INSTITUTO GEOFISICO DEL PERÚ - MINISTERIO DE ENERGIA Y MINAS -

INVESTIGATION OF SOLAR FLARES AND ASSOCIATED PLAGE PHENOMENA

FINAL TECHNICAL REPORT

By

Mutsumi Ishitsuka and Jean Lanat

This research was supported by the United States Air Force under Grant AF-AFOSR-69-1777, monitored by the Air Force Cambridge Research Laboratories of the Office of Aerospace Research, and administrated by the Air Force Office of Scientific Research.

Introduction

Throughout the period covered by the Grant, from June 1, 1969 to May 31, 1970, solar patrol observations with a monochromatic heliograph and a 9400 MHz radiopolarimeter were made at the Huancayo Observatory. Re-- pair and modification of instruments, necessary for the observations, were also carried out.

The observation results were edited monthly and submitted to the Grant Monitor, Dr. John W. Evans, Sacramento Peak Observatory and Mr. John P. Castelli, Air Force Cambridge Research Laboratories under titles:

"Monthly Report of Solar H-Alpha Patrols", and
"Monthly Report of Solar Radio Noise Observations at 9400 MHz".

The Reports were forwarded also to the World Data Centers and to institutions making concurrent observations.

The repairs and modifications were principally made on the monochromatic heliograph with a Lyot filter. The most indispensable and urgent repair was the fixing of the Lyot monochromatic filter, and the most important modifi -- cations were a newly built shutter system for the cinematographic camera and a modified construction of the mechanical structure of the counter balance weight.

Although the work financed by the Grant should include correlative studies between H-alpha flares and 9400 MHz radio bursts after analyzing the ob-- tained observation results, the present report covers only the observations and the instrumental repairs and modifications carried out throughout the period covered by the Grant, due to illness of the principal investigator dur ing the grant period.

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CHAPTER I

Patrol Observations of Solar Chromosphere by a Monochromatic Heliograph with Lyot Filter

Cinematographic patrol observations of the solar chromosphere were carried out during day-light hours, ranging approximately between 1130 and 2230 UT, with the monochromatic heliograph during the Grant period, as well as before its commencement.

The monochromatic heliograph with Lyot filter built by Société d'Etudes et de Construction d'Appareiliages Scientifiques et Industriels (SECASI), France, is characterized by 14 cm aperture; 16 mm image diameter; and built-in Lyot filter with band-pass 0.69 Angstrom at H-alpha 6563 Angstrom; operation temperature 44.80°C.

This apparatus had been operated since July. 1964 for solar flare patrol work under the contract NBS CST-7552. The routine observation were continued since January, 1968 until the commencement of the present grant, although the contract NBS CST-7552 terminated at the end of 1967.

The observations were made with Kodak Solar Flare Patrol Film SO-392 of 35 mm width. The exposures were made at intervals of 30 seconds for inactive state of the sun, and 15 seconds when active regions appeared, unless the sun was occulted by dense clouds. As the shutter speed, regulated automatically by a photoelectric exposuremeter, was too slow for this film and the image density appropiate for heliogram reduction had to be obtained by reducing extremely the telescope aperture and photographic processing time, a possible modification of the shutter mechanism had to be urgently considered to shorten the shutter speed. The modification of the shutter mechanism is detailed in Chapter III.

On the other hand, the built-in Lyot monochromatic filter in the heliograph were suffering from a large air bubble, causing frequently a double image in the daily heliograms. The repair of the monochromatic filter is mentioned in detail in Chapter IV.

Monochromatic heliograms obtained during daily observations were reduced on the next day. The detected solar flares were measured by the method determined by the last resolution of International Astronomical Union (1966) .

Compiled Monthly Report of Solar H-Alpha Patrols were sent to:

Scientific Monitor:

Dr. John W. Evans
Sacrament Peak Observatory
New Mexico, U.S.A.

World Data Center A :

Upper Atmosphere Geophysics
National Oceanic and Atmospheric
Administration
Boulder, Colorado
U.S.A.

World Data Center B :

Moledeshnay 3
Moscow, B-296
USSR

World Data Center C :

Observatoire de Meudon
Meudon (seine-et-oise)
FRANCE

Mr. John P. Castelli :

Air Force Cambridge Research Laboratories
L.G. Hanscom Field
Bedford, Massachusetts
U.S.A.

and other observatories which make concurrent observations.

The obtained results are published in the following data bulletins:

1. Solar-Geophysical Data
   Edited by U.S. Department of Commerce
   National Oceanic and Atmospheric Administration
   Environmental Data Service

2. Quarterly Bulletin on Solar Activity
   Published by International Astronomical Union
   Eidgenösische Sternwarte in Zürich.

An example of Monthly Report of Solar H-alpha Patrols is displayed in Appendix A.

CHAPTER II

Radiotelescopic Observations of Solar Radio Emission at 9400 MHz

During the period covered by the Grant, the observations of solar radio emission at 9400 MHz were carried out at Huancayo Observatory from

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sunrise to sunset, ranging between 1130 and 2230 UT approximately. The employed radiopolarimeter built by Mitsubishi Electric Corporation, Japan, had been operated since the apparatus was supplied under Grant AF-AFOSR-898-65-68. The apparatus is specified by a 3-foot paraboloidal aerial fixed on an equatorial mounting, a superheterodyne receiver and 2 pen re-corders corresponding to total sum of circular polarizations in right and left hand sense, and difference between two circular polarizations, respectively. The recorded quantities were reduced into flux density by calibrations made more than twice a day.

The calibrations for the total flux density observations were carried out by attaching a non-reflection terminal with known temperature on the primary horn of the paraboloidal aerial, then by directing the aerial to the zenith, without the non-reflection terminal. Through these operations, two different levels of known antenna temperatures were marked on the total sum record, that is, a known antenna temperature corresponding to the terminal tempera-ture, ranging about 265° K to 295° K; and a supposed temperature of 10° K corresponding to the zenith. Total sum record of 9400 MHz radio emission from the sun was evaluated by these known levels in terms of effective an-tenna temperature, then these values were converted into international flux density units in terms of $10^{-22} W.m^{-2}.Hz^{-1}$ by multiplying a conversion factor 1.129, which was obtained by a correlative study made between the antenna temperature values of Huancayo Observatory, and the international unit values of Toyokawa Observatory, Japan, at the same frequency through June and July, 1968.

The calibrations for the circular polarization observations were made by inserting a matched absorber of known temperature into one of two wave guides connecting the primary horn and the polarization selector, which corresponds to right and left hand sense circular polarization, respectively.

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The same insertion was made into another wave guide. Two levels obtained by inserting the right and left absorbers corresponding to a known temperature were marked on the difference record, then the aerial was directed to the zenith in order to get the zero level of polarization. The difference records of the solar radio emission were evaluated by three levels of known antenna temperatures obtained by the mentioned procedures and the conversion to the international unit was made as well as of the total flux density evaluation.

The "Monthly Report of Solar Radio Noise at 9400 MHz" compiled each month, consists of:

observation results of slowly varying component,
observation results of outstanding occurrences,
observation results of polarization anomalies,
life tracing curves of great occurrences larger than 300 international units, and
observed hour table.

The following description gives the details of the report.

1. Observation results of slowly varying component:

1st column : Date of observation,
2nd to 4th column: Mean total flux density corresponding to 12 - 15, 15-18 and 18-21 UT intervals,
5th column : Mean daily flux density,
6th to 8th column: Circular polarization degree in % corresponding to the same three hour intervals.

2. Observation results of outstanding occurrences appearing in total flux density records:

1st column :	Date of observation,
2nd column :	Type of occurrence determined by the classification of Dr. Covington (1970) and type of occurrence by IAU classification (1968),
3rd column :	Time of commencement of occurrence,
4th column :	Time of maximum of occurrence,
5th column :	Life duration of occurrence in minutes,
6th column :	Peak flux density,
7th column :	Mean flux density,
8th column :	Polarization degree at time of peak flux density,
9th column :	Polarization sense at time of peak flux density, r, l and 0 corresponding to right, left hand sense circular polarization and 0 polarization, respectively.
10th column :	Polarization process through the occurrence r-0-l means a polarization sense inversion from right hand sense to left hand sense.

3. Observation results of polarization anomalies appearing in circular polarization records:

1st column :	Date of anomaly,
2nd column :	Type of anomaly determined by Huancayo classification (1969),
3rd column :	Time of commencement of anomaly,
4th column :	Time of maximum of anomaly
5th column :	Life duration of anomaly in minutes,
6th column :	Circular polarization at time of maximum anomaly in terms of international unit of flux density,

7th column : Polarization degree at time of maximum anomaly in percent,

8th column : Sense of circular polarization at maximum anomaly. r, l and 0 means right, left hand sense and zero polarization, respectively,

9th column : Polarization process through the anomaly,

10th column : Type of corresponding occurrence by Dr. Covington's and IAU classification (1970).

4. Curves of life tracing:

When an occurrence greater than 300 international unit above the pre-occurrence level was observed, three curves of life tracing were displayed; the first curve of polarization degree in terms of percent, the second of polarization anomaly in terms of flux density and the third of occurrence in terms of flux density.

5. Table of observed hours:

Time periods, in which observations were made in total flux density and circular polarization with permissible accuracy, were tabulated. Time periods lost by calibrations, heavy rains and hail storms, were not mentioned in the table.

The Monthly Report of Solar Radio Noise Observations at 9400 MHz were sent to:

Grant Monitor :

Dr. John W. Evans
Sacrament Peak Observatory
New Mexico, U.S.A.

Mr. John P. Castelli :

Air Force Cambridge Research Laboratories
L.G. Hanscom Field
Bedford, Massachusetts
U.S.A.

World Data Center A :

Upper Atmosphere Geophysics
Environmental Science Services Administration
Boulder, Colorado
U.S.A.

World Data Center B :

Nizmir WDC
P/O Vatutenki, Moscow 17
USSR

World Dat. Center C :

Sterrewacht "Sonnenborgh"
Servaabolwerk 13, Utrecht
NETHERLANDS

and other observatories making concurrent observations.

The obtained results are published in the following data bulletins:

1. Geophysics and Space Data Bulletin
   Edited by Space Physics Laboratory
   Air Force Cambridge Research Laboratories
   United States Air Force

2. Solar-Geophysical Data
   Edited by U.S. Department of Commerce

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National Oceanic and Atmospheric Administration
Environmental Service

3. Quarterly Bulletin on Solar Activity
Published by International Astronomical Union
Eidgenösische Sternwarte in Zürich

At the beginning of the grant, the installation of the numerical printing re-corders was planned in order to simplify the daily labor in reduction of the data. This plan was abandoned because the numerical display of records was advantageous only when the gain of the instrument might be so stable so that the correction for gain variation would not be necessary. The gain variation of the instrument under ordinary maintainance was about 2.5% and it always required small corrections for flux density evaluation.

CHAPTER III

Modification of Shutter System in Monochromatic Heliograph

The cinematographic camera in the monochromatic heliograph had functioned, since its installation on July 1964, until October 1969, with the original structure, which contained a shutter system regulated automatically through a photoelectric exposuremeter. The shutter speed, however, was slower than 1/8 second, because the design of the shutter was based on the use of sensitive photographic film such as Kodak Mocrofile Film, Kodak High Contrast Copy Film and Kodak Spectroscopic Film 5-E.

When the shutter speed is so slow as 1/8 second, the image definition is inferior than to that taken with a faster shutter speed such as 1/100-1/200 second. So a complete modification of the shutter system was planned by making use of other faster shutter elements. Another reason why the modification plan was generated, was because a very violent impact shock was produced by a huge electromagnet regulating a shutter sector of the original structure, with which considerable sharpness of the image was lost.

While the new shutter system was designed, experimental exposures were made with a still-camera Nikon F, which had shutter speed rang B-1/1000 second, and had been loaded with Kodak Solar Flare Patrol Film SO-392 . During the experimental exposures, the aperture of the monochromatic heliograph was reduced to 72 mm at the back of the objective lens, by locating a metallic diaphragm covered with a set of red and yellow filters, in order not to damage the color filters put in front of the Lyot filter and also in order to avoid excessive heating of the Lyot filter.

The heliograms obtained with the shutter speed 1/125 and 1/250 second displayed an image definition much better than the long exposure heliograms . With this result of the experiment, it was decided that a small shutter element, which does not vibrate the whole apparatus and can stand against high speed operation such as 1/100 - 1/300 second and long use, several months at least, would be adequate for the new design of shutter system.

Consequently the new camera was designed with a small shutter element built in a still-camera Nikkorrex, which was a ready-made shutter of focal plane curtain type named "Copal Square". The advantage of use of this shutter element was its low cost, and that it can easily be purchased. Furthermore, the whole cinematographic camera was replaced with a 35 mm Recording Camera Type A, Fairchild Camera and Instrument Corporation, New York, U. S. A. loaned by the High Altitude Observatory, University of Colorado, U.S.A.

Before beginning the camera design there was a discussion if the use of a shutter element of a still-camera with weak structure, would be appropriate for cinematographic observations for which the frequency of exposures would be incomparably higher than in the case of a normal still-camera. But the authors considered that the weak structure was found only in the driving system of the shutter element and the shutter element itself built with thin plates of hard steel would stand against hard use for considerably more than 35,000 exposures, as warranted by the manufacturer. Although the life of the shutter element of 35,000 exposures corresponds approximately to use during 2 months, which was practically a very short time, the authors in--sisted in the trial of this shutter element, because it might be considered as an expendable article from the point of view of its low cost, even if the re--placement would be necessary each 2 months. Fortunatelly, it was proved later that the durability of the shutter element "Copal Square" exceeded 12 months without any serious change of its performance.

The new shutter system was designed principally by Jean Lanat and was built in the machine shop of the Institute. The construction of new shutter was begun in October, 1969 and the complete system was terminated in February, 1970.

Through the initial trial of the new shutter, a solenoid was used for shutter charging, bu the solenoid was replaced with a miniature electric motor as the former produced much vibration to the camera

A photosensitive resistance RCA 4402 was used as exposure-meter detector, which interprets necessary exposure time, instead of the 90 CV exposureme-ter installed originally. The exposuremeter detector was placed at the cen--ter of the sun's image formed by a newly built telescope of 120 cm focal length and 26.5 mm aperture The space between the objective lens and the exposuremeter detector was covered with a metallic tube to shield the scat--tering light coming from clouds and environment The external appearance

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of the exposuremeter telescope is shown on plate 4. In order to make coincidence the sensitivity longitude with the longitude of the characteristic curve of photographic emulsion, a neutral filter of adequate transparency, which was determined empirically, was placed in front of the exposuremeter detector. In the future, it will be more convenient to find the coincidence of the exposure longitude with the emulsion longitude by adjusting the re--lative position angle between two polarizers installed in front of the objec--tive lens of the exposuremeter telescope, and a red filter will be placed in front of the objective lens of the exposuremeter telescope.

Although rigorous examinations about nonuniformity of the image density has not yet been made, the response of new exposuremeter for the atmospheric attenuation seems to be better than that of the original 90 CV exposure-meter. According to a rough estimate, the image density near sunrise is 0.86 minus 0.10, and the density near sunset is 0.86 minus 0.11, when the density of the sun's image near zenith is kept at 0.86, through normal photographic processing.

The shutter speed has not yet been measured precisely but it is estimated to be approximately 1/100 - 1/125 second for the sun nearby the zenith.

A modification of the illuminator for dater and clock, was required, as the exposure time was reduced considerably and Kodak Solar Flare Patrol Film SO-392 is not very sensitive to the green color of clock indicators. A booster reflector was added to the original illuminator to duplicate the illu--mination. The external appearance of the booster is shown on Plate 5.

CHAPTER IV

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Repair of Lyot Monochromatic Filter

Since the end of 1968, a large air bubble was formed in the immersion oil filled in the Lyot monochromatic filter. It was caused by oil leakage through constant evaporation, which had been appreciable by oil dew stuck on the back surface of the front polarizer of the monochromatic filter. Around the vertical position angle of the telescope, the bubble formed frequently double images of the sun and it was difficult to make precise measurements of solar flare images. Consequently, the complete fixing of the Lyot filter by the manufacturer, Société D'Optique Précision Electronique et Mécabique (SOPELEM), France, was considered. Although the manufacturer estimated 2 weeks for this job, the authors decided to undertake the repair at the Observatory taking into account the long delays at Customs Offices.

A small quantity of the oil was extracted from the Lyot filter and sent to a chemical laboratory in Peru and to Dr. Edward Manring, North Carolina State University, U.S.A., in order to identify the quality and type of the oil. Thanks to Dr. Edward Manring, 2 types of immersion oil with the same refractive index $n_D = 1.5150$ (- 0.0002) at 25°C were obtained. These oils, with different viscosities, were mixed in a proportion of 1 to 1, then poured into the opened filter. After stabilizing the filter temperature at 55°C, which is higher than the operating temperature of 44.80°C, the filter was covered with the clean front glass. An air bubble of 6 mm diameter remained in the immersion oil. The front glass was secured with the clamp screws, after its surfaces were paralleled to the first quarz element of the filter under the operation temperature 44.80°C, with a shop-made autocollimator.

The repaired filter was examined with a spectrohelioscope to detect the characteristics caused by the repair No changes of the position angle of

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two polarizers and the operation temperature were found during the visual examinations, repeated several times, with the second order spectrum of H-alpha line in dispersion 2.7 A/mm.

CHAPTER V

Modification of the Counter Weight of Monochromatic Heliograph

Since the installation of the monochromatic heliograph, the operators suffered from seriously unbalanced weight distribution over the whole apparatus. Two counter weights of 60 kg attached provisionally at both extremes of the supporter arms for the declination adjustment arc could reduce considerably the weight unbalance but could not eliminate it, because the additional weights and their supporting bars could not be increased, due to the structural weakness of the extremes of the supporter arms of the declination adjustment arc.

During the period covered by the Grant, a new counter weight was hung with a new supporter, constructed with iron tubes, toward the opposite side of the telescope. The new supporter was secured to the outer shell of the declination adjustment arc. The appearance of the new supporter and the counter weights is shown in plate 6.

As a result of the new construction, the provisional weights and the lenghts of their supporters could not be only reduced to one-half, but also the weight unbalance over the whole apparatus disappeared completely.

Acknowledgements

We are indebted to Dr. John W. Evans of the Sacramento Peak Observatory, the Air Force Cambridge Research Laboratories for approval of the Grant; to

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Mr. John P. Castelli, Ionospheric Physics Laboratory, the Air Force Cambridge Research Laboratories for most helpful technical advice; to Dr. Edward Manring, North Carolina State University, who kindly identified the quality of immersion oil to fill the Lyot monochromatic filter and supplied us sufficient quantity of the oil.

Our thanks are due to Mr. T. Nomura and Mr. J. Crisostomo for cooperation in edition of the report, to Messrs. I. Astete, S. Melgar and J. Melgar for maintenance of observations, to Messrs. C. Aliaga and J. Mucha for data reductions, and to Mr. A. de la Cruz for mechanical work in machine shop.

References

U.S. Department of Commerce: Environmental Science Services Administration	1970:	Solar-Geophysical Data Descriptive Text, p. 39 N° 306
International Council of Scientific Unions:	1966:	IQSY Note p.p. 8-12, N° 16
Special Committee of International Years of the Quiet Sun		
International Council of Scientific Unions: Special Committee for the IQSY	1968.	Annals of the IQSY p.p. 33-34 Volume 1
Mutsumi Ishitsuka:	1969:	Final Technical Report Grant AF-AFOSR-898-67, Radio Telescope Measurement of the Solar Flux Density on 9400 MHz at Huancayo, Perú

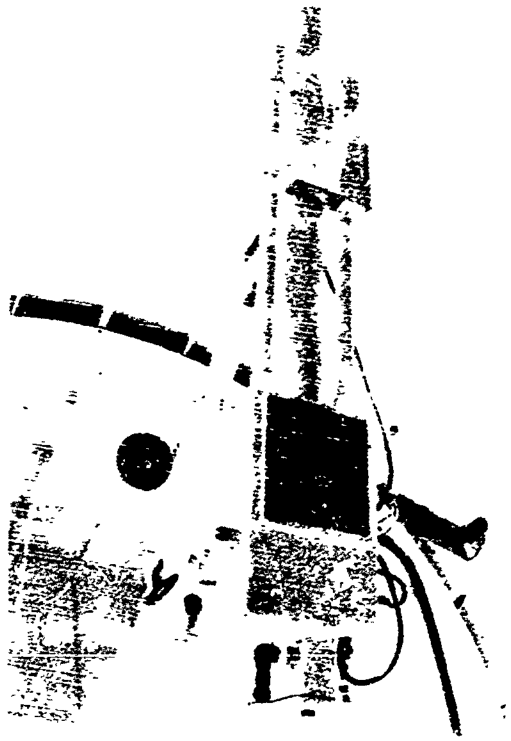

Plate N° 1
Monochromatic heliograph
installed at
Huancayo Observatory
before modification

Plate N° 2
New cinematographic camera
of monochromatic heliograph

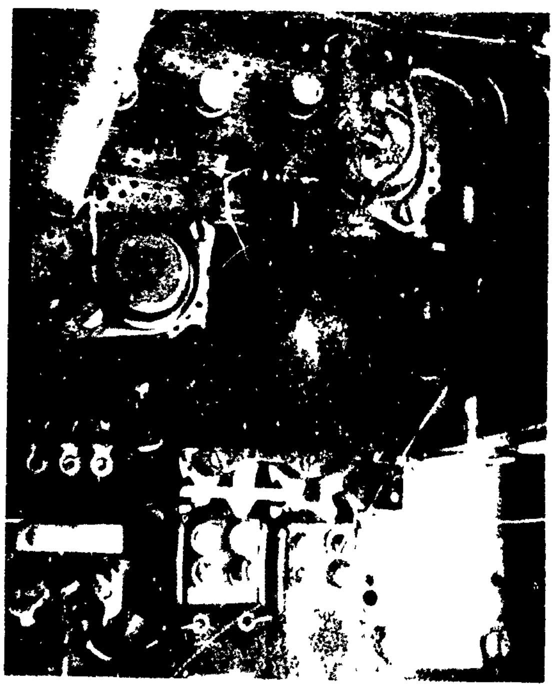

Plate N° 3
New shutte ystem
monochromatic heli graph

Plate N° 4
New telescope fo exposuremeter

Plate N° 5
Illumination booster for
dater and clock

Plate N° 6
New counter weight system

Plate N° 7
2400 MHz radiopolarimeter
installed at
Huancayo Observatory

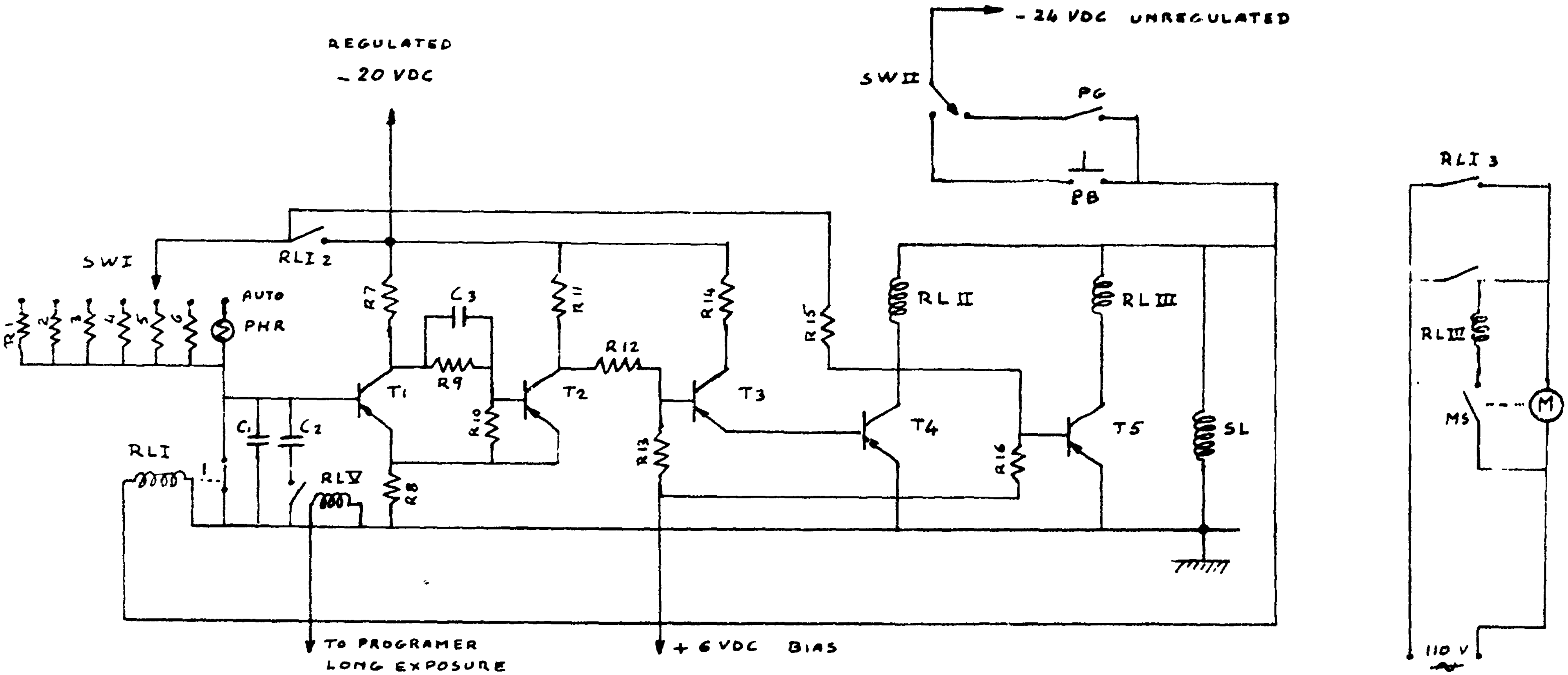

FIG _ I AUTOMATIC EXPOSURE ADJUSTMENT FOR THE MONOCHROMATIC HELIOGRAPH

$T_1 - T_2$	-	Variable gate generator, length function of the time constant CI through PHR
PHR	-	Photo resistor R. variable with sun light
RLII-RLIII	-	Shutter blades relay release
SL	-	Selenoid film advance
SWI	-	Manual or automatic time exposure switch
SWII	-	Manual or automatic shutter action switch
PG	-	Automatic shutter action switch (from programmer)
PB	-	Manual shutter action switch (push button type)
RLI	-	Relay three poles
M	-	Arm shutter motor
RL IV	-	Memory relay
MS	-	Motor stop microswitch

$T_1\ T_2\ T_3$	-	2N414
$T_4\ T_5$	-	2N255

APPENDIX A

CHARACTERISTICS OF THE MONOCHROMATIC HELIOGRAPH AND EXAMPLE OF MONTHLY REPORT OF SOLAR H-ALPHA PATROL OBSERVATIONS

Characteristics of the Monochromatic Heliograph

Free aperture	:	14 cm
Operating aperture	:	7.2 cm
Image diameter	:	16 mm approximately
Mounting	:	Equatorial
Guiding	:	Automatic photoelectric system for hour angle and declination
Record	:	35 mm cinematographic camera
Exposure control	:	Photoelectric-automatic by time length

Monochromatic filter:

Transmission	:	H-alpha 6563 A
Band pass	:	0.69 A
Operation temperature	:	44.80°C

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Monthly Report

of

Solar H-Alpha Patrols

March, 1970

Departamento de Actividad Solar
Instituto Geofísico del Perú
Apartado 46, Huancayo
Perú

HOURS OF H-ALPHA FLARE PATROL

Station. Huancayo, Perú Month: March Year: 1970

Date	From	To	From	To	From	To	From	To	From	To	From	To
1-11	NO	DATA										
12	1531	1534	1542	1546	1558	1600	1619	1624	1633	1635	1715	1731
	1737	1750	2100	2128	2135	2144						
13-15	NO	DATA										
16	1704	1724	1822	1828	1834	1936						
17-18	NO	DATA										
19	1243	1616	1623	1627	1632	1644	1645	1650	1653	1655	1657	1706
	1708	1712										
20-22	NO	DATA										
23	1131	1132	1153	1155	1203	1205	1242	1340				
24	1137	1140	1146	1209	1242	1332	1410	1412	1414	1417	1421	1531
	1604	1606	1610	1616								
25	1315	1424	1434	1503	1507	1517						
26	1204	1206	1212	1213	1216	1219	1222	1224	1258	1314	1335	1337
27	1416	1417	1421	1425	2109	2113	2132	2136				
28	1415	1420	1425	1438	1451	1527	1529	1631	1640	1712		
29	1358	1553	1555	1602								
30	1315	1319	1328	1330	1337	1338	1340	1341	1356	1358	1832	1843
	1901	1903	1908	1933								
31	1234	1246	1251	1256	1349	1356	1359	1409	1421	1422	1438	1447
	1450	1459	1503	1654	1655	1742	2028	2053				

HOURS OF H-ALPHA FLARE PATROL

Page 1 of 1 Page

Station. Huancayo, Perú Month: March Year: 1970

Date	From	To	From	To	From	To	From	To	From	To	From	To
1-11	NO	DATA										
12	1531	1534	1542	1546	1558	1600	1619	1624	1633	1635	1715	1731
	1737	1750	2100	2128	2135	2144						
13-15	NO	DATA										
16	1704	1724	1822	1828	1834	1936						
17-18	NO	DATA										
19	1243	1616	1623	1627	1632	1644	1645	1650	1653	1655	1657	1706
	1708	1712										
20-22	NO	DATA										
23	1131	1132	1153	1155	1203	1205	1242	1340				
24	1137	1140	1146	1209	1242	1332	1410	1412	1414	1417	1421	1531
	1604	1606	1610	1616								
25	1315	1424	1434	1503	1507	1517						
26	1204	1206	1212	1213	1216	1219	1222	1224	1258	1314	1335	1337
27	1416	1417	1421	1425	2109	2113	2132	2136				
28	1415	1420	1425	1438	1451	1527	1529	1631	1640	1712		
29	1358	1553	1555	1602								
30	1315	1319	1328	1330	1337	1338	1340	1341	1356	1358	1832	1843
	1901	1903	1908	1933								
31	1234	1246	1251	1256	1349	1356	1359	1409	1421	1422	1438	1447
	1450	1459	1503	1654	1655	1742	2028	2053				

FLARE DATA

Station: Huancayo, Perú   Month: March   Year: 1970

Date	Time of Obs.			Position		Imp.	Obs.	Max. Area			Remarks
	Beg.	End.	Max.	Lat.	M.D.			Time	Appa.	Corr.	
1-11	NO	DATA									
12	-	-	-	-	-	-	-	-	-	-	-
13-15	NO	DATA									
16	1900	1904	1902	S 02	W 19	Sn	2c	1902	24	0.30	5
17	-	-	-	-	-	-	-	-	-	-	-
18	NO	DATA									
19	1424	1429	1425U	E 69	N 20	Sn	2c	1425	24	-	4
	1420E	1455D	1433U	00	W 60	Sf	2p	1433	24	0.50	4
22	NO	DATA									
23	1242E	1249D	1245U	N 18	W 70	Sf	2p	1245	24	-	4
24	1137E	1140D	1139U	N 17	W 80	Sf	2p	1139	48	-	5
	1245E	1332D	1253U	N 18	W 80	Sn	1p	1253	60	-	5
	1631E	1700D	1631U	N 14	E 05	Sb	2p	1631	120	1.40	9
25	1315E	1424D	1318U	N 12	E 07	Sb	2p	1318	97	1.00	5
	1350	1407	1355U	S 11	W 28	Sb	2p	1355	73	0.80	5
26	1305	1314D	1311	N 16	E 63	1b	2p	1311	97	2.30	5
27-30	-	-	-	-	-	-	-	-	-	-	-
31	1619E	1628	1623U	S 10	E 80	Sf	2p	1623	36	-	5

PROMINENCES AND FILAMENTS

Date	
1-31	NONE

APPENDIX B

CHARACTERISTICS OF 9400 MHz RADIOFOLARIMETER
AND
EXAMPLE OF MONTHLY REPORT OF SOLAR RADIO NOISE OBSERVATIONS
AT 9400 MHz

Characteristics of the 9400 MHz Radiopolarimeter

Frequency	: 9400 MHz	
Polarization	: Right and left circular	
Receiving system	: Superheterodyne Dicke Radiometer	
Intermediate fr quency	: 30 MHz	
Band width	: 10 MHz	
Receiver noise figure	: Less than 10 db	
Integrator time constant	: 0.5 or 1.0 second	
Standard noise temperature	: 333°K	
Polarization switching frequency	: 80 Hz	
Dicke switching frequency	: 220 Hz	
Paraboloidal aerial	:	
	Diameter	: 91.4 cm
	Mounting	: Equatorial motor drive

Monthly Report

of

Solar Radio Noise Observations

March, 1970

Departamento de Actividad Solar
Instituto Geofísico del Perú
Aparrado 46, Huuncayo
Perú

Daily Flux Density and Polarization

Frequency: 9400 MHz

Month : March, Year: 1970
Station : Huancayo, Perú

Date	Total Flux Density of 2 Polarizations, Unit: $10^{-22} W.m^{-2} Hz^{-1}$ 12-15 UT	15-18 UT	18-21 UT	Daily Mean	Polarization Percent and Sense 12-15 UT	15-18 UT	18-21 UT	Daily Mean
1	336	336	336	336	0.7 l	0.6 l	0.6 l	0.6 l
2	336	338	338	337	0.7 l	0.7 l	0.8 l	0.7 l
3	336	336	336	336	0.1 l	0.2 l	0.3 l	0.2 l
4	323	323	323	323	0.3 l	0.3 l	0.5 l	0.4 l
5	316	320	320	319	0.7 l	0.7 l	0.8 l	0.7 l
6	320	320	320	320	0.1 l	0.0	0.1 l	0.1 l
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	316	316	316	316	1.3 r	1.4 r	1.3 r	1.3 r
11	301	301	301	301	1.2 r	1.0 r	0.6 r	0.9 r
12	309	309	309	309	0.9 r	0.6 r	0.6 r	0.7 r
13	300	300	300	300	0.5 r	0.3 r	0.0	0.3 r
14	298	298	298	298	0.2 r	0.2 l	0.3 l	0.1 l
15	295	295	294	295	0.0	0.4 l	0.5 l	0.3 l
16	297	297	297	297	0.2 l	0.4 l	0.6 l	0.4 l
17	295	295	295	295	0.2 l	0.5 l	0.5 l	0.4 l
18	294	294	294	294	0.4 l	0.5 l	0.5 l	0.5 l
19	292	294	294	293	0.2 l	0.3 l	0.4 l	0.3 l
20	294	294	294	294	0.5 l	0.5 l	0.5 l	0.5 l
21	294	294	294	294	0.5 l	0.7 l	1.0 l	0.7 l
22	294	294	292	293	0.2 l	0.2 l	0.4 l	0.3 l
23	299	299	299	299	0.1 r	0.2 r	0.1 l	0.1 r
24	305	306	306	306	0.5 r	0.2 r	0.2 r	0.2 r
25	305	305	305	305	0.1 l	0.7 r	1.1 l	0.6 l
26	304	304	304	304	1.1 l	1.3 l	1.6 l	1.3 l
27	297	294	292	294	1.3 l	1.4 l	1.4 l	1.4 l
28	292	292	291	292	0.8 l	1.0 l	1.3 l	1.0 l
29	295	295	295	295	0.9 l	1.4 l	1.8 l	1.4 l
30	294	-	294	294	0.7 l	-	1.1 l	0.9 l
31	303	304	304	304	0.1 r	0.1 r	0.1 l	0.0

Monthly Means: 305.1 Units. 0.33 % Left.

Outstanding Occurrences oin Flux Density

Month: March Year: 1970
Station: Huancayo - Perú

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Peak	Mean	Degree Percent	Polarization at time of Max. Sense r, l & 0	Polarization Process r & l
1	4S	1126.3	1127.8	2.5	589.1	147.7	13.0	r	r
	20S	1224.8	1227.2	5.2	15.0	7.5	33.5	l	l
	46C	1358.9	1400.3	4.6	104.7	81.6	2.8	r	r
			1400.8		123.4		3.4		
			1401.7		170.2		2.5		
	29p.i.	1403.5	1403.5	18.7	33.7	9.6	-	-	-
	21S	1510.6	1512.2	3.5	7.5	4.3	27.9	l	l
	8S	1511.3	1511.6	0.7	39.3	17.5	57.4	l	l
	3S	1530.0	1530.9	6.3	729.3	232.8	4.3	l	l
	20S	1555.6	1616.1	59.4	13.1	7.7	25.5	l	l
	45C	1711.1	1711.8	2.6	31.8	21.3	6.6	l	l
			1712.2		54.2		10.0		
			1712.5		35.5		17.7		
	1S	1729.8	1730.5	2.1	13.1	4.7	25.5	r	r
	23S	1749.8	1755.4	47.7	9.4	5.4	-	-	-
	20S	1825.8	1826.8	1.9	7.5	5.1	-	-	-
	46C	2002.5	2005.2	3.3	346.0	94.8	5.3	r	r
	30p.i.	2005.8	2005.8	13.0	35.5	13.1	18.8	r	r
	45C	2007.6	2008.0	2.8	48.6	19.9	4.3	r	r
			2009.2		26.2		16.0		
			2009.8		35.5		4.7		
	45C	2022.8	2023.6	4.5	37.4	25.1	16.8	l	l
			2024.2		67.3		24.2		
	21S	2029.3	2035.8	16.7	7.5	4.3	-	-	-
	3S	2029.6	2029.8	1.7	37.4	14.5	-	-	-
	4S	2031.8	2032.7	2.6	18.7	6.4	-	-	-
2	3S	1127.6	1128.0	1.1	37.4	13.5	44.7	r	r
	23S	1303.4	1419.8	293.7	56.1	18.1	17.5	l	l

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Peak	Mean	Degree Percent	Polarization at time of Max. Sense r, l & 0	Polarization Process r & l
2	22S	1338.3	1343.2	14.4	33.7	12.8	8.3	l	l
	3S	1[illegible]26.3	1429.0	8.4	29.9	10.9	4.2	l	l
	1S	1628.6	1628.9	1.0	9.4	5.1	22.2	r	r
	3S	1714.1	1714.8	2.2	43.0	23.1	6.8	l	l
	29p.i	1716.3	1716.3	33.0	18.7	7.8	-	-	-
	22S	1824.4	1857.5	102.2	7.5	3.0	-	-	-
	45C	2157.5	2157.9	2.8	13.1	9.4	41.5	l	l
			2159.5		18.7		15.7		
3	26S	1453.7	1453.7	486.3E	9.3	8.5	-	-	-
	3S	1750.6	1751.4	3.9	13.0	4.7	45.5	r	r
	22S	1854.1	1923.6	89.7	11.2	3.9	41.4	r	r-0-l
	28 Precursor	2031.3	2032.7	1.4	18.6	7.0	22.7	r	r
	46C	2032.7	2034.1	4.6	283.0	157.2	14.6	r	r
			2035.7		240.0		20.0		
			203[illegible].4		208.5		23.1		
	29p i	2037.3	2037.3	37.6	46.6	22.0	13.6	r	r
	22S	2118.8	2119.4	6.7	9.3	6.3	-	-	-
4	46C	1821.2	1822.8	8.8	44.2	36.5	34.5	r	r
			1824.8		46.1		23.6		
			1826.4		88.4		24.7		
	29p i	1830.0	1830.0	39.2	15.4	5.8	28.3	r	r
5	21S	1617.6	1842.6	261.1	11.2	7.5	-	-	-
	45C	1618.1	1621.3	11.2	16.8	10.1	12.5	r	r
			1622.1		24.3		15.6		
	45C	1908.2	1909.4	3.3	18.7	9.7	11.2	r	r
			1911.0		22.4		11.3		
	29p i	1911.5	1911.5	70.2	15.0	11.2	-	-	-
6	28 Precursor	1317.2	1323.9	6.7	7.5	3.7	28.4	r	r
	3S	1323.9	1324.7	1.6	58.1	24.9	33.7	r	r
	29p i	1325.5	1325.5	55.2	16.9	5.0	25.2	r	r
7-9	NO	DATA							

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Peak	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Mean	Degree Percent	Polarization at time of Max: Sense r, l & 0	Polarization at time of Max: Polarization Process r & l
10	1S	1751.2	1751.8	3.5	9.9	4.6	17.6	r	r
11	20S	1357.1	1408.7	19 2	5.6	3.2	-	-	-
12	-	-	-	-	-	-	-	-	-
13	20S	1414 0	1437.5	38.5	5.7	4.8	-	-	-
14	20S	1517 5	1519.5	41.7	7.3	4.0	-	-	-
15-16	-	-	-	-	-	-	-	-	-
17 P ecur	28	1440.6	1442.2	1.6	9.4	3.7	32.7	l	l
	45C	1442.2	1443.3	5.0	112.4	63.2	19.9	l	l
			1445.4		116.2		22.2		
	29p.i	1447.2	1447.2	24.8	15.0	5.9	20.5	l	l
18	22S	1631.6	1849.4	202.7	9.5	5.8	-	-	-
19	-	-	-	-	-	-	-	-	-
20	22S	1705.8	1817.5	170.5	7.5	4.5	-	-	-
21	22S	1615.3	1758.7	135.2	7.0	3.8	-	-	-
22	1S	1929 4	1930.4	2.8	13.4	5.7	19.3	r	r
23	46C	1545.8	1547.2	5.5	26.5	25 1	17.7	r	r
	29p i.	1551 3	1549.6	69.2	62 6	12 2	12.9	r	r
	29p i.	1551.3	1551.3	69.2	26 5	12.2	8.0	r	r
24	3S	1222.7	1223.3	1.4	49 9	18 1	21.3	r	r
	1S	1250.6	1252.7	5.3	9.6	3.4	26.7	r	r
	20S	1627 6	1649.4	152.7	17.3	6.5	-	-	-
25 Precur	28	1211 0E	1218.0	7.0U	36.5	16.9	15.3	l	l
	3S	1218.0	1220.8	9.1	314.9	118.8	30.4	r	r
	29p.i.	1227 1	1227.1	101.7	61.4	25.3	-	-	-

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Peak	Total Flux Density $10^{-22} W.m^{-2} Hz^{-1}$ Mean	Degree Percent	Polarization at time of Max. Sense r, l & 0	Polarization Process r & l
26	1S	1256.0	1257.1	5.1	13.2	5.2	16.3	-	-
	1S	1452.8	1453.1	1.4	13.2	6.0	-	-	-
	45C	1726.9	1727.3	4.4	86.8	76.5	15.9	l	l
			1727.6		199.9		14.2		
			1728.2		262.2		7.7		
			1730.3		73.5		16.2		
	29p.i.	1731.3	1731.3	6.1	7.5	3.1	22.9	l	l
	45C	2008.8E	-	5.7U	-	-	-	r	r
	29p.i.	2014.5	2014.5	73.1	32.1	13.7	5.4	l	l
27	45C	1421.5	1422.3	3.6	22.6	15.2	51.4	l	l
			1423.2		33.8	58.5			
28	20S	1351.2	1407.7	53.2	5.5	3.5	-	-	-
29	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-
31	21S	1758.6	1823.9	91.4	17.0	8.8	-	-	-
	3S	1806.3	1806.9	5.6	18.9	7.8	-	-	-

Anomalies in Circular Polarization

Frequency 9400 MHz

Month . March Year : 1970
Station Huancayo

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minute	Polarization at time Max $10^{-22} W.m^{-2} Hz^{-1}$	Percent	Polarization Process Sense	Polarization Process Process	Corresponding Occurrence Type
1	145	1126.6	1127.5	1.9	76.5	13.0	r	r	4S
	120	1222.6	1227.3	7.7	5.0	33.5	l	l	20S
	120	1328.9	1400.9	4.4	5.4	4.4	r	r	46C
	120	1508.8	1512.1	9.4	3.3	44.5	l	l	21S
	101	1511.2	1511.5	0.8	21.7	55.6	l	l	8S
	145	1527.7	1530.6	14.0	21.6	4.3	l	l	3S
	120	1615.1	1616.0	2.1	5.0	38.3	l	l	20S
	120	1638.7	1639.8	2.5	4.2	-	l	l	-
	103	1710.4	1712.5	3.3	8.3	23.3	l	l	45C
	101	1729.5	1730.6	3.0	3.3	25.5	r	r	1S
	120	1752.7	1754.3	4.1	2.9	-	r	r	23S
	145	2002.7	2005.6	3.3	24.7	29.3	r	r	46C
	129	2006.0	2006.0	1.5	4.2	11.8	r	r	30p.i.
	145	2007.5	2007.7	3.7	2.1	4.3	r	r	45C
	145	2020.4	2024.3	8.3	16.3	24.2	l	l	45C
2	103	1126.4	1128.1	4.8	16.7	44.7	r	r	3S
	124	1321.4	1352.1	518.3U	5.9	-	l	l	-
	101	1339.4	1340.4	6.3	8.4	34.4	l	l	22S
	101	1408.6	1410.2	3.2	4.2	-	l	l	23S
	120	1626.6	1629.1	13.1	2.1	22.2	r	r	1S
	101	1714.1	1714.7	1.2	3.8	8.7	l	l	3S
3	103	1750.8	1751.5	2.6	5.9	45.5	r	r	3S
	120	1849.0	1923.5	37.4	4.6	41.4	r	r-0-l	22S
	128	2029.4	2032.7	3.3	4.2	22.7	r	r	28 Precursor
	145	2032.7	2034.2	4.7	41.4	14.6	r	r	46C
			2035.7		48.1	20.0			
			2036.5		41.1	3.1			
	129	2037.4	2037.4	43.5	6.3	13.6	r	r	29p.i.

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Polarization at time Max. $10^{-22} W.m^{-2} Hz^{-1}$	Percent	Polarization Process Sense	Polarization Process Process	Corresponding Occurrence Types
4	145	1821.1	1822.6	8.9	15.3	34.5	r	r	46C
			1826.6		21.8	24.7			
			1828.1		13.1	29.6			
	129	1830.0	1830.0	6.5	4.4	28.3	r	r	29p.i
5	120	1617.9	1621.3	7.3	2.1	12.5	r	r	45C
			1622.1		3.8	15.6			
	120	1908.5	1909.3	4.3	2.1	4.0	r	r	45C
			1910.9		2.1	6.2			
6	128	1320.3	1323.9	3.6	2.1	28.4	r	r	28 Precursor
	103	1323.9	1324.7	1.8	19.6	33.7	r	r	3S
	129	1325.7	1325.7	5.6	4.2	25.2	r	r	29p.i.
7-9	NO	DATA							
10	120	1751.3	1752.8	2.9	3.1	38.1	r	r	1S
	120	2200.3	2203.2	5.9	4.4	-	r	r	-
11-12	-	-	-	-	-	-	-	-	-
13	120	1440.5	1446.3	14.1	4.0	-	l	l	20S
14-16	-	-	-	-	-	-	-	-	-
17	128	1437.8	1442.2	4.4	3.1	32.7	l	l	28 Precursor
	145	1442.2	1443.2	6.1	24.1	19.9	l	l	45C
			1445.4		26.7	22.2			
18-21	-	-	-	-	-	-	-	-	-
22	101	1929.4	1930.5	2.8	2.5	19.3	r	r	1S
23	145	1543.2	1547.2	8.7	4.7	17.7	r	r	46C
			1549.8		8.5	15.0			
	129	1551.3	1551.8	30.5	4.7	20.6	r	r	29p.i.
24	101	1222.8	1223.3	1.0	10.7	21.3	r	r	3S
	101	1251.8	1252.8	2.3	2.6	26.7	r	r	1S

Date	Type	Starting Time UT	Time of Maximum UT	Duration Minutes	Polarization at time Max $10^{-22} W.m^{-2} Hz^{-1}$	Polarization at time Max Percent	Polarization Process Sense	Polarization Process Process	Corresponding Occurrence Types
25	128	1210.8	1218.2	7.4	2.6	15.3	l	l	28 Precursor
	103	1218.2	1220.5	8.2	36.1	30.4	r	r	103S
26	101	1255 8	1257 2	5.8	3.4	26.1	l	l	1S
	145	1726 9	[illegible]	4.4	13.8	15 9	l	l	45C
			[illegible]		20 2	7.7			
			1726.6		28 4	14.2			
			1730 2		9.5	16.2			
	129	1731 3	1731 3	5.8	1.7	22.9	l	l	29p.i.
	103	2008 8E	-	5.7U	-	-	r	r	45C
	129	2014.5	2014 5	30.7	1.7	5.4	l	l	29p.i.
27	145	1420.3	1422.3	4.0	11.6	51.4	l	l	45C
			1423.2		19.8	59.5			
28-31	-	-	-	-	-	-	-	-	-

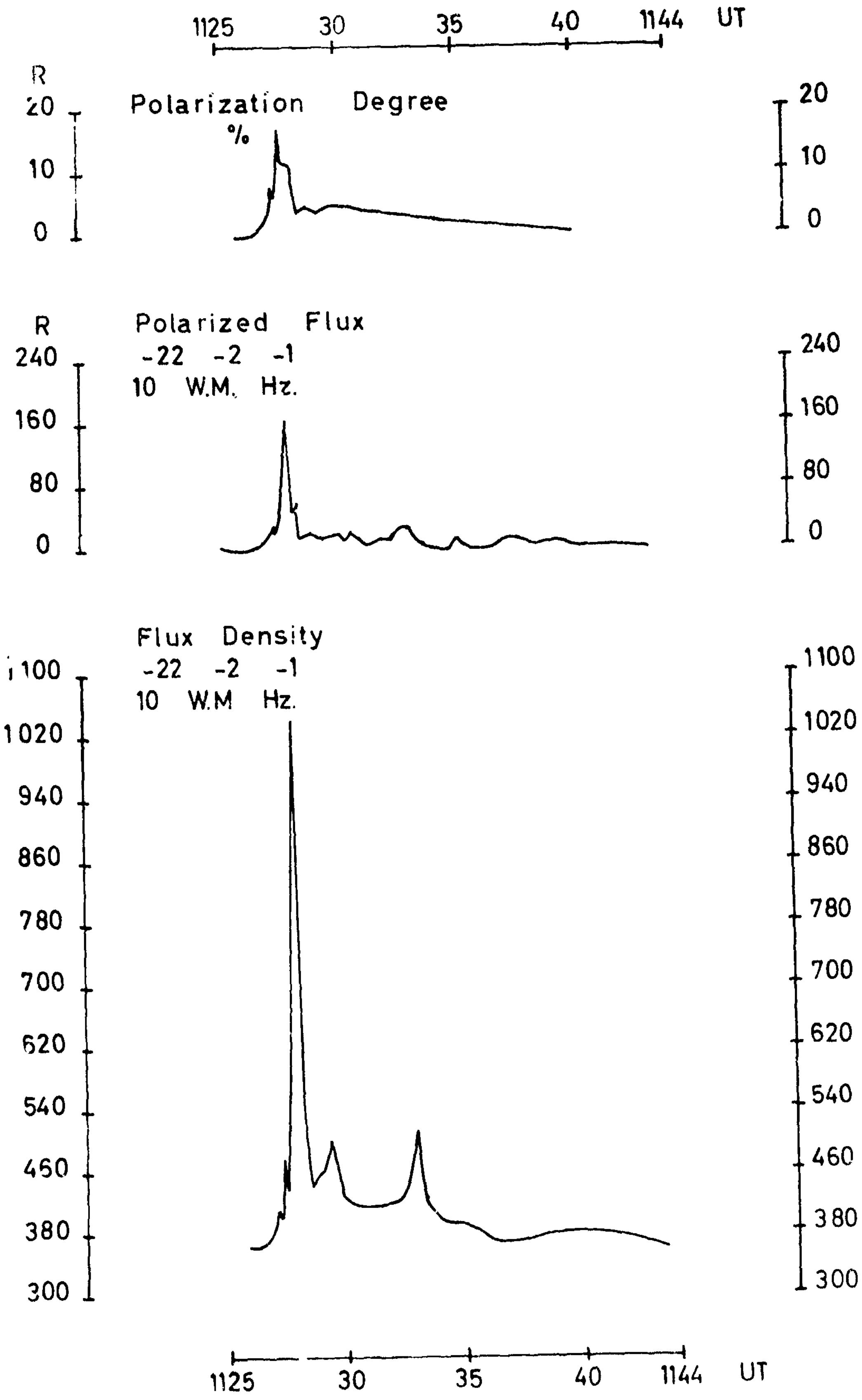
Hours of Solar Noise Observations

Frequency. 9400 MHz.

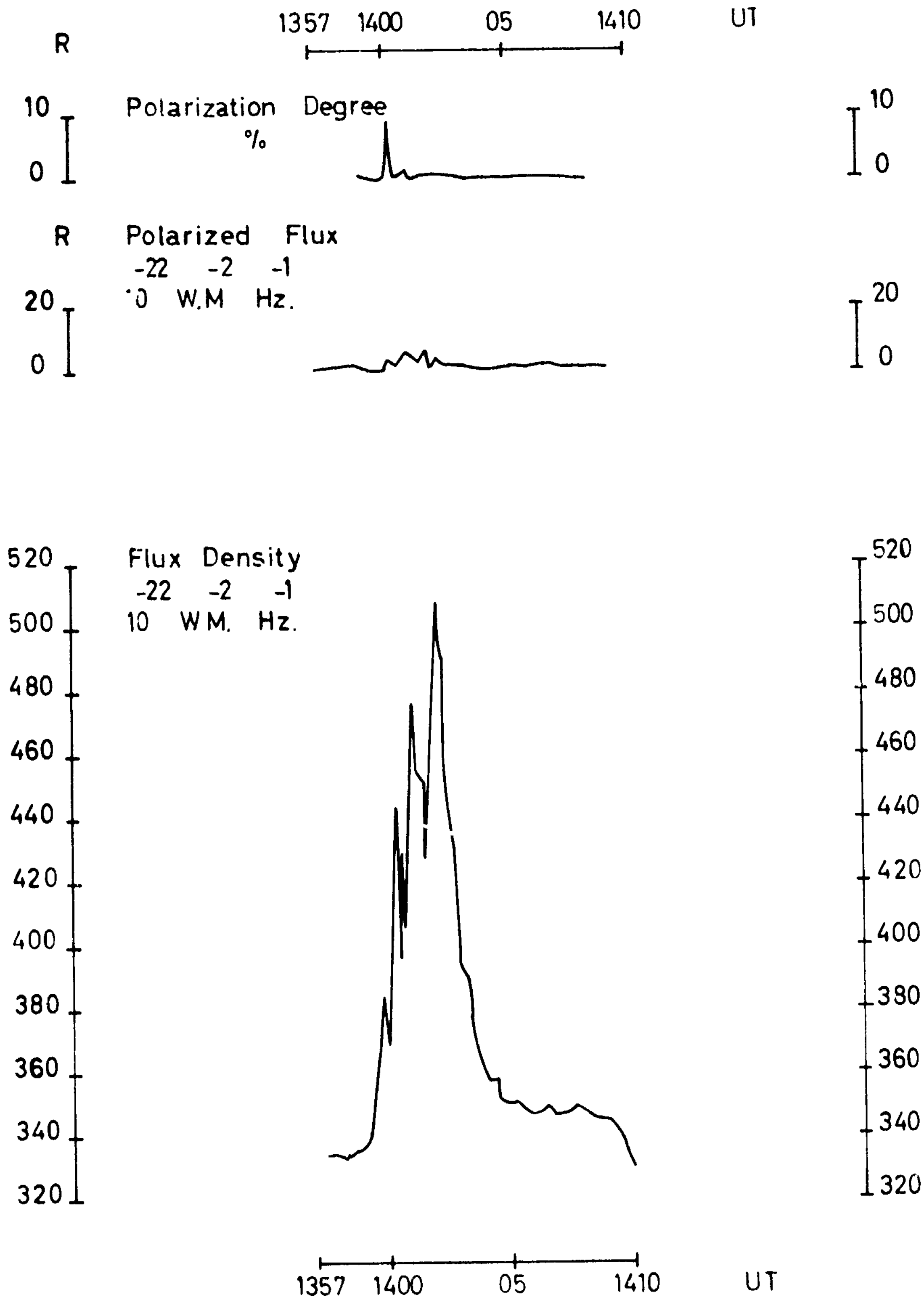
Type of Observations:
Flux Density of
2 polarizations.
& polarization

Station: Huancayo Peru Month: March Year: 1970

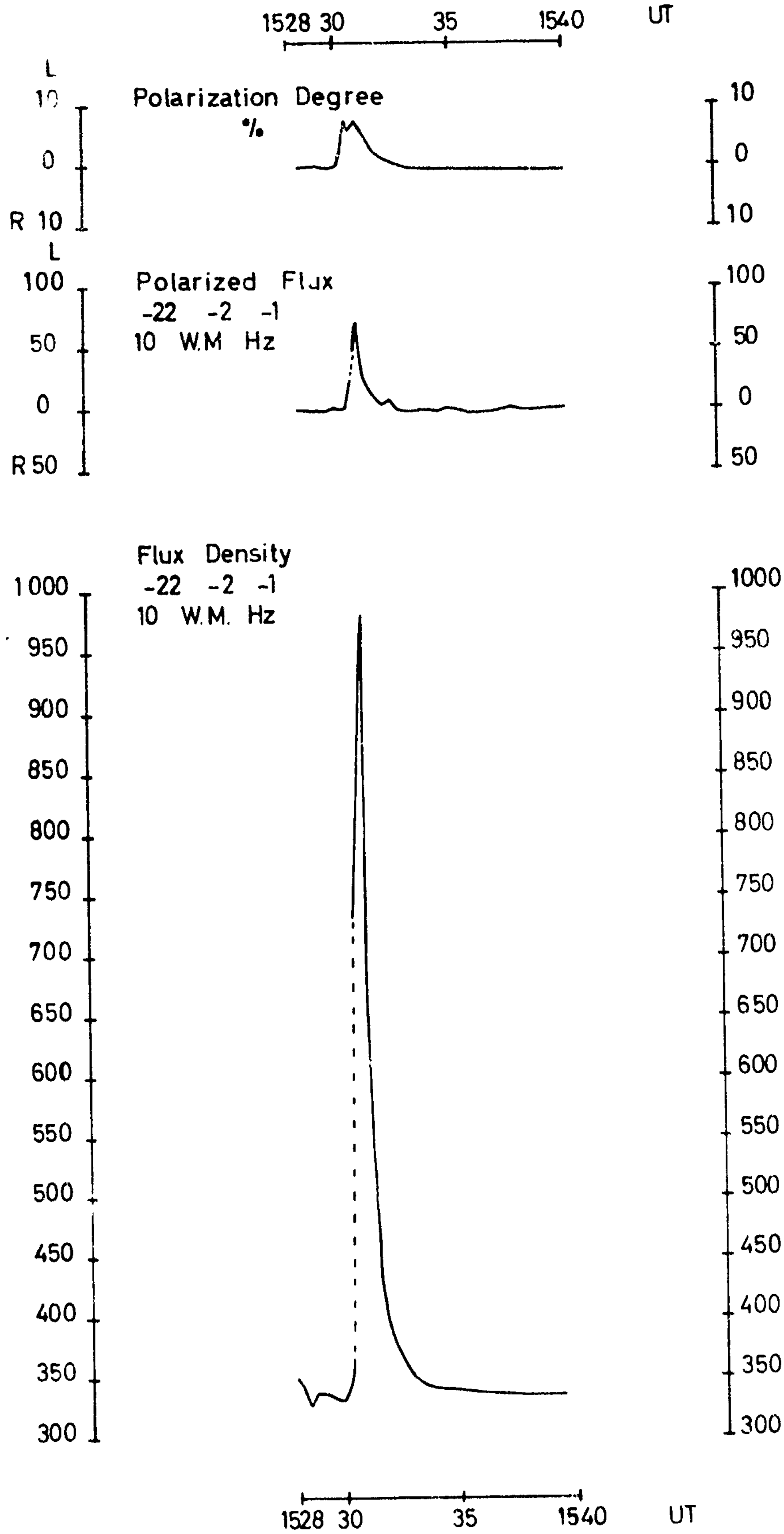
Date	From	To	From	To	From	To	From	To	From	To	From	To
1	1152	1241	1248	1456	1501	1706	1709	1956	1958	2300		
2	1125	1242	1249	1618	1620	1656	1659	2001	2007	2300		
3	1126	1301	1309	1516	1519	1701	1704	2006	2009	2300		
4	1210	1315	1318	1450	1453	1710	1713	2006	2010	2259		
5	1215	1306	1315	1502	1505	1706	1709	2001	2005	2133	2145	2227
6	1215	1256	1305	1456	1500	1811	1815	1930	2020	2200	2230	2258
7-9	NO	DATA										
10	1205	1251	1257	1456	1459	1710	1713	2006	2009	2254		
11	1200	1247	1255	1502	1505	1702	1705	2131	2135	2253		
12	1200	1256	1306	1506	1509	1716	1720	2010	2014	2253		
13	1200	1300	1307	1511	1515	1706	1708	2006	2008	2252		
14	1150	1236	1243	1301	1304	1506	1509	1706	1708	2001	2004	2252
15	1150	1256	1305	1506	1509	1656	1659	1956	1959	2251		
16	1130	1251	1253	1501	1504	1736	1738	1956	1959	2227		
17	1130	1246	1256	1506	1508	1702	1705	1956	2000	2250		
18	1130	1315	1325	1456	1459	1701	1704	1956	1959	2250		
19	1130	1300	1308	1505	1508	1705	1708	2002	2005	2249		
20	1130	1256	1314	1512	1514	1656	1659	2001	2004	2248		
21	1220	1256	1305	1506	1509	1701	1704	2005	2008	2247		
22	1130	1242	1251	1446	1513	1705	1708	1951	1957	2247		
23	1130	1306	1313	1502	1505	1706	1708	2004	2009	2246		
24	1125	1301	1311	1501	1504	1706	1709	2004	2012	2247		
25	1125	1330	1338	1450	1457	1706	1708	2002	2005	2247		
26	1147	1246	1255	1506	1509	1706	1708	2005	2008	2247		
27	1125	1300	1309	1501	1504	1655	1658	2015	2018	2247		
28	1125	1321	1327	1456	1500	1656	1658	2002	2005	2248		
29	1125	1246	1253	1457	1615	1746	1748	2026	2030	2247		
30	1125	1306	1314	1501	1504	1549	1852	1956	1959	2247		
31	1125	1251	1259	1505	1508	1702	1705	2006	2009	2245		



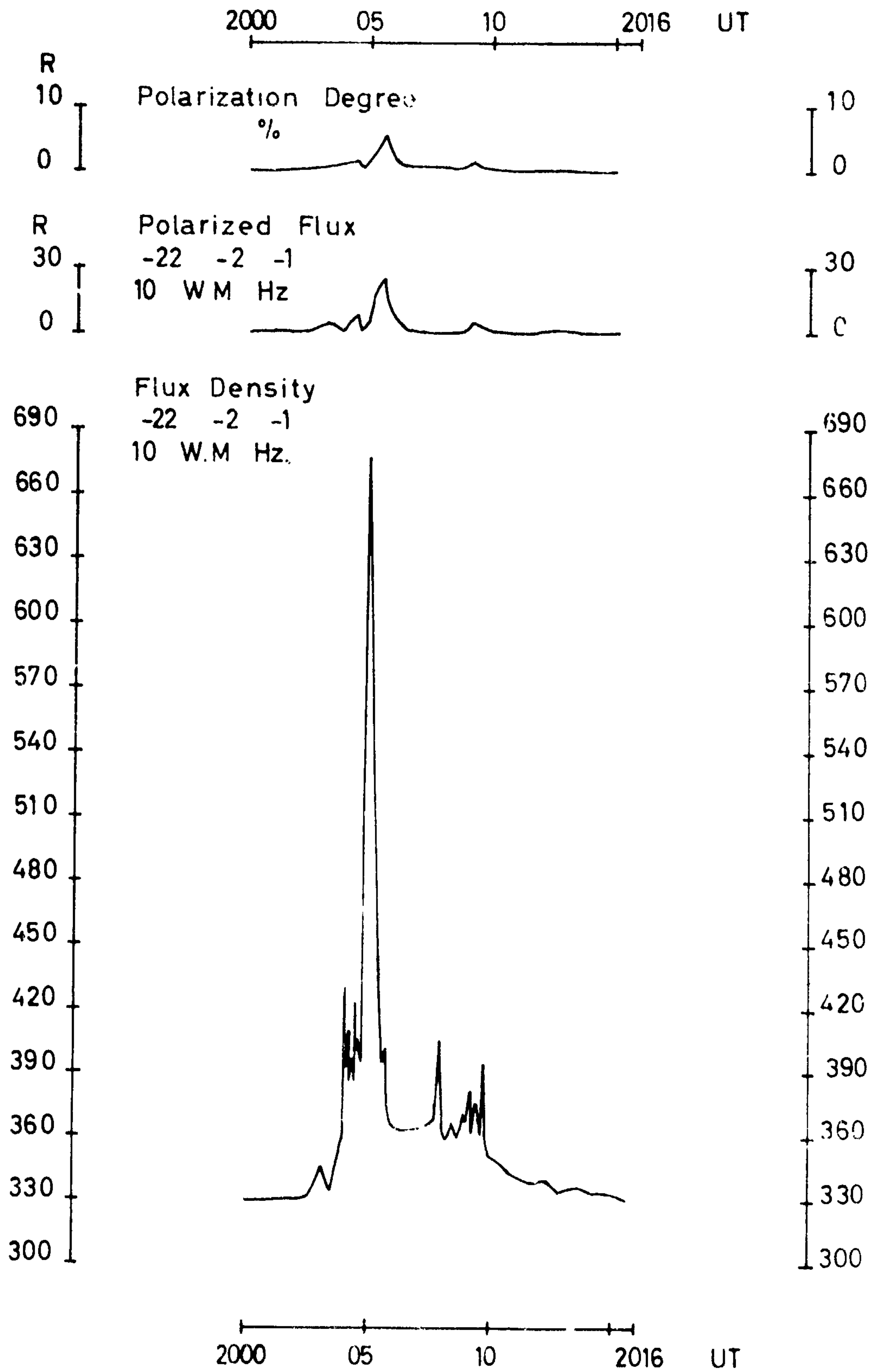
Complex Burst at 9400 MHz.
Huancayo, Perú
March ,1 1970



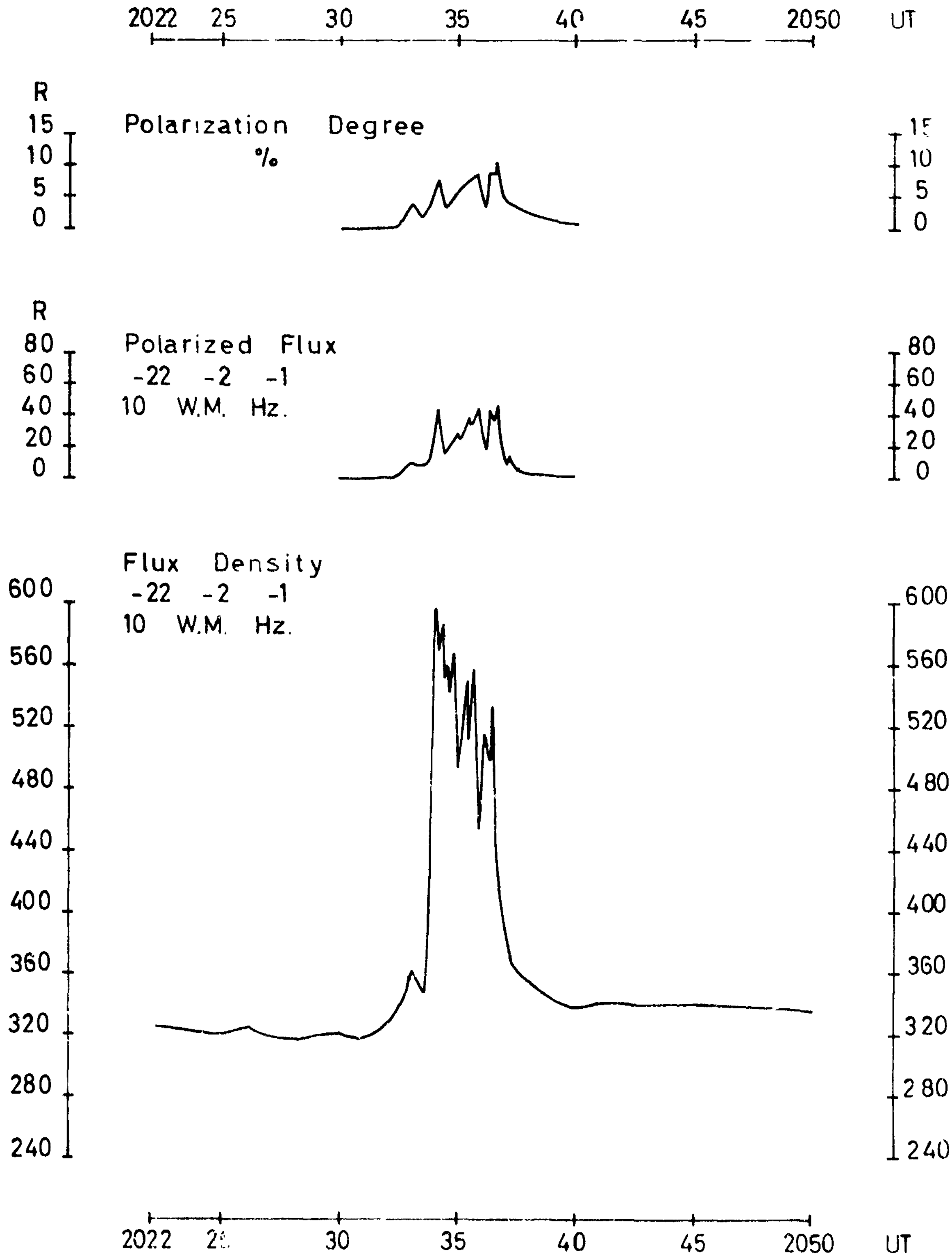
Complex Burst at 9400 MHz.
Huancayo, Perú
March., 1 1970



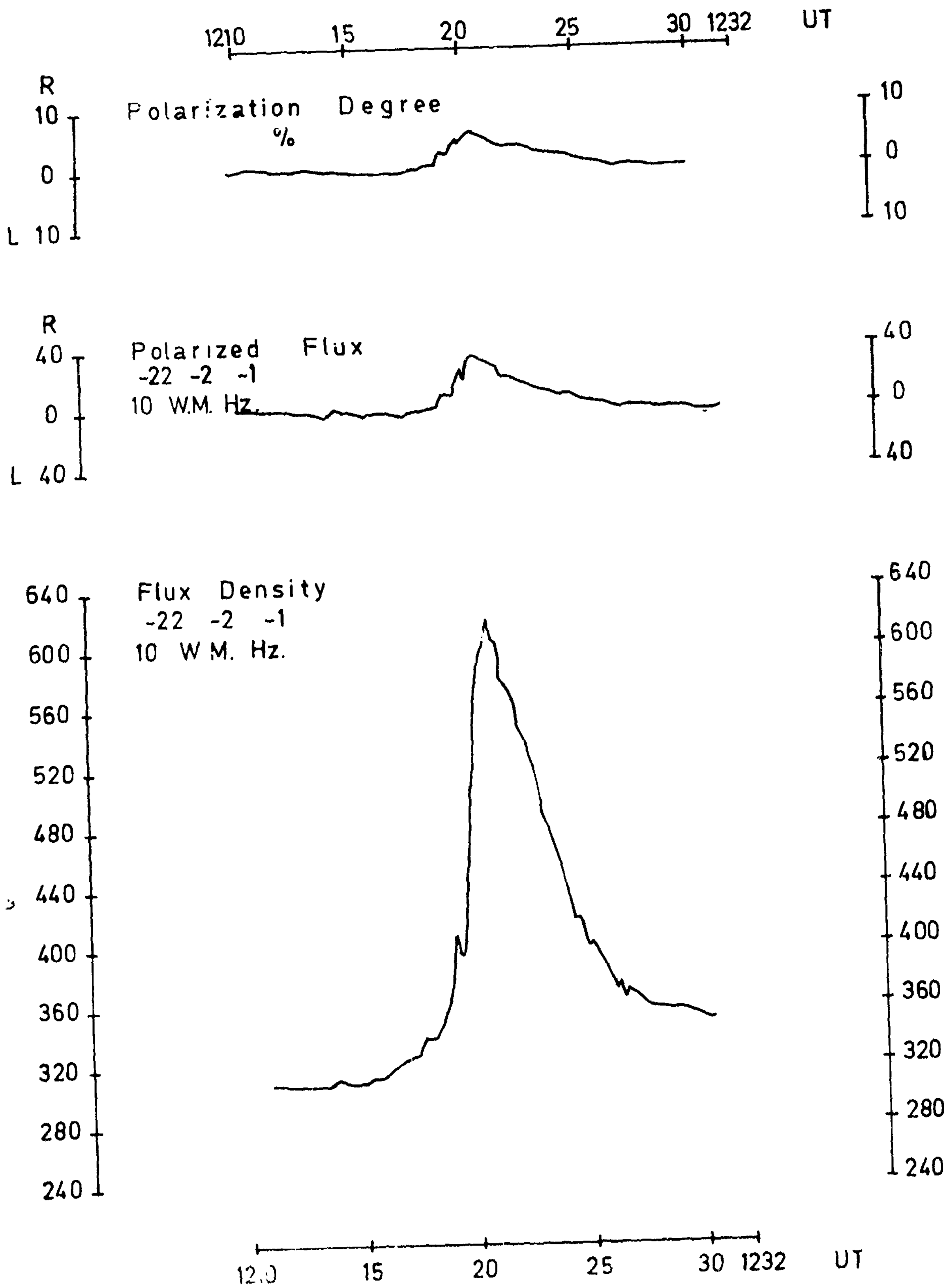
Simple Burst at 9400 MHz.
Huancayo, Perú
March, 1 1970



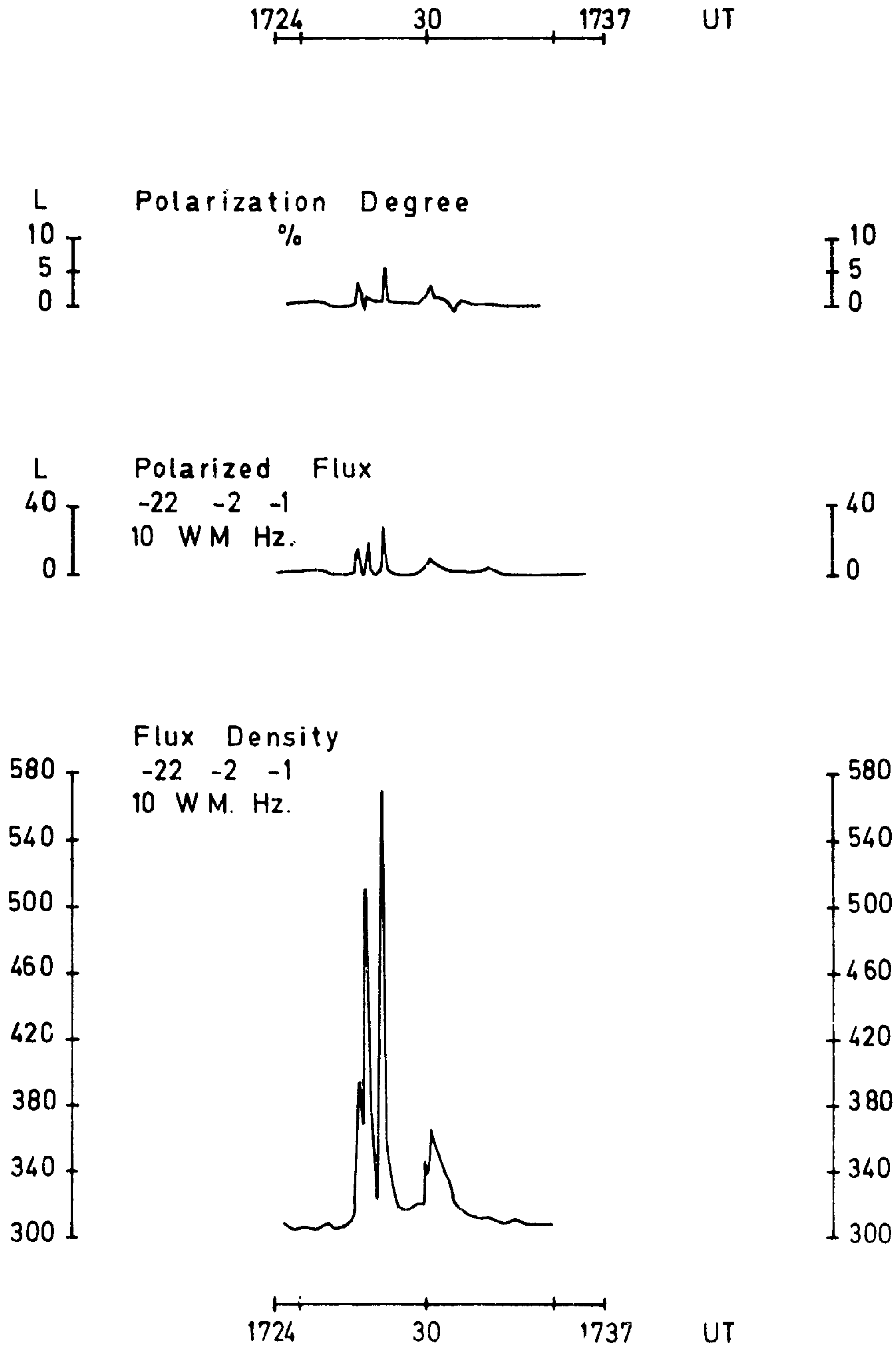
Complex Burst at 9400 MHz.
Huancayo, Perú
March, 1 1970



Complex Burst at 9400 MHz
Huancayo, Perú
March 3 1970



Simple 4 Burst at 9400 MHz
Huancayo , Perú
March , 25 1970



Complex Burst at 9400 MHz.
Huancayo, Perú
March, 26 1970

Codes in the Outstanding Occurrences and Polarization Anomalies.

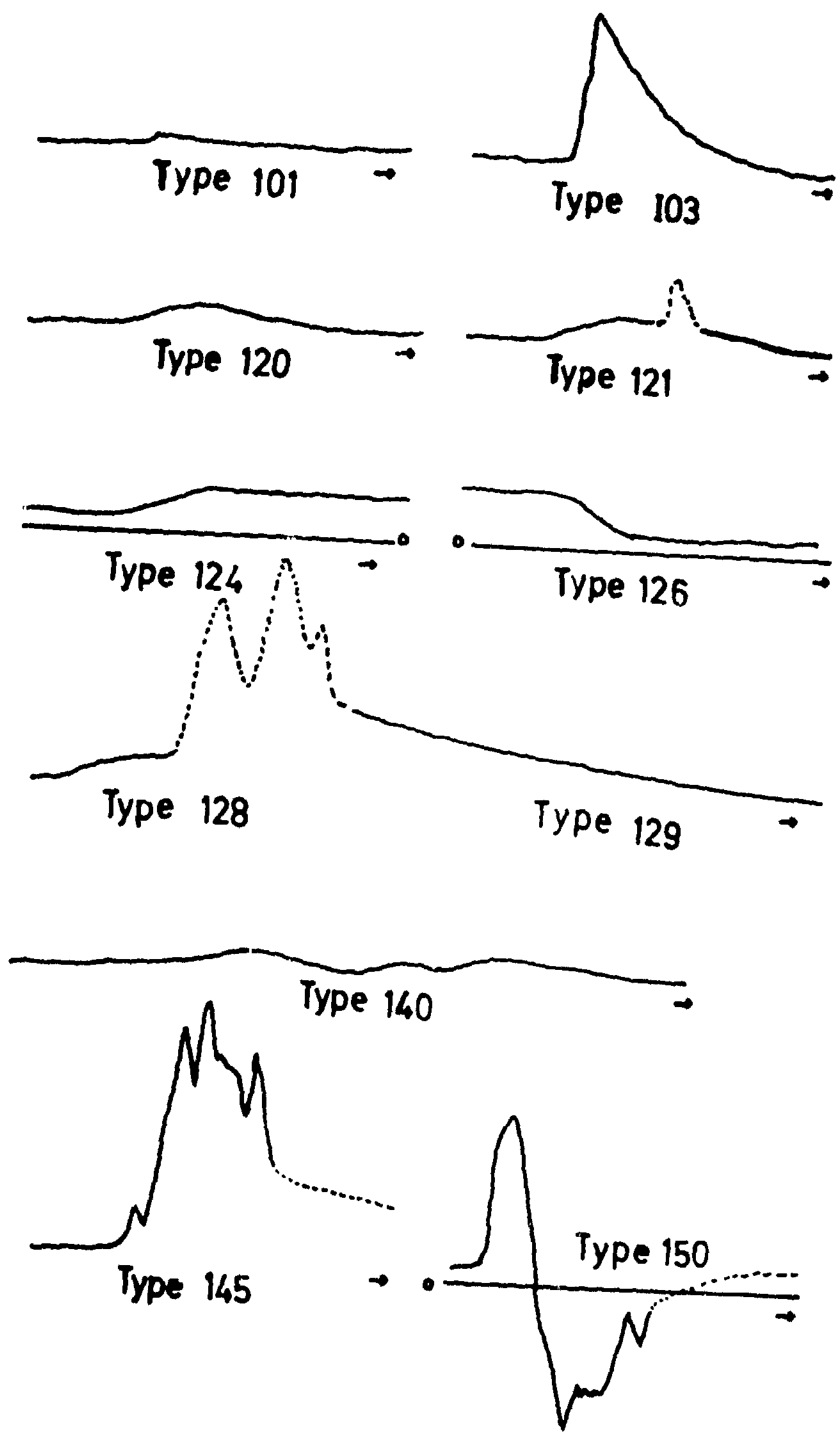
1. Definiteness of occurrence time of phenomena
   - E : Phenomenon in progress before observation began.
   - D : Phenomenon continues after observations began.
   - U : Approximate.

2. Types of phenomena in flux density measurements.

   - 1: Simple 1
   - 2: Simple 1F
   - 3: Simple 2
   - 4: Simple 2F
   - 8: Spike
   - 20: Simple 3
   - 21: Simple 3A
   - 22: Simple 3F
   - 23: Simple 3AF
   - 24: Rise
   - 25: Rise A
   - 26: Fall
   - 27: Rise and Fall
   - 28: Precursor
   - 29: Post Burst Increase
   - 30: Post Burst Increase A
   - 31: Post Burst Decrease
   - 32: Absorption
   - 40: Fluctuation
   - 41: Group of Bursts
   - 42: Series of Bursts
   - 45: Complex
   - 46: Complex F
   - 47: Great Bursts

3. Types of Anomalies in polarization measurements.

   - 101: Simple Small impulsive anomaly
   - 103: Simple impulsive anomaly
   - 120: Gradual anomaly
   - 121: Gradual anomaly mounting other anomaly
   - 124: Rise of polarization
   - 126: Fall of polarization
   - 128: Precursory anomaly before major anomaly
   - 129: Gradual decrease after an impulsive anomaly
   - 140: Fluctuation
   - 145 Complex anomaly
   - 150: Complex anomaly inverting polarization sense.


Type 101
Type 103
Type 120
Type 121
Type 124
Type 126
Type 128
Type 129
Type 140
Type 145
Type 150