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Report No. IITRI-A6122
(Final Report)

OPTICAL DETERMINATION OF TEMPERATURE VARIATIONS THROUGHOUT THE SOLAR CORONA DURING THE ECLIPSE OF MAY 30, 1965

National Aeronautics and Space Administration
Office of Space Science and Applications
Washington, D.C. 20546

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1 February 1965 through 31 July 1965

Contract No. NASr-65(12)/14-003-912
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Office of Space Science and Applications
Washington, D.C. 20546

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IIT RESEARCH INSTITUTE

FOREWORD

This is Report No. IITRI-A6122 (Final Report) of IIT Research Institute Project A6122, Task Order Contract No. NASr-65(12)/14-003-912, entitled "Optical Determination of Temperature Variations throughout the Solar Corona During the Eclipse of May 30, 1965".

Gordon Henderson of the Optics Research Section designed the apparatus, supervised its construction and carried out the observations on the Island of Manuae. Acknowledgement is extended to Howard T. Betz and Harold F. Bennett of the Optics Research Section and Carl Groom of the Experimental Support Section for invaluable assistance in the design and construction of the system.

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OPTICAL DETERMINATION OF TEMPERATURE VARIATIONS THROUGHOUT THE SOLAR CORONA DURING THE ECLIPSE OF MAY 30, 1965

This is the final report on NASA Contract NASr-65(12)/14-003-912, IITRI Project No. A6122, entitled "Optical Determination of Temperature Variations Throughout the Solar Corona During the Eclipse of May 30, 1965.

The last report on this project covered the period up to the shipment of the completed equipment to Manuae via Los Angeles. Dr. Gordon Henderson departed for Manuae on May 2 and joined the other members of the United States eclipse expedition at Los Angeles. The group then flew to Papeete, Tahiti where the yacht "Goodwill" was waiting to take them on board.

On May 6 the Goodwill departed from Papeete and proceeded to Bellingshausen where she unloaded approximately half of the expedition members with their equipment. The operation of unloading was the same at both Bellingshausen and Manuae and consisted of unloading small amounts of cargo (about 1500 lbs at a time) into a surf boat which then negotiated a 10-foot wide channel in the reef through a low surf. The unloading was effected at Bellingshausen without mishap in two days and the Goodwill then left for Manuae Island, some 200 miles further west. Unloading at Manuae was completed by May 16 and the U.S. party set up camp on a site some four-hundred yards from the shore in an area cleared of undergrowth and cocoanut trees. Originally, an observing site had been set aside next to the

beach but most of the U.S. party decided that there was too much wind there and thus, we set up observing sites beside the accommodation area.

The next thirteen days were spent in setting up camp and equipment, and performing tests to check out the performance of all components. The weather took a turn for the worse after the third day on shore and clouds prevented final checks of the heliostat performance until two days before the eclipse. The check out of the interferometer performance consisted of the following:

(i) Line scans of the λ5461 Hg line obtained from a low pressure rectified mercury lamp.

(ii) A check for drift of the λ5303 filter was obtained on a one-meter spectrograph through the kindness of Dr. G. Nikolski of ISMIRAN, Moscow, a member of the Soviet expedition.

(iii) Finally, several scans of the daylight sky, both before and after the eclipse, showed the scattered λ5302.3 solar absorption line. A typical example of the trace obtained is shown in Figure 1. It is interesting to note that Dr. J. James and Mr. W. Sternberg of Manchester University, England, who were attempting a similar observation using a photographically

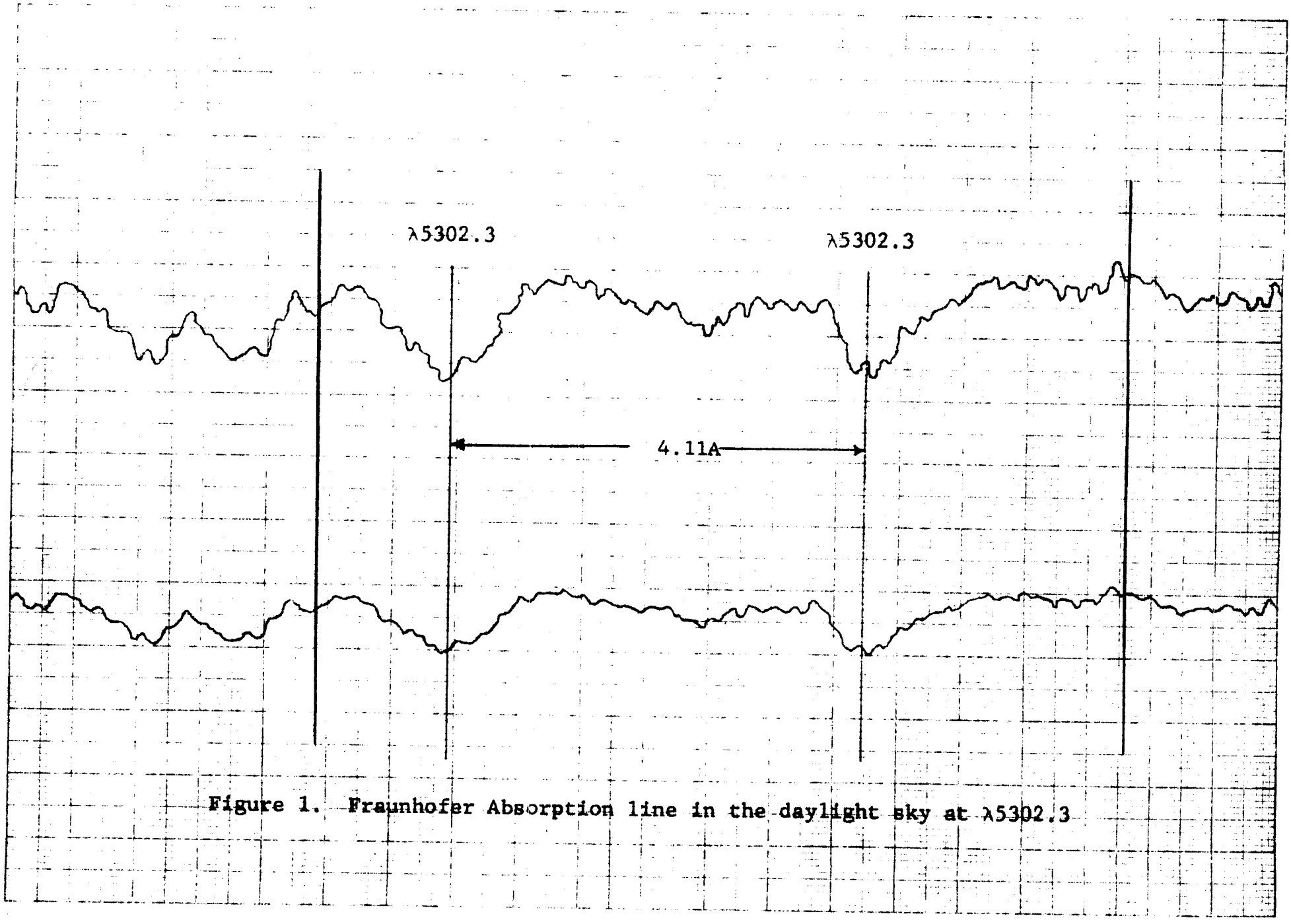

Figure 1. Fraunhofer Absorption line in the daylight sky at λ5302.3

recording Fabry-Perot and a 10-inch Newtonian telescope, remarked that they were unable to observe this line.

The morning of the eclipse day dawned with a very encouraging prospect for good viewing. Approximately two-tenths cloud were present and this coverage continued up to about half an hour before second contact. At that time, moderate cumulus started to come in from the east and, although the solar image was visible right up to second contact, it was apparent that the transmission of the cloud cover was such that coronal measurements would have little chance. Nevertheless, the complete routine of observing was maintained with the hope that occasional gaps in the clouds would occur. In all, measurements were made at eighty different points around the sun, viz: eight position angles 45° apart; at each position angle readings were taken at radii 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 2.0, 2.2, 2.5, 3.0 solar radii from the sun's center.

A preliminary review of the results showed that on about twenty scans, involving about a dozen different viewing regions, a distinct feature appeared near λ5303A. The wavelength calibration is unambiguous since the absorption line which was used for calibration had a wavelength of 5302.3A while the undisplaced Fe XIV emission line was at 5302.86A. Hence, the calibration line and the emission line were each transmitted through the interferometer in the same order of interference. An exam-

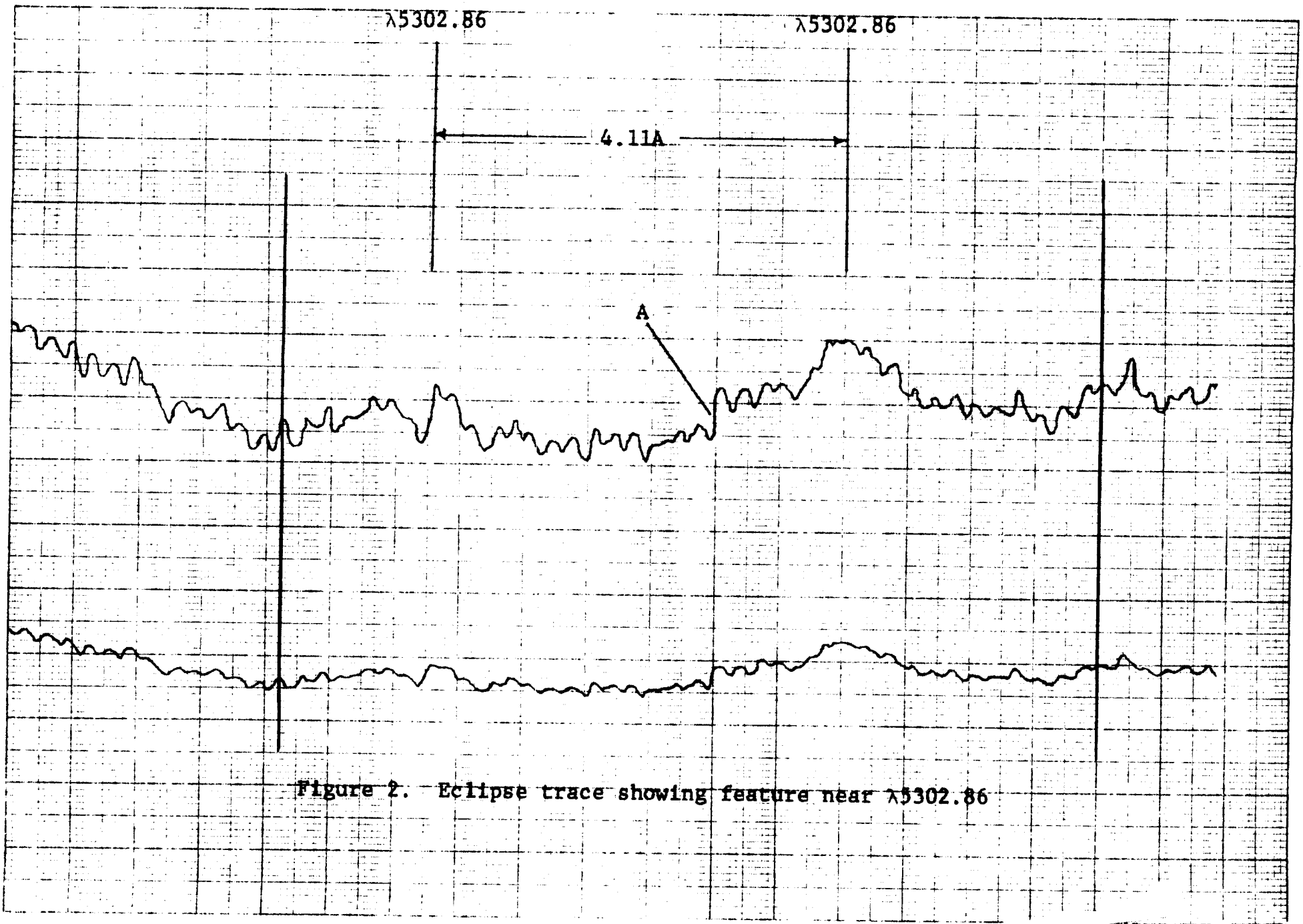

Figure 2. Eclipse trace showing feature near λ5302.86

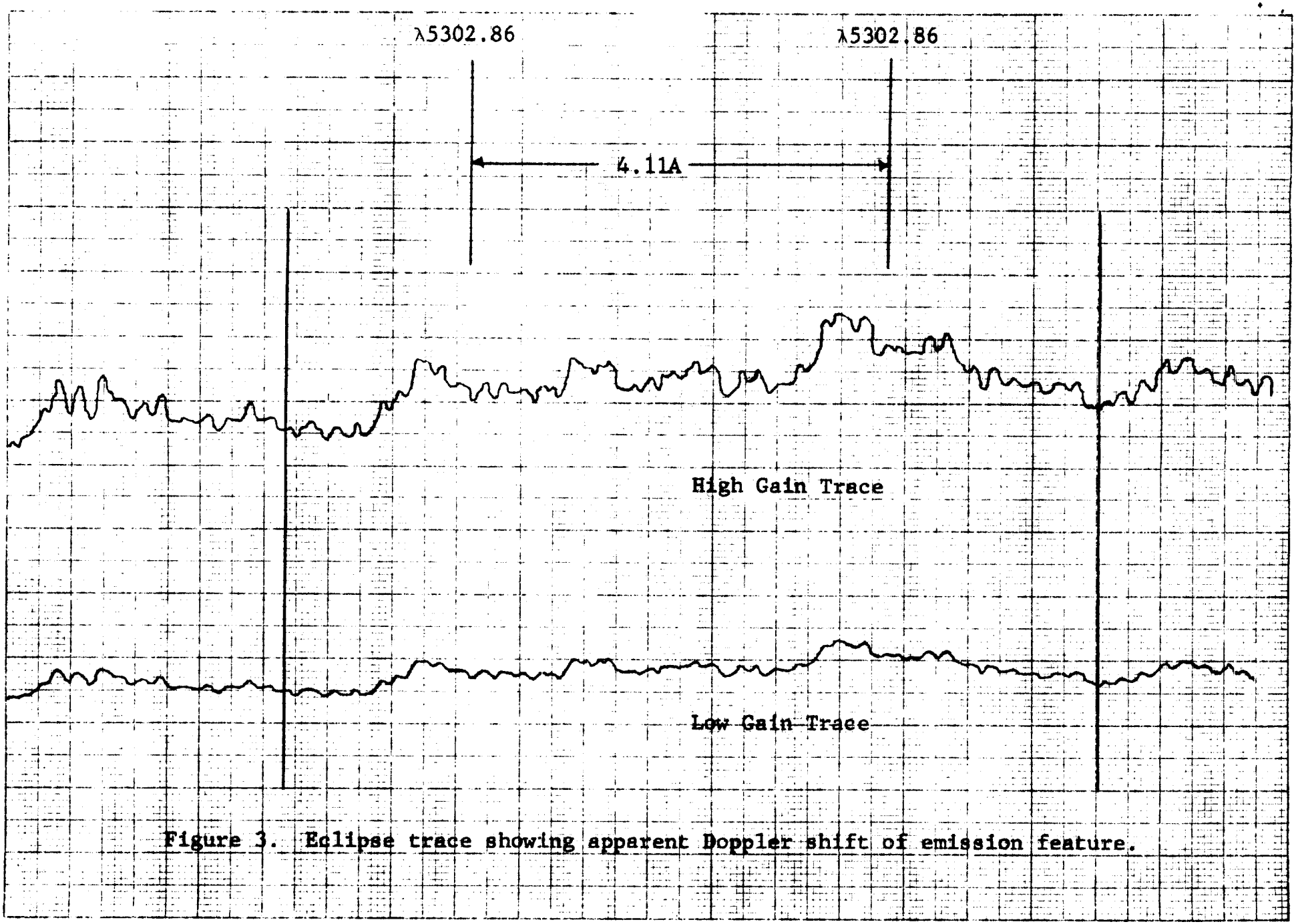

Figure 3. Eclipse trace showing apparent Doppler shift of emission feature.

ple of this apparent emission feature is shown in Figure 2. In this figure the wavelength of interest, λ5302.86, is marked in two adjacent orders. The region viewed is 2.5 solar radii from the center of the sun. The apparent emission feature can only be seen in the right hand order and this could be explained by a change in atmospheric transmission during the scan. This would cause a change in the d.c. level and such a change can be seen at the point marked 'A' in the figure. It should be noted that only the portion of the scan between the red lines should be regarded as significant since this scan is nonlinear outside this region. Since for some of the regions viewed, several scans were obtained due to the time lag in changing the field of view, it will be possible to add three or four scans to improve the signal-to-noise ratio. Figure 3 shows another interesting feature, namely an apparent Doppler displacement corresponding to a velocity of 7 km/sec if the observed feature is indeed due to Fe XIV emission. The region viewed is again at a distance of 2.5 solar radii from the sun's center.

In conclusion, it is felt that the equipment has behaved in a most encouraging manner and if, after some further careful analysis of the results, it transpires that we have, in fact, observed the emission in spite of the cloudy conditions, this would present a strong case for further development of the photoelectric recording Fabry-Perot interferometer for coronal emission line observations. In this respect we are not only considering the eclipse of November 1966, but we also feel that a

coronagraph system suitable for use in balloons or aircraft might be investigated.

We thank you for your interest and support of this work.

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