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IMPROVING THE IMAGE QUALITY AT THE CALCIUM K AND HYDROGEN SPECTROHELIOGRAPHS AT THE KODAIKANAL OBSERVATORY

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1. Introduction

In the Kodaikanal spectroheliograph a 45 cm Foucault siderostat, mechanically driven by gravity, collecting light from the Sun and directing it to a fixed telescope, consists of a 30 cm triplet achromatic lens by Cooke & Sons of 6.1 m focal length. The objective is mounted on a moveable platform to achieve accurate focusing of the image on to the spectroheliograph slit.

The calcium K spectroheliograph being used at Kodaikanal since 1904 was built by the Cambridge Scientific Instrument Company based on G.E.Hale's design in which the image of the Sun and the camera remain stationary, while the collimating lens, camera lens, dispersing elements and slits fixed on a rigid frame moves at right angles to the optical axis. The details of the design were worked out by the company with the help of H.F.Newall. The necessary uniformity and smoothness of motion is attained by mounting the rigid frame of spectroheliograph on three steel balls running on horizontal plane

steel surfaces. The movement is controlled and regulated by attaching a large plunger working in cylinder of oil, with a valve to regulate the flow of oil through a small adjustable aperture. The collimating and camera lenses are of 12.5 cm aperture and 180 cm focus. Two prisms of 10 cm height and 16 cm across disperse the Sun light. The camera slit width allows 1.1 A of spectrum centred around calcium K to fall on the photographic plate. First G.E.Hale pointed out and later Walker (1910) showed mathematically that the spectral lines formed by a plane grating or prism are slightly curved in nature. The original slits had problems of adjustments in width and plane. Therefore, a new camera slit, made in the observatory workshop, was fitted in March 1908 which improved the general quality of the photographs considerably.

The spectroheliograph made in 1907 in the observatory workshop for obtaining photographs of the Sun in Hydrogen-alpha line was put into regular use in the year 1911 after a few modifications. The H-alpha spectroheliograph was mounted on the framework of calcium K spectroheliograph. In the present set up a single meniscus lens by Cooke, of 11 cm aperture and 240 cm focal length, serves as collimator and camera lens. The reflection grating, 10 cm x 12.5 cm in size, with 1200 lines per mm, disperses the light from the Sun. The camera slit selects 0.3 A of the spectrum centred on H-alpha line.

Excellent photographs of the Sun were obtained with both of these spectroheliographs for 70-80 years. The image quality started deteriorating in 1985 and became rather poor in 1986. S.C.Tapde under the instruction from a scientist got the steel plates, on which the rigid frame of spectroheliograph moves,

polished to an high accuracy in October 1986. But the image quality did not improve as is evident from the photograph taken on 1986 Nov. 22.

Careful study and analysis revealed that these spectroheliographs need overhauling. We describe here the work done during 1986 Dec. - 1987 Jan. to improve the image quality at the Kodaikanal spectroheliograph.

2. Present operations

i. Line shifters: The line shifters in front of the second slit of Ca K spectroheliograph and H-alpha spectroheliograph were removed from their housings.

These were found to be full of dust and fungus and were washed with acetone and soap solution. Most of the dust and fungus has been removed. Two small stains of fungus have gone into the glass surface of Ca K line shifter and hence cannot be removed by washing.

ii. Gravity weights: The gravity weights meant to move the spectroheliograph with uniform speed were touching one concrete wall of the housing at a number of points. The varying friction between the wall and weights produced non-uniform motion. The gravity weights were readjusted to ensure uniform motion.

iii.Photographic plate housing: There was a large amount of friction between the faces of the photographic plate housing and the moving part of the spectroheliograph, again causing non-uniformity in motion.

The housing was removed and machined to minimize friction.

iv. Guiding bar: The movement of the spectroheliograph should be along the guiding bar. This however was not the case; in the last one mm of winding, the spectroheliograph moved in a different direction. That is, away from the guiding bar. As a result, on releasing spectroheliograph, a sudden motion and jerk was produced which disturbed the centering of the line and image quality.

A washer was put in the winding unit, removing the defect to a large degree.

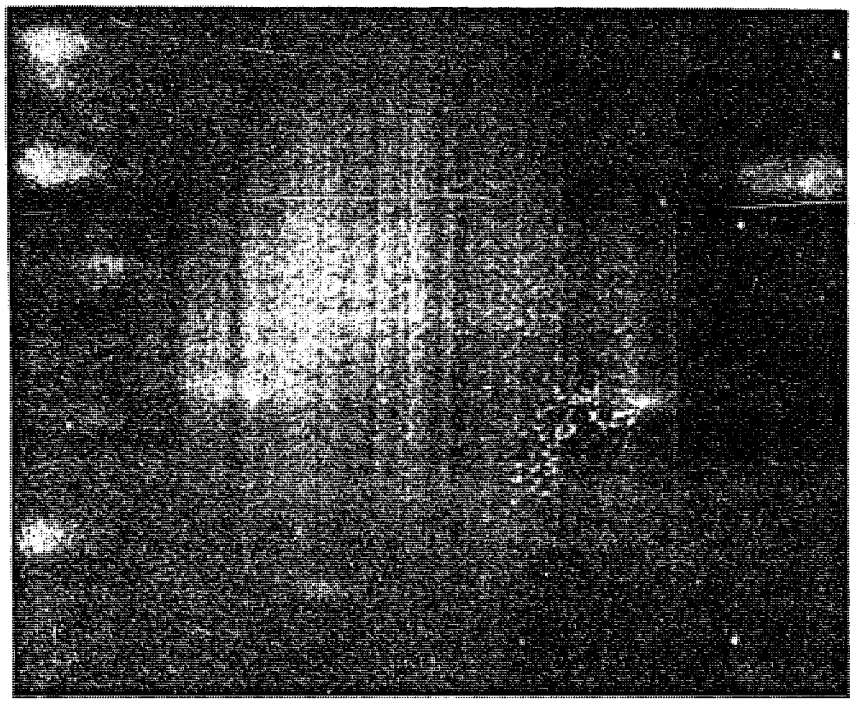
v. Image position: The top 3 mm portion of the (60 mm) image was fainter than the rest because of defects in the top portion of the second slit. Pending replacement of the second slit, the image was lowered to avoid the top portion of the second slit. The image now is more uniform.

vi. Oval image: The rate of the siderostat's gravity clock was not accurately compensating for earth's rotation. This produced an oval image of the Sun.

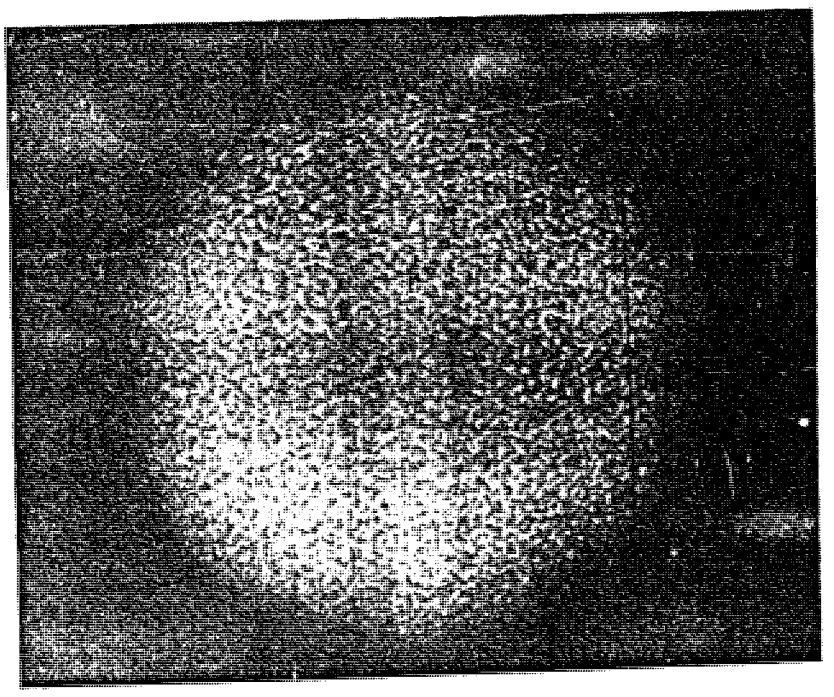
The clock was adjusted to track the Sun accurately, so that a round image could be produced.

3. Result

Figure 1 shows photograph A was taken before the operations on 1986 Nov. 22 & photograph B after the operations, on 1987 Jan. 14. A comparison of the two shows that there is indeed a significant improvement in the image quality.



A Nov. 22, 1986



B Jan. 14, 1987

Fig.1. Spectroheliograms in ionized Ca K line obtained at Kodaikanal

4. Remaining work

The second slit of Ca K spectroheliograph needs to be replaced because of number of scratches on the edges of the slit. The fungus-infested line shifter of Ca K spectroheliograph grating mount and cover for optics of H-alpha spectroheliograph are needed to be replaced.

References

Walker,G.T. 1910, Kodaikanal Obs. Bull., 2, 71.