SOLAR ACTIVE REGIONS IN MG II LIGHT

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ABSTRACT

During 1965 two rockets were launched in order to obtain monochromatic pictures of the Sun in the Mg II line at 2802·7 Å. The Mg II filterheliograms have been compared with simultaneous Hα and Ca II K spectroheliograms. An important observation from both flights concerns the relative intensities of different active regions. In the Hα pictures there are old fairly faint active regions and newly formed more intense regions. In the Mg II pictures, however, the older regions appear more intense than the younger regions.

Different explanations for this intensity-reversal effect have been considered. The effect has also been looked for in broadband Ca II H filterheliograms, with negative results, however.

1. Introduction

NASA Aerobee rockets were launched on April 12, 1965 and December 2, 1965, which carried instruments designed to obtain monochromatic pictures of the Sun in the singly ionized Magnesium line at 2802·7 Å. The instrument package was prepared at Goddard Space Flight Center and consisted of a Cassegrain-Maksutov telescope, behind which was placed a Šolc-type birefringent filter and an automatic camera. The birefringent filter had a spectral bandpass of 4·0 Å in the first flight and 3·5 Å in the second flight. The instrument was flown with a biaxial solar pointing control permitting a resolution of 1·0 arc-minute in the pictures.

2. Results

Figures 1 and 2 show a comparison between one Mg II picture from each flight and spectroheliograms in Hα and Ca II K obtained from Sacramento Peak Observatory at the same time as the flights. All active regions in the Mg II pictures correspond very well to the plages visible in Hα and Ca II K spectroheliograms. Even the detailed structure shows very good correspondence. A coarse mottling network is visible in the Mg II pictures.

An interesting observation from both flights, pointed out earlier by Fredga (1966), concerns the relative intensities of the different active regions. In the Hα picture taken on April 12, the small plage just coming around the East limb is considerably brighter than the more extended area in the Northern hemisphere. In the Mg II picture of the

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Kiepenheuer (ed.), Structure and Development of Solar Active Regions, 299–303. © *I.A.U.*

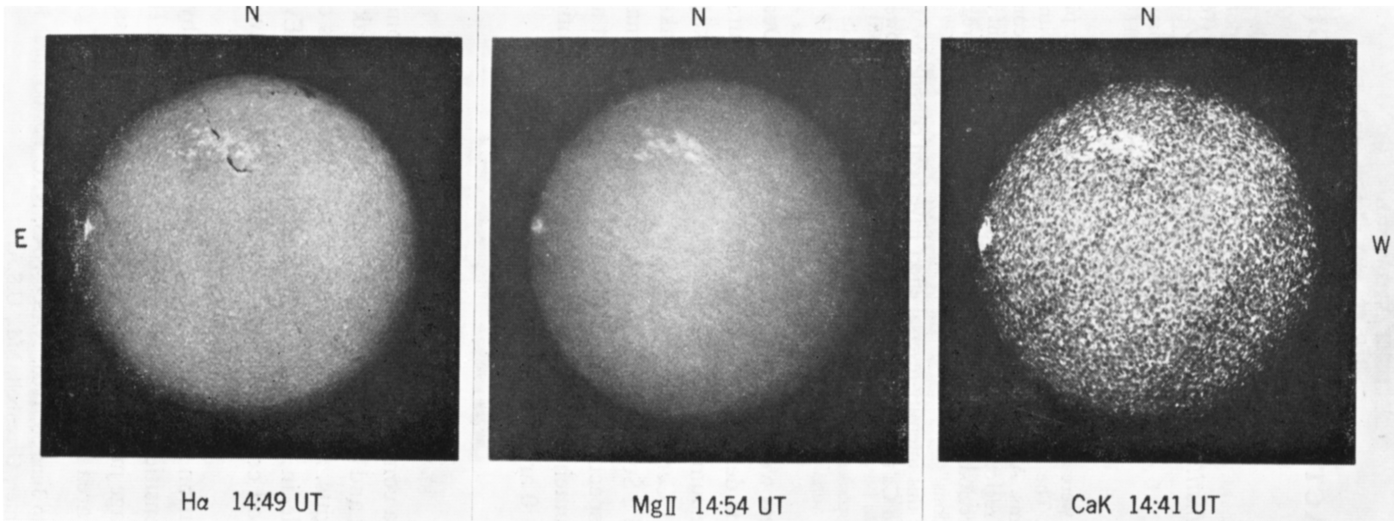

FIG. 1. *Three monochromatic pictures of the Sun obtained on April 12, 1965. (a) Hα filtergram at 14·49 UT, bandwidth 0·5 Å; (b) Mg* II *filtergram at 14·54 UT, bandwidth 4·0 Å; and (c) Ca* II *K spectroheliogram at 14·41 UT, slit width 0·5 Å. (Hα and Ca* II *K pictures by courtesy of Sacramento Peak Observatory, Air Force Cambridge Research Laboratory, New Mexico.)*

https://doi.org/10.1017/S0074180900021690 Published online by Cambridge University Press

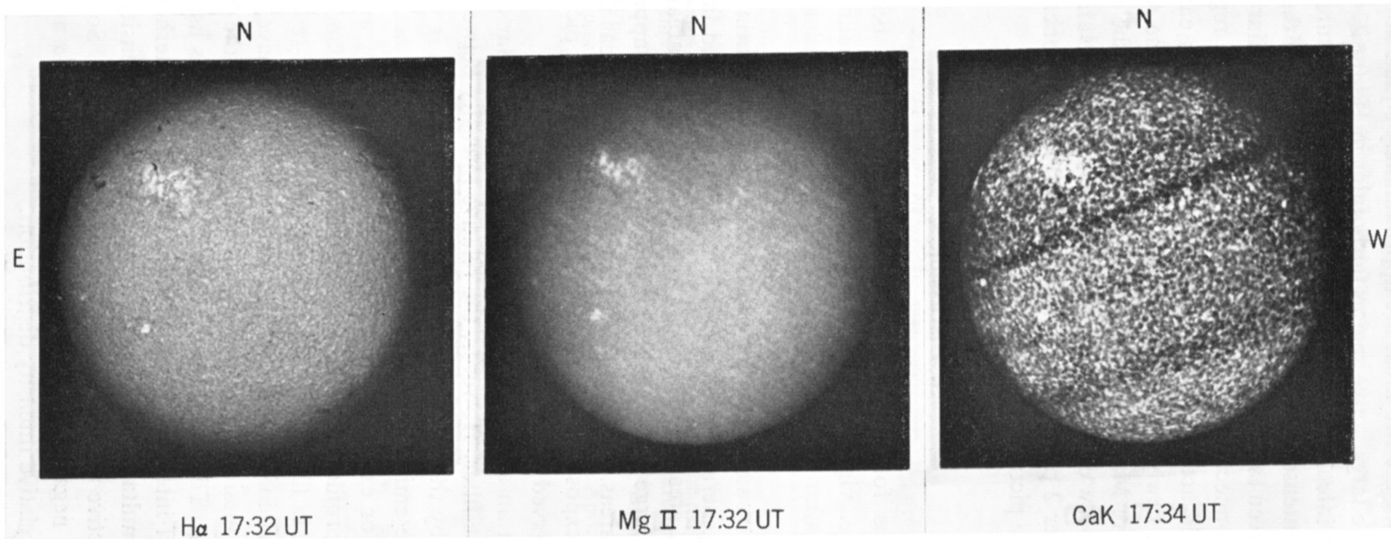

FIG. 2. ***Three monochromatic pictures of the Sun obtained on December 2, 1965.*** *(a) Hα* ***filtergram at 17·32 UT, bandwidth 0·5 Å;*** *(b) Mg* II ***filtergram*** *at 17·32 UT,* ***bandwidth 3·5 Å; and*** *(c) Ca* II *K spectroheliogram at 17·34 UT, slitwidth 0·5 Å. (Hα and Ca* II *K pictures by courtesy of Sacramento Peak Observatory, Air Force Cambridge Research Laboratory, New Mexico.)*

https://doi.org/10.1017/S0074180900021690 Published online by Cambridge University Press

same day the intensities of the two areas are approximately equal. In the December 2 picture, there is also one large active region fairly faint in Hα (at 27 N, 27 E) and a small region of higher intensity (at 18 S, 33 E). In the Mg II picture, however, the larger area is the more intense of the two. The relative intensities of the Ca II K plages fall approximately between those of Hα and Mg II but are more similar to those of Hα.

This effect may be connected with the life history of the active regions. Both the large plage areas are old active regions visible one solar rotation earlier, while the small active regions are newly formed. The larger area shown in the April 12 picture was formed on or before March 11, 1965. The smaller area, at the East limb, was probably formed only a few days before it became visible at the East limb. The larger area shown in December 2 picture was formed on or before October 31, 1965. The smaller area in the same picture was only 3 days old.

3. Discussion

Different explanations for this intensity-reversal effect have been considered. Instrumental effects (i.e. vignetting) have been checked, and calibrations of the instrument before and after the flights show that this cannot explain the observed effect.

There is a considerable smearing in the Mg II pictures due to pointing errors during the exposure time. In general, a smearing will influence small and large areas in a different way; the small areas lose more in contrast than the big areas. In this case, however, the so-called large areas consist of individual parts of approximately the same size as the small areas. The individual parts of the large areas do not overlap each other during the exposure time. The smearing in the Mg II pictures probably cannot explain the observed intensity reversal.

The contrast between an active region and the undisturbed solar disk is affected by the bandwidth of the filter. However, the relative intensity between two regions should not be affected by the spectral bandpass. This conclusion is valid only with the assumption that the emission-line profiles of old and young active regions are approximately equal. For example, if the emission-line profile of an old region is much broader than the profile of a young region, the difference in bandwidth between the Mg II filter and the Hα filter could give the observed intensity-reversal effect.

In order to find what influence the broad bandwidth may have, Ca II H filter-heliograms have been obtained during the summer of 1967 at the Swedish Solar Observatory at Anacapri. The Ca II H birefringent filter which was used has a bandwidth (full width at half intensity) of approximately 2 Å. The filterheliograms have been compared with simultaneous Hα pictures to search for intensity reversals between old and young active regions of the type mentioned above. So far the results of this study have been negative; that is, the active regions in Hα and broad band Ca II H show the same relative intensity distribution.

The intensity reversal has so far only been found in the Mg II pictures. More material is needed for confirmation and interpretation of this effect. A future rocket experiment (hopefully with improved pointing) will take place during the time of maximum solar activity (1968). At this time one can expect to have several active regions on the Sun of different ages and in different stages of development.

Acknowledgements

The author is very much obliged to Goddard Space Flight Center, Greenbelt, Md., and all the individuals there who took part in the rocket experiments. Thanks are also due to the Swedish Solar Observatory at Anacapri.

Reference

Fredga, K. (1966) *Astrophys. J.*, **144**, 854.

DISCUSSION

Sheeley: What about time changes? If the K spectroheliogram and Mg II spectroheliogram were taken at different times perhaps the relative intensities of the two plages had changed in the intervening time? We know of such cases in Hα: Flares, of course, are extreme cases, and we know that the bright network varies in time also.

Fredga: It depends on what time scale you have in mind. For the pictures taken on April 12, 1965 the difference in time between the Hα picture and the Mg II picture was 5 min. The Hα and Mg II pictures from December 2, 1965 were secured within the same minute. No flares were reported.

Kiepenheuer: What was your exposure time?

Fredga: The exposure time was 1/8 sec for the picture taken on April 12, 1965, and 1/9 sec for the picture taken on December 2, 1965.