PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Preliminary Report on the Results Obtained in Novaya Zemlya with the Prismatic Camera during the Eclipse of the Sun, August 9th, 1896

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X. *Preliminary Report on the Results obtained in Novaya Zemlya with the Prismatic Camera during the Eclipse of the Sun, August 9th,* 1896.

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[Plate 9.]

I state in another communication the arrangements made for obtaining results with prismatic cameras in Lapland, and how the attempts failed through bad weather.

After the instruments had been dispatched to Lapland in H.M.S. "Volage," Sir George Baden-Powell, K.C.M.G., M.P., generously, and with admirable public spirit, offered to take an expedition to Novaya Zemlya in his yacht "Otaria," if observers and instruments were forthcoming. Sir George Baden-Powell consulted me on the subject, and ultimately, with the authority of the Vice-President of the Council, Mr. Shackleton, one of the computers employed by the Solar Physics Committee, was detailed to form part of the expedition.

The prismatic camera available was that which had been used in Brazil during the solar eclipse of 1893. The object glass is a Dallmeyer doublet of 19 inches equivalent focal length, with an aperture of 3·25 inches; the image of the inner corona, therefore, is a ring of 0·2 inch diameter. Two prisms of 3 inches clear aperture were used, with their refracting edges perpendicular to the horizontal, each having a refractive angle of 60°, the light being reflected into the apparatus by a siderostat. The length of the spectrum given by this combination was 1·5 inches, from F to K, or 2·3 inches, from D_3 to K.

In 1893, the photographs obtained by this instrument in Brazil were not in focus in the ultra-violet, in consequence of the difficulties of adjustment under eclipse conditions. The precaution was taken, therefore, of making all the necessary adjustments by obtaining some stellar photographs with the instrument before it left England. Ultimately, a photograph of α Lyræ left nothing to be desired, and the then positions of all the parts were carefully marked.

Three specially-constructed dark slides, carrying eight plates each ($4\frac{1}{4} \times 1\frac{5}{8}$ inches), were employed, the change from plate to plate being effected by means of a rack and pinion attached to the dark slides. The plates used were Edwards' isochromatic.

The following table, based on data furnished by the results of the 1893 eclipse,

gives the lengths of exposures and times in totality which I drew up for use at a station on the central line in Novaya Zemlya :—

PROVISIONAL Table of Exposures.

No. of Plate.	Exposures.	Time in totality.	Remarks.
		Slide No. 1.	
1	Instantaneous	−30 seconds	Before totality
2	,,	−20 ,,	
3	,,	−15 ,,	
4	,,	−10 ,,	
5	,,	− 8 ,,	
6	3 seconds	0 ,,	Totality begins
7	10 ,,	5–15 ,,	
8	3 ,,	17–20 ,,	
		Change to Slide No. 2.	Chromosphere goes
9	2 seconds	25–27 seconds	
10	20 ,,	29–49 ,,	
11	40 ,,	51–91 ,,	
12	5 ,,	93–98 ,,	
13	Instantaneous	100 ,,	Chromosphere again visible
14	10 seconds	102–112 ,,	
15	Instantaneous	114 ,,	
16	Waste		
		Slide No. 3.	
17	Instantaneous	119 seconds	A series of snapshots, hoping to include the flash
18	,,	121 ,,	
19	,,	123 ,,	
20	,,	125 ,,	
21	,,	127 ,,	
22	,,	129 ,,	
23	,,	131 ,,	
24	,,	133 ,,	

Unfortunately, however, the expedition found it impossible to reach the central line of totality, and the duration was consequently shortened by 25 seconds. Mr. SHACKLETON, therefore, made the necessary alterations in the exposures, and the following revised table was determined upon.

Column 1 contains the numbers of the photographic plates, which will be quoted in subsequent references ; Column 2 gives the exposures ; Column 3 gives the times of exposing the plates in totality.

The exposures were made by means of a card moved by hand in front of the prisms, and when this was done as quickly as possible the exposures are tabulated as "instantaneous."

Revised Table of Exposures.

No. of Plate.	Exposures.	Time in totality.	Remarks.
		Slide No. 1.	
1	Instantaneous	−30 seconds	
2	,,	−20 ,,	
3	,,	−10 ,,	
4	,,	0 ,,	Totality begins
5	3 seconds	3–6 ,,	
6	10 ,,	8–18 ,,	
7	3 ,,	20–23 ,,	Chromosphere goes
8	2 ,,	25–27 ,,	
		Slide No. 2.	
9	Waste	——	
10	2 seconds	35–37 seconds	
11	40 ,,	39–79 ,,	
12	5 ,,	81–86 ,,	
13	Instantaneous	88–89 ,,	Chromosphere reappears
14	10 seconds	91–101 ,,	
15	Waste		
16	,,		
		Slide No. 3.	Sun reappears
17	Instantaneous	109 seconds	
18	,,	110 ,,	A series of snapshots
19	,,	113 ,,	
20	,,	115 ,,	
21	Waste	..	
22	Instantaneous	117 ,,	
23	,,	119 ,,	
24	,,	121 ,,	

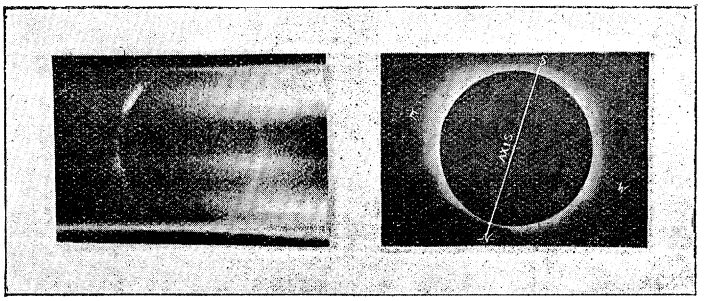
As the final reduction of the photographs will take some considerable time, I think it of importance to give at once, for the benefit of other workers, reproductions of two of the best photographs obtained. These are reproduced in Plate 9.

No. 4 is given in two sections, on a scale of 3·4 times that of the original negative. It was taken instantaneously at the exact beginning of totality. The principal arcs are those of hydrogen and the H and K lines seen in the spectrum of calcium; these long arcs, together with the numerous short ones, represent the spectrum of the sun's limb at the moment of totality, Mr. Shackleton determining the exact instant by watching the disappearance of the bright continuous spectrum with the aid of a small direct-vision slitless spectroscope. This plate may undoubtedly be said to have been exposed within 0·5 second after the commencement of totality; it had an instantaneous exposure, and this was sufficient to give a record of the spectrum from D_3 to H_μ in the ultra-violet.

No. 11 is on a scale of 2·1 times that of the original negative, being exposed for a period of 40 seconds, beginning at 39 seconds from the commencement of totality, so that it records the spectrum near mid-totality. The two overlapping disconnected rings to the left are the images of the prominences round the sun's limb represented in the H and K light, the other discontinuous rings to the right are the images in H_δ, H_γ, and H_β radiations respectively, the ring further to the right, which is of more continuous structure than the others is the 1474 K ring of the corona spectrum.

There are other fainter rings, both of the prominences and the corona, which are well seen on the original negative, but it is too much to hope that these will be seen in the Plate, being lost in the process of reproduction.

Fig 1.



1474 K ring. Corona.

Fig. 1 shows an enlargement of the 1474 K ring compared with an oriented photograph of the lower corona. It will be seen that the prismatic camera has picked out the brightest parts of the corona, and where it is strongest the spectrum ring and the continuous spectrum at those points are most intense, whilst a prominence occurring at any point of the sun's limb does not alter the intensity of the ring at the corresponding part.

The wave-lengths of the lines in Photo No. 11 have been measured by Dr. W. J. S. Lockyer, and a preliminary comparison of the results obtained in 1893 and 1896 has shown many points of difference; it also indicates that the photograph of the flash so happily caught by Mr. Shackleton, and the cusp photograph secured by Mr. Fowler, in 1893, both represent the spectrum of the chromosphere.

Except in the case of the lines visible in the spectrum of hydrogen, and the cleveite gases and the longest lines in the spectra of some of the metallic elements, notably calcium and strontium, there is little or no relation between the intensities of the lines visible in the chromosphere and Fraunhofer spectrum.

There is already evidence that the photographs which we owe to the public spirit of Sir George Baden-Powell and the energy and skill displayed by Mr. Shackleton will considerably widen our knowledge of solar physics and chemistry.

Mr. SHACKLETON'S report on the local arrangements, and the complete discussion of the results of the observations in their relation to solar physics will form the subject of a subsequent communication. The investigation of the chemical origins of the various lines will occupy some time, and it seems desirable that the results of 1893 and 1896 should be studied together. These will also be communicated at some future date.

The enlarged photographs from which the accompanying plate has been prepared, and those on which the wave-lengths have been measured, have been prepared by Corporal HASLAM, R.E.

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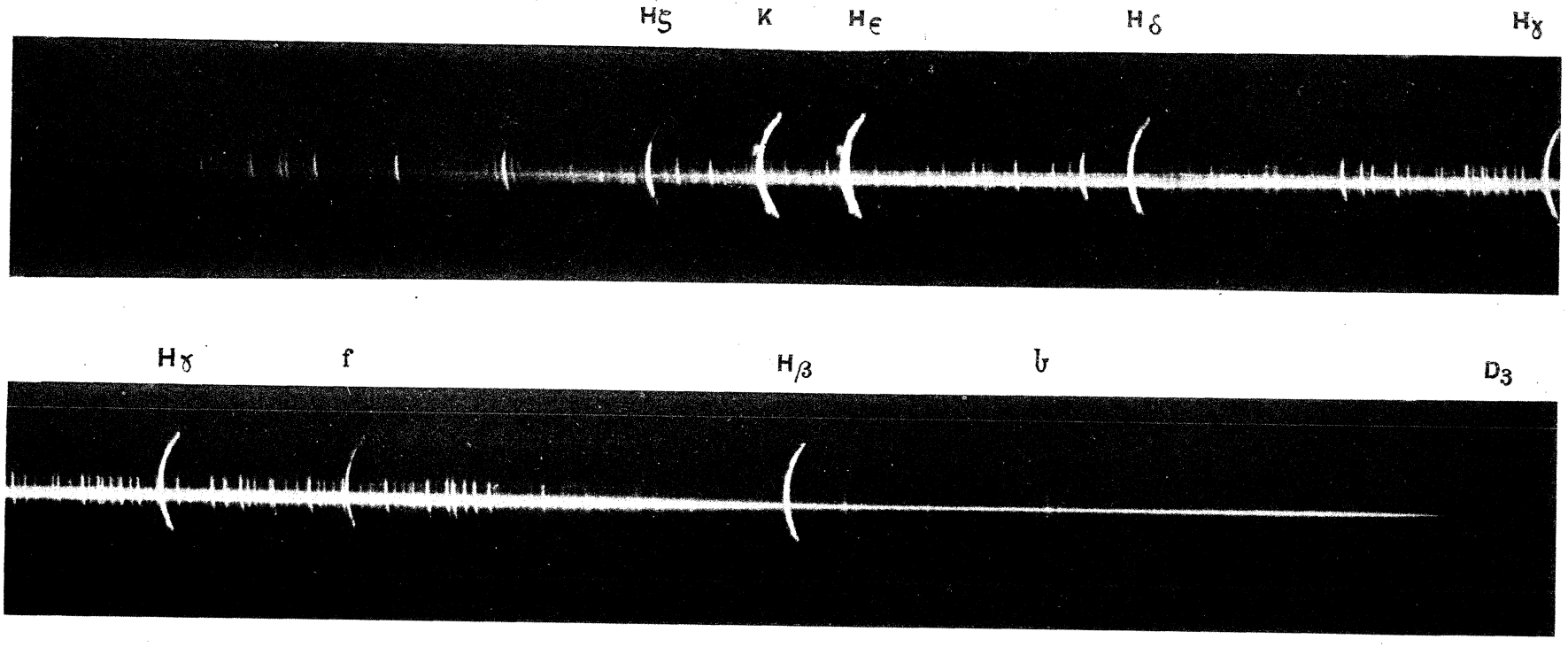
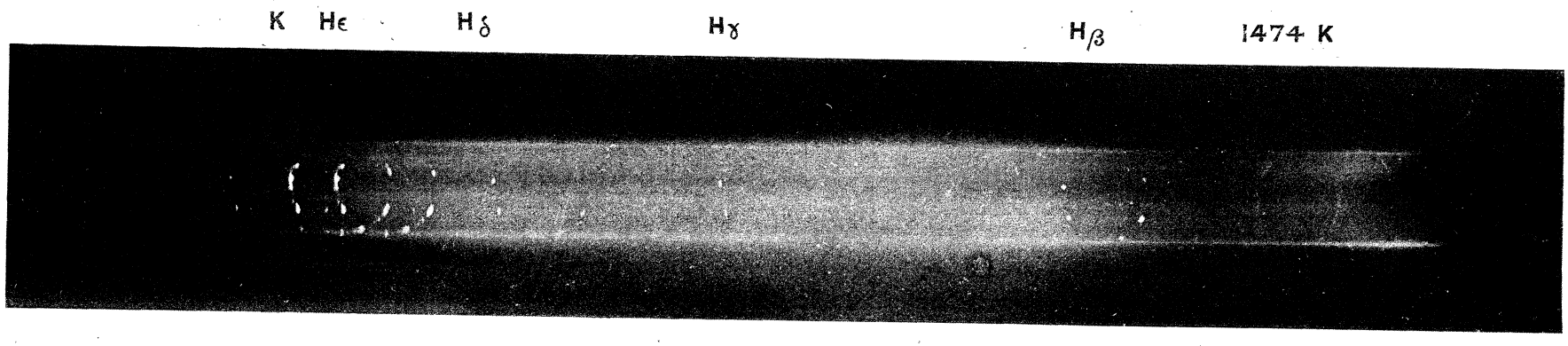
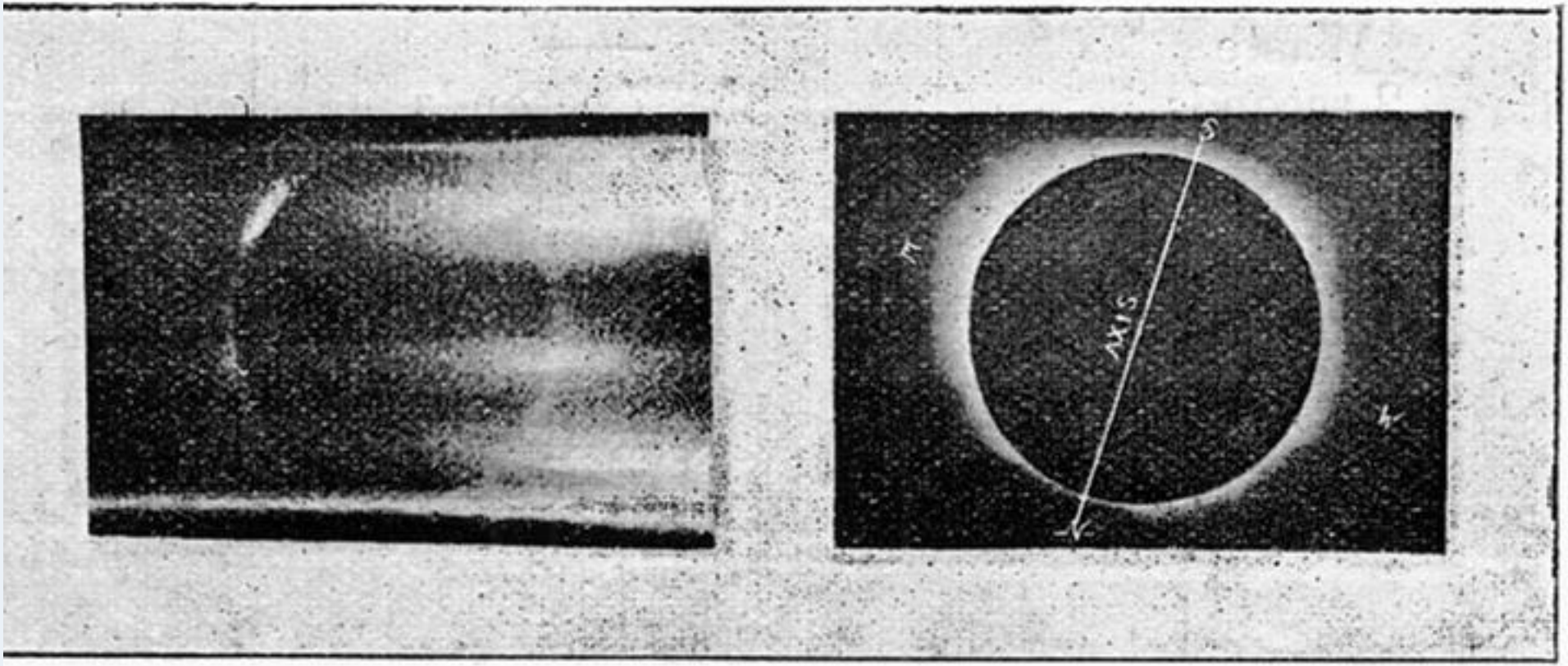


REPRODUCTION OF PHOTO. 4 IN TWO PORTIONS SHEWING ARCS

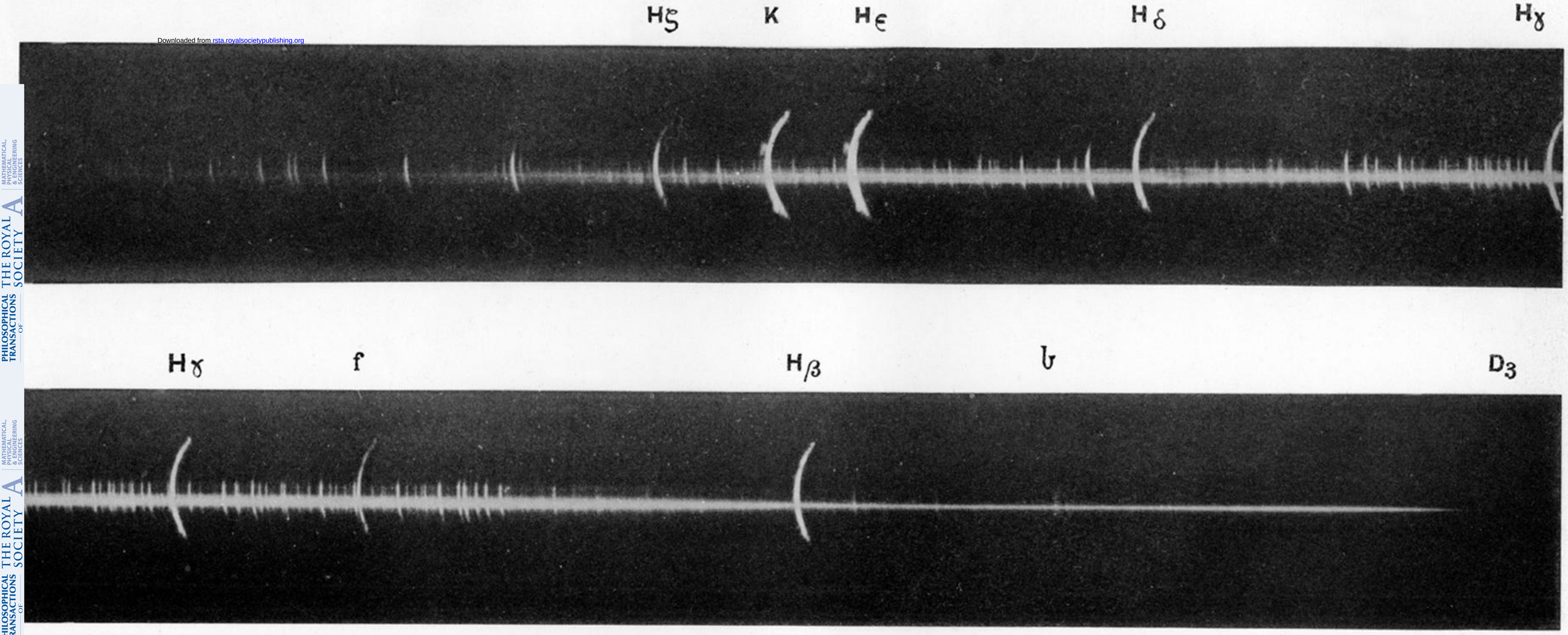


REPRODUCTION OF PHOTO. 11 SHEWING CORONAL RING IN 1474 LIGHT.

Fig 1.



1474 K ring. Corona.



REPRODUCTION OF PHOTO. 4 IN TWO PORTIONS SHEWING ARCS

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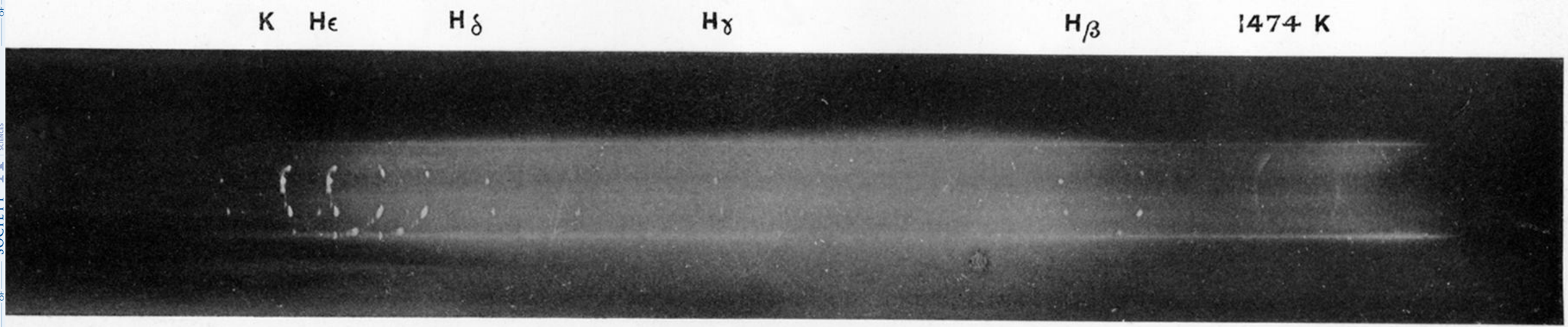

REPRODUCTION OF PHOTO. 11 SHEWING CORONAL RING IN 1474 LIGHT.