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Imaging Fabry-Perot observations of green coronal line during the total Solar eclipse of 21 June 2001

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Abstract. A Fabry-Perot interferometric experiment on the Green Coronal line was successfully performed during the total solar eclipse of 21 June 2001 from Lusaka, Zambia. Use of a cooled CCD camera permitted 17 separate exposures during the totality which lasted 194 sec. Green line fringes could be traced up to and beyond 1.5 $R_{\odot}$. Details of the experiment and emerging results are presented.

Keywords : Total Solar Eclipse, Green Coronal line, Fabry-Perot etalon

1. Introduction

Line profile measurements of the Green Coronal Line [Fe XIV] at 5303 Å made simultaneously at many positions in the solar corona with good spatial and temporal resolution can provide important observational constraints for various coronal heating mechanisms. The line profiles can lead to determination of line width temperatures, delineation of velocity fields in the emission corona and can also provide unambiguous evidence of mass flows through fringe splitting. The Fabry-Perot etalon due to its superior light gathering advantage over prism or grating instruments is ideally suited for studying isolated emission lines in extended sources like the solar corona. Our earlier eclipse experiments (Chandrasekhar et al., 1991) had made use of photographic film as the detector which permitted only a few exposures during totality. In this paper we report the use of a 1K x 1K thermoelectrically cooled CCD camera which enabled as many as 17 exposures to be successfully made during totality of the Zambian eclipse of 21 June 2001.

2. Instrumentation

Fig. 1 shows the experimental set-up used at the eclipse site in Lusaka, Zambia (15° 25′ S, 28° 17′ E, 1277 m). The Coelostat deflects sunlight into a 81.3 mm diameter f/15 collector lens which produces a solar image with a diameter of 11.16 mm in its focal plane. A coronal green line filter with a bandwidth (FWHM) of 7 Å is introduced in the f/15 beam covering the

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interferometer box front end and preventing thereby leakage of stray light into the stsyem. A collimator and a zoom camera lens combination reimages the front focal plane onto a 1024 x 1024 pixel CCD array. Pixel size of the CCD is 24 μm which corresponds to 3.4 arcseconds on the sky. The field of view of the CCD on the sky permits coronal coverage all round the eclipsed sun upto 1.8 $R_\odot$ which was considered adequate for imaging the emission line corona. The optically contacted Fabry-Perot etalon used has a working aperture of 40 mm. Its free spectral range at λ 5303 Å is 4.75 Å. The instrumental profile determined using the He-Ne Green laser at λ 5435 Å has a full width (FWHM) of 0.2 Å (Fig. 3). The effective finesse is ~ 24. The etalon was tilted with respect to the optical beam so that fringe centre and solar centre were not coincident but separated by nearly 1 $R_\odot$.

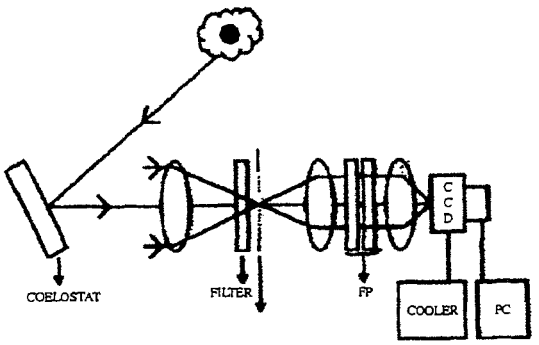

Figure 1. Experimental set up

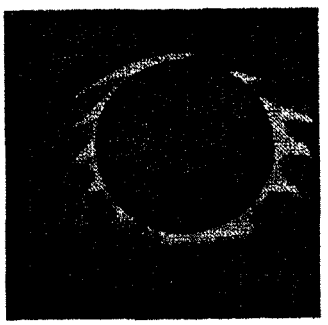

Figure 2. Coronal interferogram (Exposure 3 sec)

3. Observations

The totality with a duration of 194 seconds at Lusaka was observed under extremely clear sky conditions. The exposure sequence of the CCD frames during totality was preprogrammed and carried out in an automatic mode. It was possible to give as many as 17 exposures in both the binned (512 x 512 pixels) and unbinned (1024 x 1024 pixels) modes of operation of the CCD during totality. The time required to read out each frame and write it to disk was 2 sec for binned mode and 5 sec for the unbinned mode. During totality more frames can be accomodated in the binned mode but at the cost of spatial resolution. The actual totality exposures contained a judicious combination of binned and unbinned frames (8 binned and 9 unbinned). The exposures ranged from 2s to 30s. One coronal interferogram recorded with 3 sec exposure is shown in Fig. 2.

4. Analysis

A sample line profile derived at the coronal position 1.062 $R_{\odot}$ and azimuth 129°.2 (NESW) is shown in Fig. 4. The experimental data for this profile is best fit with a Gaussian corresponding to a green line width temperature of 2.5 x 10^6 K convolved with the instrumental profile. Several hundred profiles are expected to be generated for a detailed study of the green line corona in the near future.

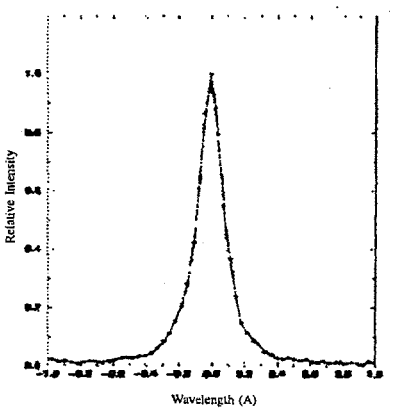

Figure 3. Instrumental Profile

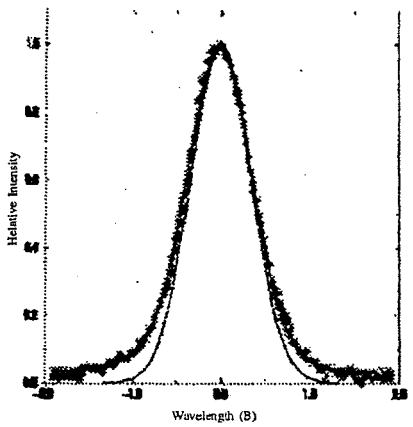

Figure 4. Green line profile.

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References

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