DEVELOPMENT OF MAGNETIC FIELDS IN ACTIVE REGIONS*

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1. Introduction

The magnetograph of the High Altitude Observatory station at Climax has been used to study changes in the longitudinal component of the magnetic field in a number of active regions. For a description of the instrument see Lee, Rust, and Zirin (1965). By securing simultaneous Hα pictures of the regions we compare the magnetic data with the optical appearance of the plages. From such studies we have selected the results of two active regions to present here.

2. The Observations

The observations were made with a 10″ aperture scanning the active regions to build up a map (magnetogram) of the distribution of the longitudinal component of the magnetic field. Figures 1 and 2 pertain to two different regions, A and B, both observed on 28 February 1967. Figure 1 shows the magnetic field in region A (PA 334, RV 0·75) at 1730 UT and at 2000 UT. There is no great change in the structure of the magnetic field, but the field strength of the Southern bipolar structure (dominated by a bipolar sunspot group) has decreased significantly. For instance, the Southern positive plage area decreased in intensity from a maximum value of about 380 gauss (±15 gauss) to 190 gauss (±11 gauss). To within the accuracy of our measurements, the Northern positive plage area remained unchanged during this same period at 95 gauss (±12 gauss).

Figure 2 shows the development of region B (PA 360, RV 0·60) between 2140 UT and 2304 UT. The main change is an invasion of a positive magnetic field into a previously mainly negative magnetic plage in the Northern part of the observed region. This was not accompanied by any visible change in the Hα plage. The structure of the Southern bipolar area remained in essence unchanged during this time. In addition to the Hα picture we show in Figure 2 an Aerospace white light photograph of region B.

* Presented by J. M. Malville.

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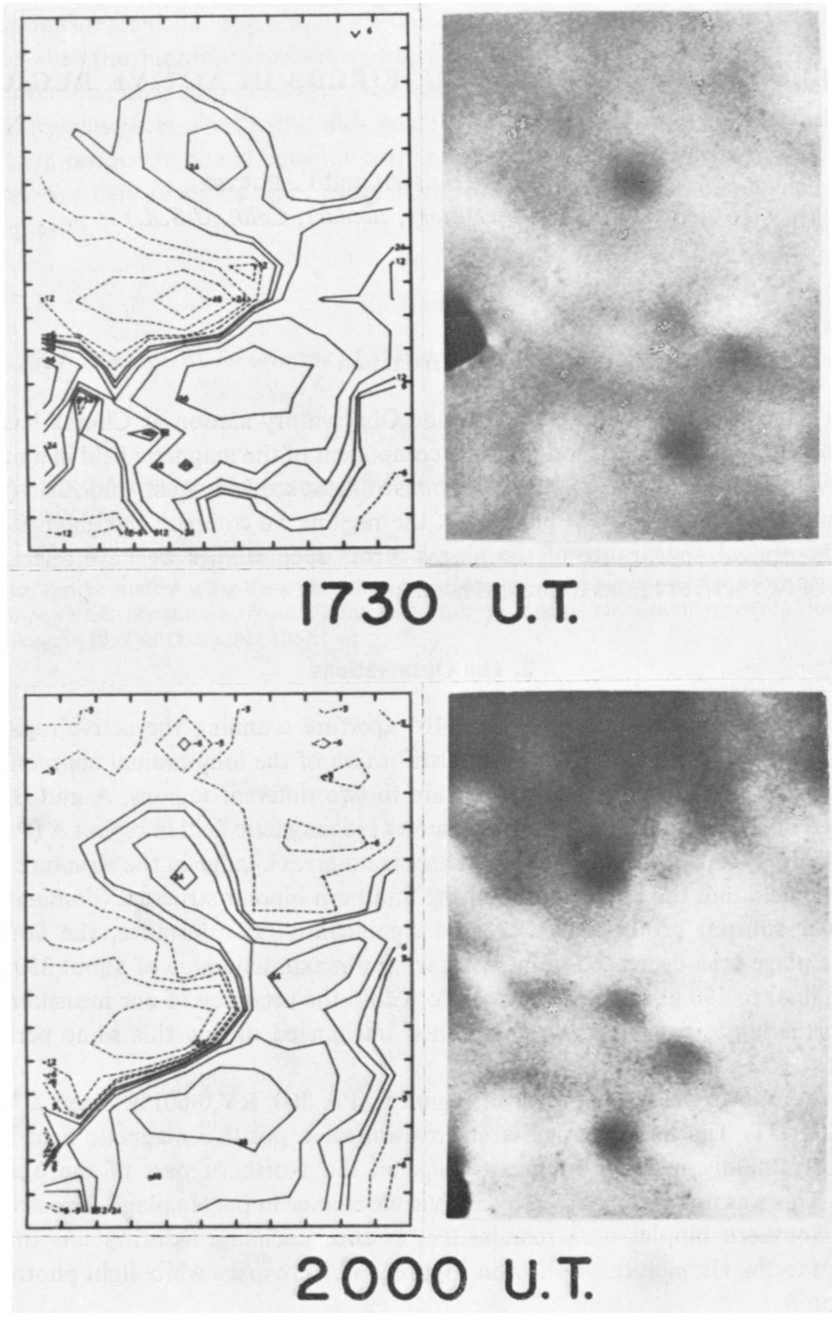

FIG. 1. *Magnetograms (isogauss plots) and Hα filtergrams of active region A (PA 334, RV 0·75) at 1730 UT and at 2000 UT.*

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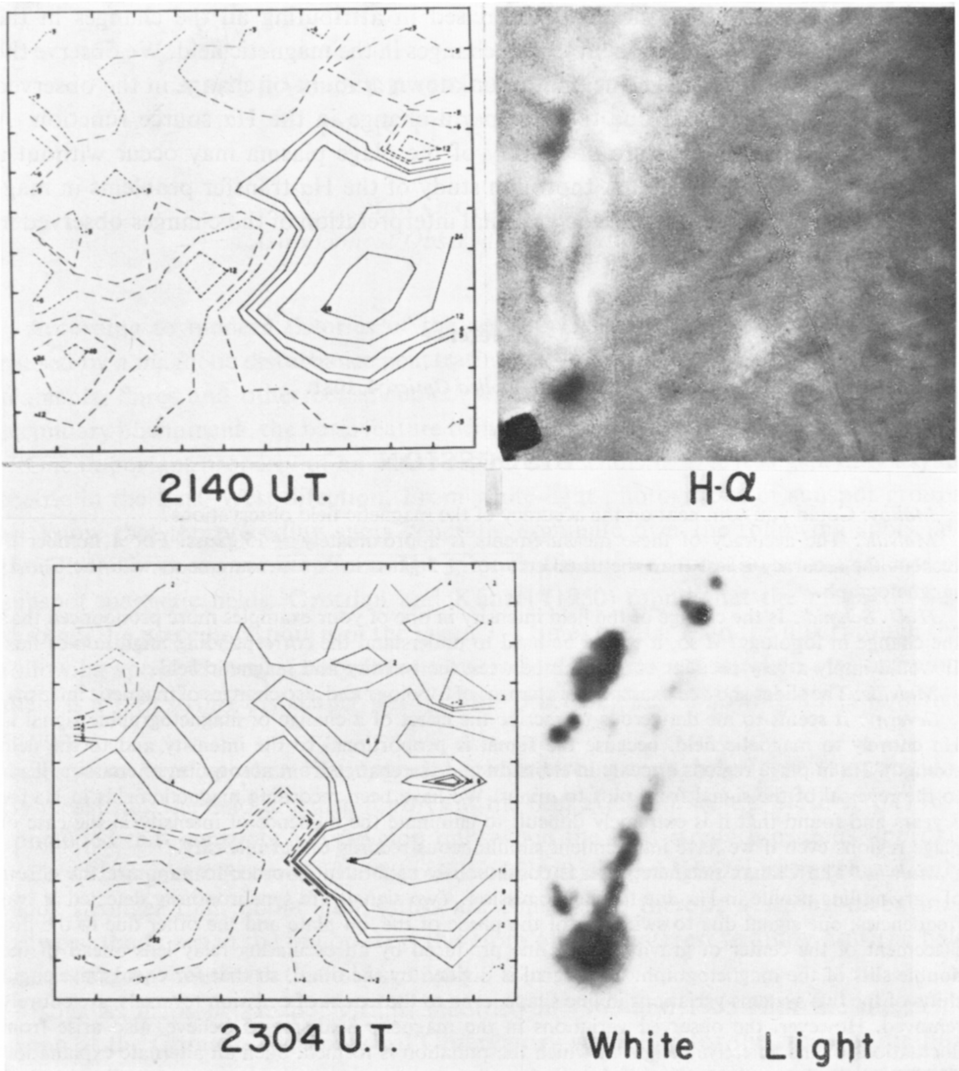

FIG. 2. *Top; magnetogram and Hα filtergram of active region B (PA 360, RV 0·60) at 2140 UT. Bottom: magnetogram at 2304 UT and white-light picture (Aerospace Corporation) of active region B.*

3. Discussion

A straightforward interpretation of the above-mentioned observations indicates that – even in plages dominated by strong sunspot fields – there are at times significant changes in periods of several hours. The changes pertain either to variations in the magnetic-field intensity, or to changes in the distribution of positive and negative fields. However, caution should be exercised in attributing all the changes in the observed longitudinal component to real changes in the magnetic field. We observe the magnetic field using the Hα line and an unknown amount of change in the observed longitudinal field may be due to a temporal change in the Hα source function. A certain change in temperature or density of the plage plasma may occur without a change in the magnetic field. A thorough study of the Hα-transfer problems in magnetic plages must therefore precede any final interpretation of the changes observed in the longitudinal component.

Reference

Lee, R.H., Rust, D.M., Zirin, H. (1965) *Applied Optics*, **4**, 1081.

DISCUSSION

Maltby: Could you comment on the accuracy of the magnetic-field observations?

Malville: The accuracy of these measurements is approximately ± 15 gauss. For a number of reasons the accuracy is less than the usual error of ± 2 gauss in our measurements with the Climax magnetograph.

H. U. Schmidt: Is the change of the field intensity in one of your examples more pronounced than the change in topology? If so, it would be hard to understand the corresponding migration of flux. It would imply a very peculiar correlation between the velocity and magnetic field.

Malville: The slides showed examples of changes of topology and also changes of magnetic intensity.

Severny: It seems to me dangerous to ascribe the effect of a change of magnetographic signal in Hα entirely to magnetic field, because the signal is proportional to the intensity and to the field strength. Hα in plage regions appears in emission and the change from absorption to emission leads to the reversal of the signal from plus to minus. We have been recording magnetic fields in Hα for 3 years and found that it is extremely difficult to eliminate the influence of intensity in the case of plage regions even if we have independent simultaneous records of Hα intensity.

Malville: The Climax magnetograph is continuously calibrated in order to minimize the effects of varying line profile in Hα due to plage emission. Two signals are synchronously detected at two frequencies, one signal due to switching of the phase of the $\lambda/4$ plate and the other due to the displacement of the center of gravity of the line produced by an oscillating relay lens ahead of the double slits of the magnetograph. One signal is divided by the other, so that for equal wavelength shifts of the two systems variations in line shape, even to the extent of emission reversals, are entirely removed. However, the observed variations in the magnetic field, may I believe, also arise from fluctuations of the 'effective' height at which the radiation is formed. Such an alternate explanation for the observed fluctuations cannot be eliminated.

Beckers: To elaborate on a remark made by Drs. Krat and Severny about the interpretation of Hα-magnetograph measurements: With a height reversal of the source function as may occur in plages one has indeed a superposition of a background Hα-absorption line on the plage-emission line. Were only the plage-emission line present one would measure an opposite signal from the case in which only the Hα-absorption line is present under the same magnetic-field conditions. It is therefore very hard to estimate either field sign or magnitude for a mixture of the two, if the field is different in both. This is so even if you make a calibration as done at HAO. The changes in the magnetic field in the paper may be real changes but may also be changes in the Hα optical properties in plages (see *Solar Physics* **3** (1968), Section 6).