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A brief report on the observations recorded during the Solar Eclipse of 30 June 1954 at Phalodi in Rajasthan

1. Introduction

The expedition organized by the India Meteorological Department to observe the Solar Eclipse of 30 June 1954 at Phalodi consisted of observing personnel from (*i*) Solar Physics Observatory, Kodaikanal, (*ii*) Meteorological Office, Poona, (*iii*) Magnetic Observatory, Alibag (Bombay) and (*iv*) Meteorological Office, New Delhi. Shri Raj Bahadur, Deputy Minister, Ministry of Communications of the Government of India, Shri Jainarain Vyas, Chief Minister of Rajasthan and Shri S. Basu, Director General of Observatories, were also present at the camp at Phalodi on 30 June 1954 to observe the eclipse. The expedition assembled at Phalodi which is about 70 miles northwest of Jodhpur, a few days before the eclipse, each group having equipped itself with the necessary observational equipment. The observations, which commenced some days before the eclipse, were taken at more frequent intervals during the eclipse and continued for a few days after. Table 1 on next page shows the programme of observations as planned for the eclipse.

The circumstances of the eclipse at Phalodi (Lat. 27°08′N, Long. 72°22′E) were computed as follows—

	h	*m*	*s*	
Beginning of eclipse	18	32	9·4	(IST)
Beginning of total eclipse	19	25	49·7	(IST)
End of total eclipse	19	26	58·3	(IST)
End of eclipse	(after sunset)			

The duration of totality which was computed as 68·6 seconds, was found to be correct within a fraction of second on observation.

Some pictures (Figs. 1 to 5) of the expedition will be found on pp. 221—224.

A summary of the observations collected by the different groups of the expedition is presented below for general information. The summary is divided into five parts as follows—

(*a*) *Weather observations*

(*b*) *Optical observations of the sun*

(*c*) *Radio noise and ionospheric observations*

(*d*) *Magnetic observations*

(*e*) *Atmospheric potential gradient and conductivity*

More detailed reports giving the actual records and data arising from these observations will be published in the form of papers.

2. Weather conditions

29 June 1954, the day previous to the solar eclipse, began with skies overcast with *Sc*, *As* and *Ac* clouds which continued till the forenoon, the clouds changing thereafter to *Cu*, *Cb* and *As*. Dust devils were seen at 1450 IST and intermittent peals of thunder were heard from 1535 to 1705 IST. The temperature registered 107°F between 1515 and 1540 IST. The wind was southwesterly to northwesterly up to 1700 IST and then changed to northeasterly to southeasterly. Later in the evening a thunderstorm occurred at 1905 IST with showers at 2025 IST and slight to moderate continuous rain till 0500 IST on the morning of 30 June 1954, the day of the eclipse. The thunderstorm caused a

TABLE 1

Programme of Observations

Element	Period and intensity of observations
1. *Astronomical*	
Photograph of Solar Corona	The photographs to be taken during the eclipse
2. *Magnetic Observations*	
(*a*) Quick run and normal speed registration of horizontal force of the earth's magnetic field	Observations to be taken between 22-6-54 and 1-7-54 including control observations before and after the eclipse day
(*b*) Continuous photographic registration of the horizontal and vertical components of the earth's magnetic field	18 June to 7 July 1954 including control observations before and after the eclipse day
(*c*) Determination of the abso'ute values of the horizontal and vertical components of the earth's magnetic field to provide check readings for the records obtained from the Eschenhagen Instrument	18 June to 7 July 1954 including control observations before and after the eclipse day
3. *Ionospheric Observations*	
Continuous recording of short wave signal strength; field intensity observations in one or two wave lengths	22 June to 1 July 1954 including control observations before and after the eclipse day
4. *Atmospheric Electricity*	
Measurement of potential gradient and conductivity in the upper atmosphere as well as on the ground by making balloon ascents carrying the necessary equipment	27 June to 1 July 1954 including control observations. A number of ascents per day planned
5. *Meteorological*	
Continuous recording of temperature and humidity on ground level	28 June to 1 July 1954

fall in temperature of about 12°F between 2035 and 2130 IST. The total rainfall was 1·23″ which cleared the atmosphere of its dust.

The low clouds decreased after the thunderstorm of the previous night and by 0900 IST on 30 June only 7 oktas of high and medium clouds remained. The surface winds were gusty from south to southwest throughout the day and reached a speed of 14 knots in the afternoon after which the speed decreased to 6-8 knots. Visibility was good in the morning and deteriorated to some extent by the evening due to dust raised by the wind. A further decrease of the clouds followed and by 1400 IST the sky was clear. In the meantime, however, some *Cu* and *Sc* clouds began to appear and increased to 2-3 oktas by the evening and remained so till sunset. Although there were clouds in the neighbourhood of the sun in the horizon at the time of the eclipse, the sun was not actually covered by them. The maximum temperature recorded during 24 hrs at 0830 IST on 1 July 1954 was 100°F and the minimum was 83°F.

3. Optical and instrumental observations

(1) *Optical observations*—Due to poor sky conditions anticipated at the time of total

eclipse, no elaborate optical observations were attempted. Only a 6-ft camera and a coelostat were installed on the terrace of the P. W. D. Rest House at Phalodi for photographing the progress of the eclipse corona for the study of the distribution of intensity and polarization at various distances from the solar disc. From regular observations of the sun from 23 June made daily before sunset near which the totality was to take place, it became apparent that with the large amount of dust and haze prevailing at that hour, the corona would not be visible nor could be photographed. This proved to be the case on the eclipse day in spite of the slight improvement in the sky conditions due to heavy rain the previous night.

4. Radio noise and ionospheric observations

(*i*) *Radio noise*—It is well known that in India the seasonal atmospheric noise level is dominated by local conditions, the pre-monsoon and monsoon period from May to August giving rise to an exceptionally high atmospheric noise level. However, atmospheric noise measurements were carried out for 4 days—28, 29, 30 June and 1 July at Phalodi on the wave-bands from 540 Kc/s to 29·5 Mc/s. Noise received on an inverted L-type antenna suitably oriented to pick up noise from northwest (and southeast) was observed using a Hammerlund SP-600 receiver by reading the noise levels visually on a meter. The noise data so collected have been analysed and it is found that the received noise level was dominated by the intensity of nearby thunderstorms, no reduction being observed due to the eclipse.

(*ii*) *Ionospheric observations*—Continuous registration of the signal strength of B.B.C. station GWC, 15070 Kc/s were made from 0930 to 1815 U.T. every day from 23 June to 1 July 1954. This particular choice of the transmitter was especially suitable since the control point 2000 km from the transmitting end along the great circle path was on the central line of totality at 300 km in the ionosphere. A comparison of eclipse day records with those of the control days indicated the following eclipse effects—

The signal strength was normal until 1115 U.T. when a decrease began. A minimum strength of $25\mu v$ (at Rec. input) was reached half an hour later as against a normal value of about $150\mu v$. This was followed by a recovery and the normal was attained at 1220 U.T. The most pronounced effects were observed at 1315 hrs when a gradual decrease commenced. Between 1415 and 1530 hrs the received field strength remained extremely low 50-$70\mu v$ (input at the receiver terminals) as compared to a mean control day value of about $250\mu v$. The recovery was comparatively gradual and was complete at about 1700 hrs.

An intermediate sharp decrease followed by quick recovery centred at 1248 hrs was also observed. This effect lasted only 25 minutes.

A discussion of observed variations and conclusions drawn are given below—

(*i*) The largest eclipse effect on the signal strength which was also of considerable duration was the one which began at 1315 hrs. Since the precise time of totality at the control point at 300 km obtained from the data published by the Naval Observatory, Washington was 1313 hrs this effect can be considered as due to the ultraviolet light eclipse. The simultaneous occurrence of the ionospheric effect and of total eclipse is in agreement with the observations of other workers.

(*ii*) The effect observed at 1115 hrs was somewhat less pronounced than the optical effect but was very much more significant since it preceded the optical effect by an interval of exactly 2 hours. The effect may be ascribed to eclipse of the corpuscular radiation from the sun. Such effects have been observed before and are of great significance, because if these are established, they provide a direct method of finding the velocity of the solar corpuscular radiation. Observations at Phalodi indicate that a corpuscular eclipse effect was definitely present in so far as the region of point of first reflection in the ionosphere—in this case at fairly high latitude of $49°·8$—is concerned. The time interval of

2 hours by which the corpuscular eclipse preceded the optical eclipse indicates a velocity of particles of the order of 1600 km/sec.

5. Magnetic observations

The following instruments were used for taking magnetic observations:

(1) Askania visual recording magnetograph
(2) Eschenhagen H. F. variometer
(3) Eschenhagen V. F. variometer
(4) The Quartz Horizontal Magentometer (QHM)
(5) The Magnetic Zero Balance (BMZ)

The observations with Askania visual magnetograph were taken from 22 June to 1 July. An inspection of the records did not bring out any eclipse effects in the current sheets in the upper atmosphere. The variometers were provided with suitable photographic recording drums for obtaining continuous photographic records of H.F. and V.F. The recording speed was 15 mm per hour. These recorders were not provided with automatic time marking arrangement, but the time marks were given by cutting of light manually at definite timings. The sensitivity of the instruments were as follows—

Variometers	*Sensitivity*
Horizontal intensity	$34{\cdot}2\ \gamma\ cm^{-1}$
Vertical intensity	$56{\cdot}5\ \gamma\ cm^{-1}$

The variometers were installed in two $8' \times 8'$ size rooms on the ground floor of the P. W. D. Rest House. The temperature in these rooms was almost constant, at about 99°F, quite free from diurnal variations. The temperature variation for the full period of observations was of the order of 3°F. The observations with QHM and BMZ instruments were taken in two double roofed tents in the open compound of the Darbar High School, about 300 yards from the variometer rooms in the P. W. D. Rest House.

After preliminary setting of the instruments the following regular observations were taken from 22 June to 8 July 1954.

(1) Continuous photographic recordings of H.F. and V.F. with Eschenhagen variometers

(2) Absolute observations of H.F. with QHM and V.F. with BMZ instruments

The absolute observations of *H* and *V* with QHM and BMZ instruments which were to give the baseline values for the continuous photographic records were taken as per schedule given below—

22-6-54 to 26-6-54	4 observations per day (every six hours)
27-6-54 to 28-6-54	12 observations (every two hours)
29-6-54 to 30-6-54	24 observations (every hour)
30-6-54 (0000 GMT) to 1-7-54 (0000 GMT)	48 observations (every half hour)
1-7-54 to 2-7-54	24 observations (every hour)
3-7-54 to 4-7-54	12 observations (every two hours)
5-7-54 to 8-7-54	4 observations per day (every six hours)

The values of horizontal force as observed with QHM instrument have been plotted on the daily records of the horizontal force variometer in order to see how the results of eye observations tally with the continuous records. These appear to agree fairly well. The beam observations could not yield absolute values of vertical force since this magnetic field could not compensate the greater part of the component of the geomagnetic field at Phalodi.

The mean hourly values of the horizontal force and vertical force have been tabulated

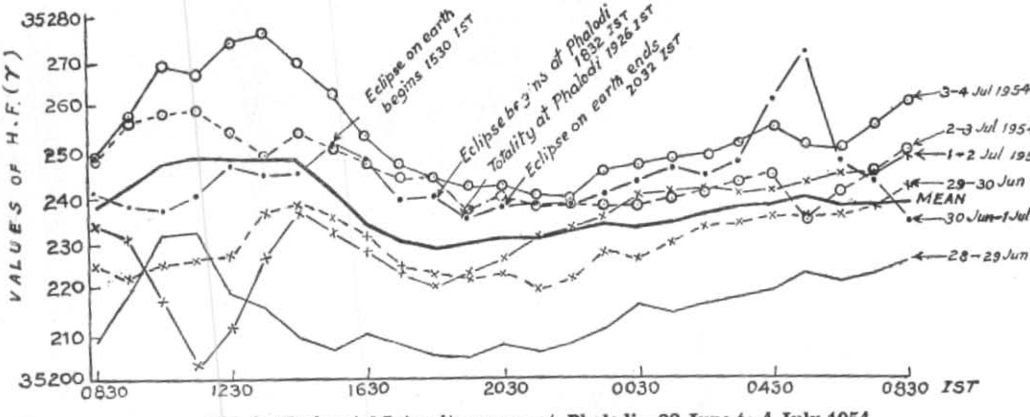

Fig. 6. Horizontal Intensity curves at Phalodi—28 June to 4 July 1954

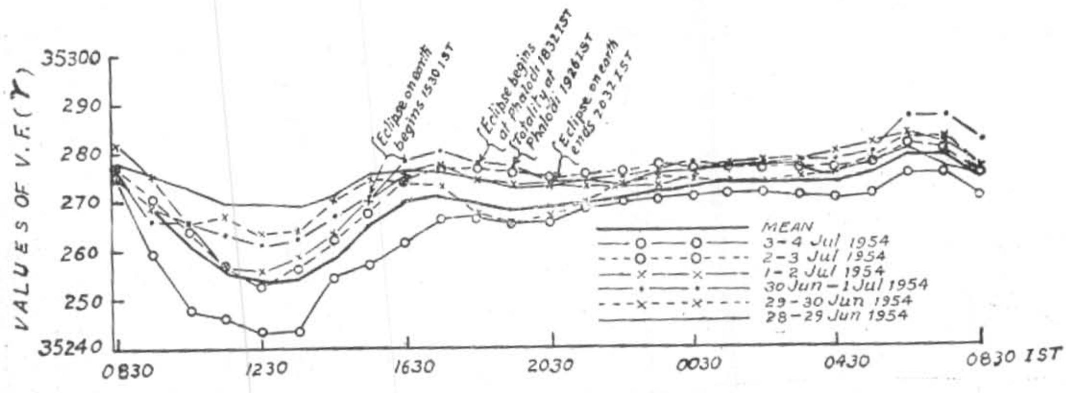

Fig. 7. Vertical Intensity curves at Phalodi—28 June to 4 July 1954

for 6 days from 28 June to 3 July. The average of the mean hourly values for the period 22 June to 8 July (excluding 30 June 1954, the day of the eclipse) have also been determined. These are shown in Figs. 6 and 7. The general diurnal variation of the horizontal and vertical forces are represented by the mean curve in these figures. The maximum appears between 1000 and 1300 IST and the minimum about 1830 IST. Throughout the period of observations the maximum characteristics have not been disturbed much except on 1 July 1954 when a hump in H.F. can be noticed from 0330 to 0630 IST with a maximum positive displacement of 30 γ during the period 0330 to 0520 IST. This is followed by a negative displacement of about 75γ from 0500 to 1130 IST and then another positive displacement of 35γ from 1130 to 1430 IST.

There is a tendency for a steady fall in the value of H.F. from about 1400 to 1900 IST every day. On the day of the eclipse an increase of 7γ has been recorded between 1430 and 1530 IST just before the solar eclipse began on earth (1530 IST). The magnetograph records show small pulsations or waves from 1620 to 2000 IST. Value of H.F. fell by 12γ during the period 1530 to 1830 IST. There was a further fall of 5γ between 1830 and 1903 IST. There are three possibilities—

(1) a small magnetic disturbance started at about 1700 IST corresponding to the increase of the H.F.

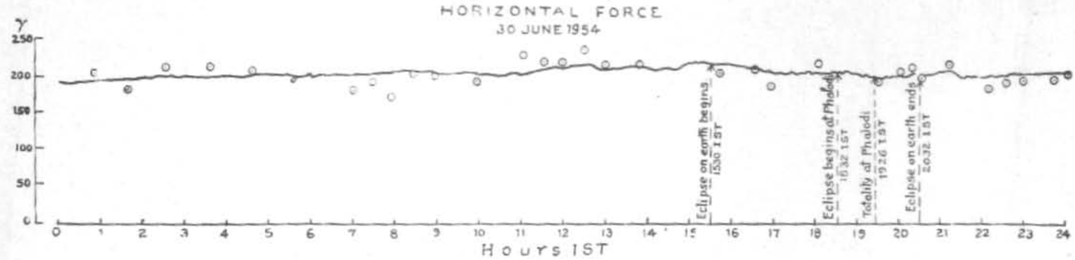

Fig. 8

and that the fall after 1530 IST corresponded to the negative phase of the magnetic storm,

(2) the fall after 1530 IST may be unconnected with any major disturbances and may be mostly local in character, or

(3) the variations may be connected with the solar eclipse.

A comparison of the records of fluctuations observed between 1530 and 2000 IST with similar records of other magnetic stations on the earth would show whether these fluctuations are associated with the solar eclipse.

The H.F. record of 30 June 1954 taken at Phalodi is reproduced in Fig. 8.

6. Atmospheric electric potential gradient and conductivity

Continuous records of potential gradient were obtained on the ground with a Cambridge Electrograph consisting of a quadrant electrometer arranged for photographic recording. An ionium collector was mounted about 3 metres above the ground and 170 cm from the wall. Open air observations were made before and after the eclipse for determining factors necessary for reducing recorded potentials to volts per metre in the open. For these observations the stretched wire method described by Simpson and Wright[1] was employed. These observations were made over a level play ground at a distance of nearly 150 yards from the school in which the ionium collector and recorder were installed.

The electric potential gradient in the upper air was measured by dipping the valve electrometer of Koenigsfeld[2] for use with audio frequency modulated American type radiosonde, with some modifications as described elsewhere in detail by Venkiteshwaran[3].

Measurement of the conductivity of the air near the ground, both for positive and negative ions, were made at frequent intervals with Gerdien apparatus fitted with Wulf electrometer. These observations were taken from 27 June to 2 July 1954. Measurements of conductivity in upper air were made by radiosonde using the technique described by Venkiteshwaran. The data will be discussed separately.

(1) *Proc. R. Soc.* A, **85**, p. 182 (1921); (2) Thunderstorm Electricity by Horace R. Byers, p. 42 (1953); (3) *Proc. Indian Acad. Sci.*, **37**, p. 260, **38**, p. 109 (1953); *Indian J. Met. Geophys.*, **5**, 3, p. 253 (1954)

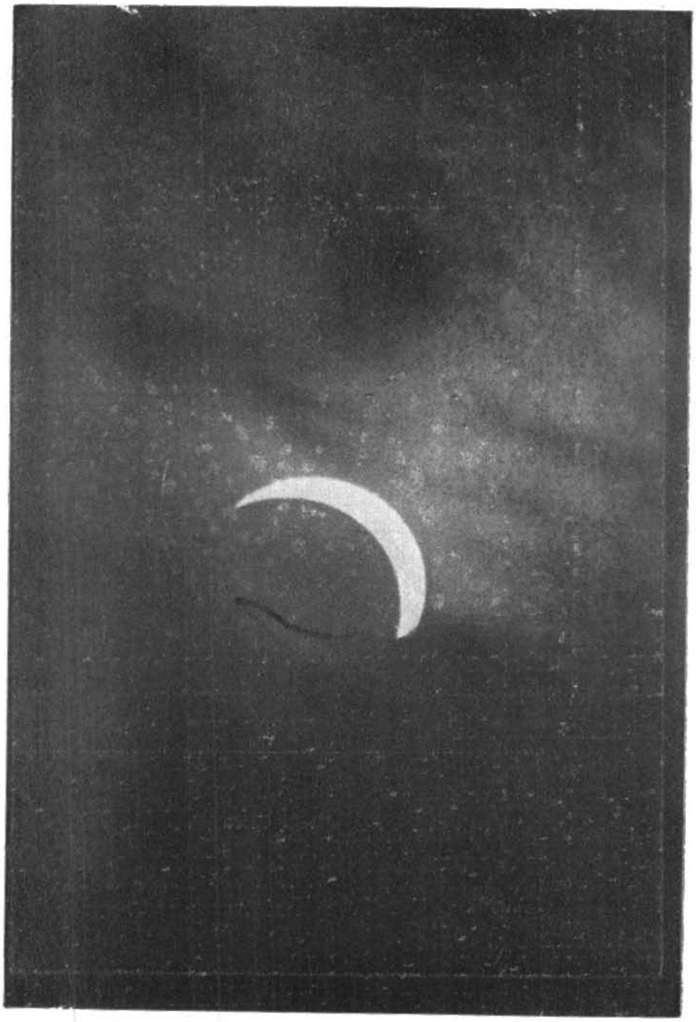

Fig. 1. Phase of partial eclipse before totality

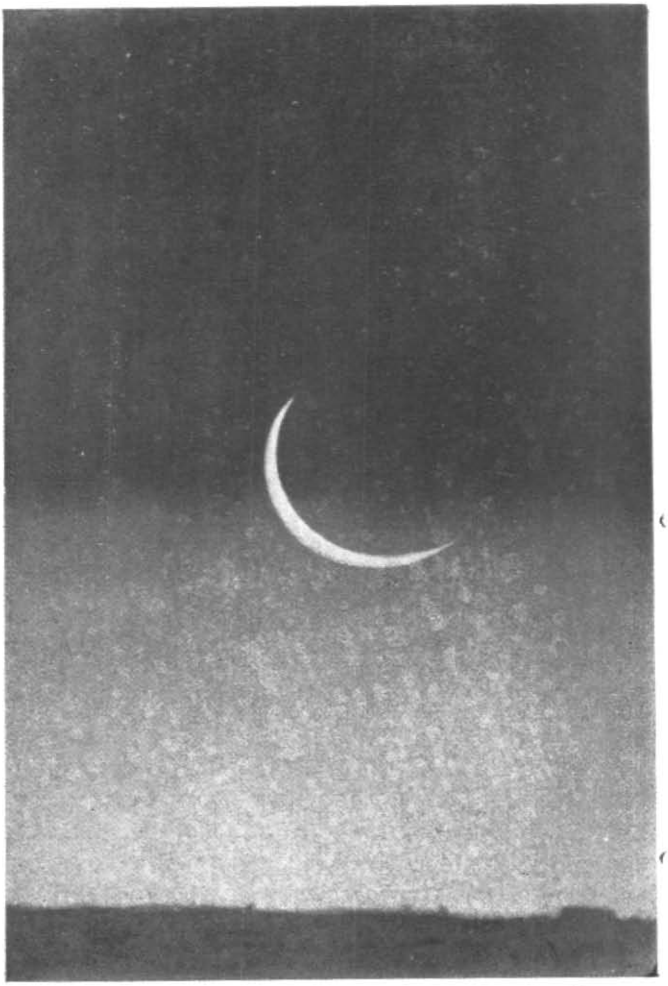

Fig. 2. The solar disc emerging out of the moon's shadow
after the total eclipse

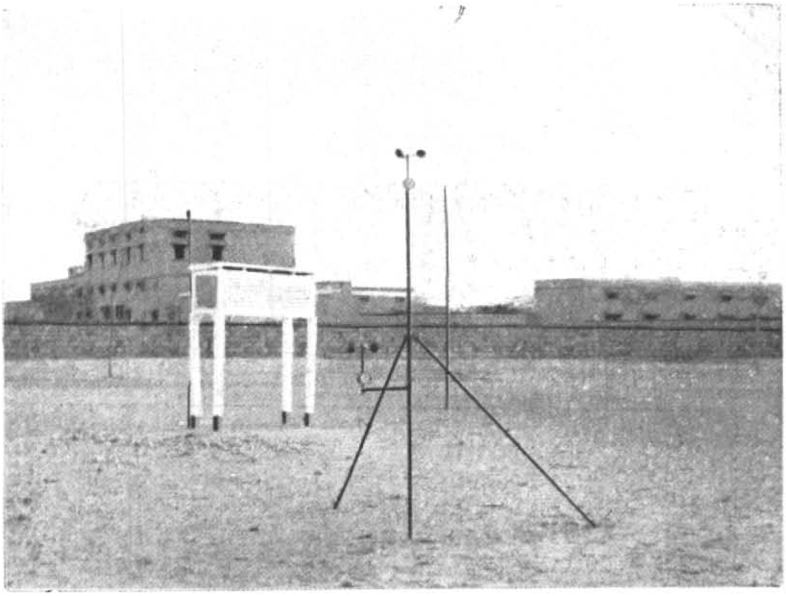

Fig. 3. Meteorological instruments for wind, temperature and humidity

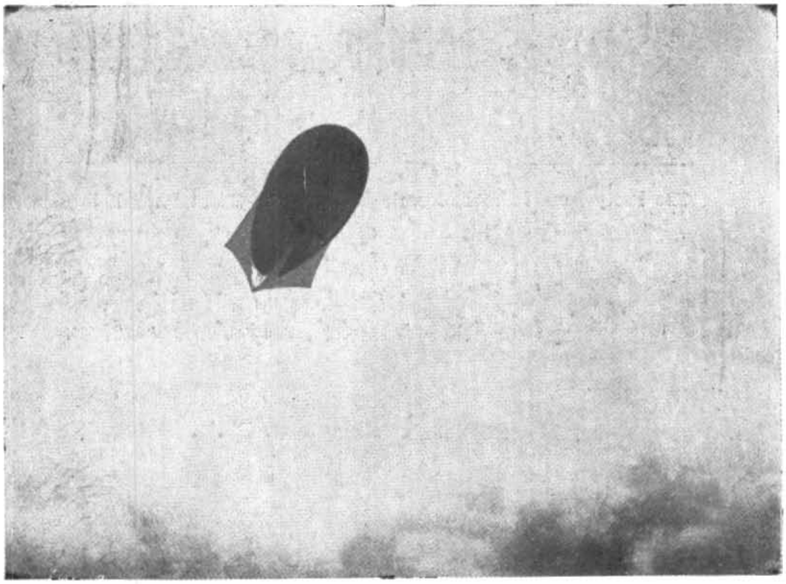

Fig. 4. Kytoon aloft

Fig. 5. The Party from India Meteorological Department at Phalodi to observe the Eclipse of the Sun