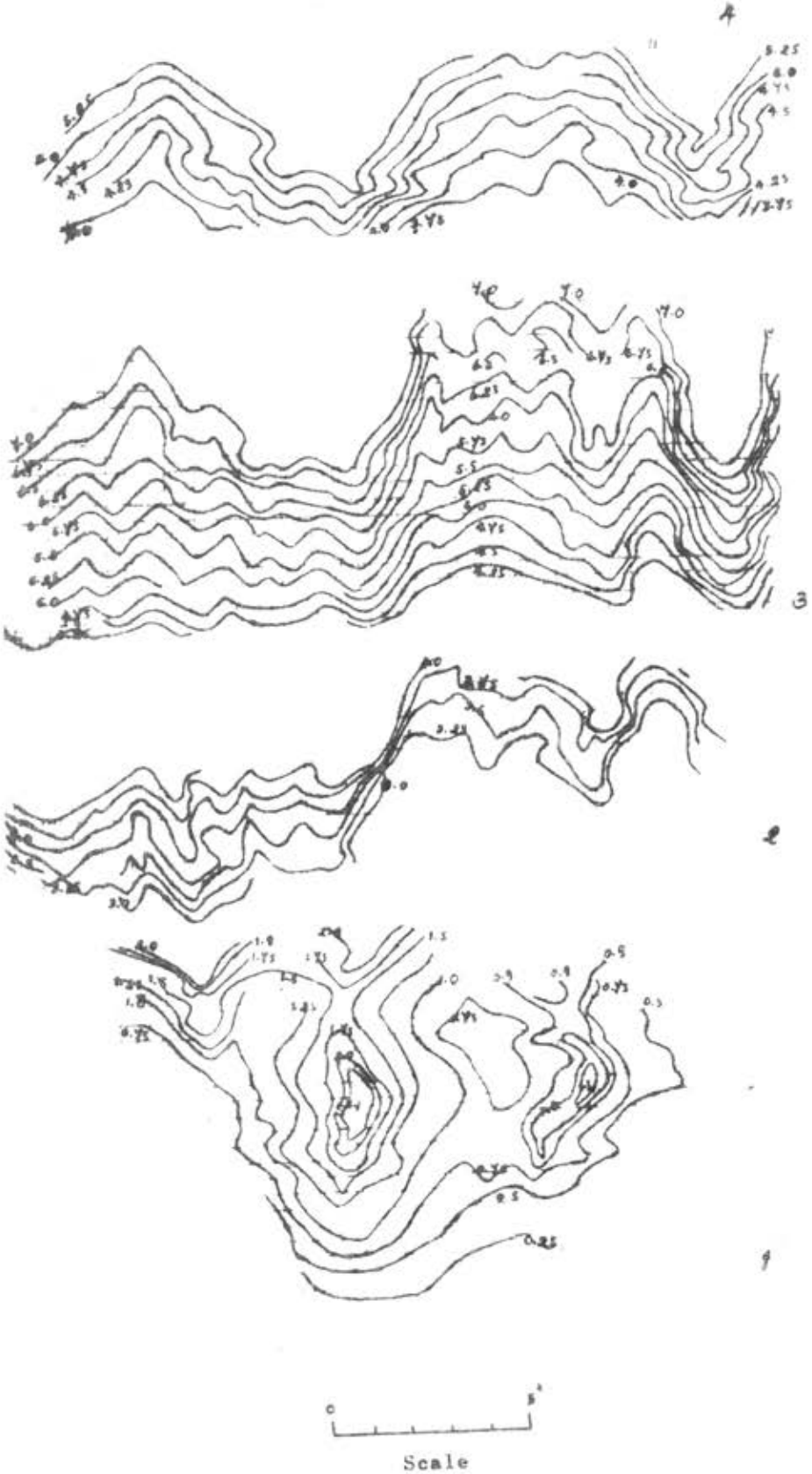

Figure 1.--Isophotal contour map of the chromospheric limb.

Location of the scanned region is between the two short lines.

0" 20" 40"

Scale

Figure 2. The solar limb at $H_\alpha + 0.75$ Å shown on five prints of different densities.

Four prints were made from the film enlarged 20 times (Figure 2), with four different exposure times. The print of the lowest exposure time shows only dark and bright features outside the disk while the prints of the increased exposure times show the features on the disk. These prints are necessary in identifying positions on the graphs with the features on the film.

4-3 RESULTS

From the curves, the following results are obtained:-

(1) The dark and bright features appearing in the curves can be easily identified with the dark and bright features on the prints as shown.

(2) The dark feature as seen in the set of curves No. 1(on the chromospheric disk) appear in the set of curves corresponding to the higher levels, although some features disappear in the set of curves No.3 and more disappear in the set of curves No. 4.

(3) On the other hand, the bright features in both sets of curves No. 1 and No. 2 appear in both sets of curves for higher levels. Besides this, it seems likely that the dark features merge with the bright features at the higher levels.

(4) Resolution of bright features into spicules appears in the sets of curves of higher levels (Nos. 3 & 4), which correspond to a height of about 2,000 km from the photosphere.

4-4 DISCUSSION

Although there are gaps between the sets of curves, each feature can be traced from the lower to the higher levels without difficulty.

With our present equipment set-up, there is difficulty in determining the exact height of the level from which the spicules originate. The result confirms the idea that the spicules do extend into the disk as bright features. From the curves and the prints, the extensions of the dark features from the disk to the limb appear quite obvious.