1963LIACo..11..535F

52. — PRELIMINARY RESULTS CONCERNING THE ATMOSPHERIC ACTIVITY OF JUPITER AND SATURN

J. H. FOCAS
Athens Observatory, Greece

General

With regard to the evolution of the jovian atmospheric phenomena, the following precisions can be made :

— The apparition of brilliantly white and dark matter on Jupiter, is the prominent character of atmospheric activity on this planet.

— The apparent amount of brilliantly white and dark matter gives evidence of the intensity of the atmospheric activity.

— The knowledge of the fine structure of the jovian features allows their classification by forms, brilliancy, dimensions, time of apparition and life time within the cycle of activity and level in the atmosphere.

— The study of the ascending, descending, lateral and vortical motions of brilliant and dark matter, allows conclusions on the dynamics of the jovian atmosphere.

— The manifestations of atmospheric activity are identical for the whole planet irrespectively of the zenographical latitude ; the scale and intensity of the phenomena vary with the zenographical latitude.

— Distribution and motion of the jovian markings as a whole characterize a zonal circulation. Meridian circulation in the cells is evident.

— The total activity on the planet during the last 100 years seems to be stronger in the southern hemisphere.

— The minimum intensity of the total activity for the whole planet seems to follow a 20-22 years cycle.

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— The propagation of the activity by starting cycle seems to be effected from 40-45° of zenographical latitude towards the equator ; it changes (opposite) direction in the course of the 20-22 years cycle.

— In the case of Saturn, activity shows propagation from 45-50° of cronographic latitude towards the poles.

Observational data

a. Visual observations and measures taken in the period 1857-1962 by : different observers 1857-1880 ; Lohse, Potsdam 1881-1909 ; British Astron. Assoc. and Lau, 1910-1923 ; S. Plakidis, Athens, 1924-1933 ; J. H. Focas, Athens 1933-1962.

b. Photographs taken by : B. Lyot and H. Camichel (for the most part), Pic-du-Midi 1914-1958 ; J. H. Focas, Athens 1953-1962.

c. Polarimetric observations taken by : B. Lyot, Meudon 1923-1926; A. Dollfus, Pic-du-Midi 1951-1955; J. H. Focas, Athens 1955-1961.

Connection between brilliant and dark matter :

— The white-yellowish zones of Jupiter examined under perfect seeing conditions with a high resolving power show a cumuliform structure of approx. 1 sec. arc size. This is the aspect of the inactive areas and should not be confused with the brilliant spots of a few seconds of arc size, characterizing the disturbed areas.

— The starting stage of the jovian activity is cataclysmic. Paroxysm is manifested by the apparition, on the said cumuliform ground, of brilliantly white spots as isolated units, couples or families ; these spots appear suddenly on one or more points of the atmospheric cells ; for the most part of the cases paroxysm propagates along the axes of the cells oppositely to the direction of rotation of the planet (successive apparition of such spots on increasing longi-

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tudes). In some cases the disturbance develops simultaneously either part of a given point of the cell. The life time of these spots varies from a few days to several weeks. The repartition of the energy in the cells seems to be non homogenous. (Fig. I and 2).

— The stage following the paroxysm is marked by the apparition of dark nodes at the following end of the brilliant spots ; dark matter as a rule, follows brilliant matter. The dark nodes are the emanation points of dark filamentary strips. Such strips moving polewards, oppositely to the direction of rotation of the planet, spread along the axes of the cells and result into dark belts. At this initial stage the belts reach their maximum darkening. The longitudinal distribution of dark matter in the cells is closely connected with brilliant matter.

Time elapsed between the apparition of brilliant matter and the formation of the belts, in principle, does not exceed one year (Fig. 3).

— The stage following the formation of the belts is characterized by the apparition by intervals, of brilliant spots in the middle of the dark or semi-dark belts or at their boundaries. Brilliant matter appearing among dark matter provokes a pressional effect and deviation of the latter ; dark belts become suddenly broader when brilliant matter appears along their central axis. Brilliant matter appearing at the boundaries of the belts provokes curvature of the components inwards.

The apparition of bright matter and the resulting deviation of dark matter denote ascending motion of bright matter in the cells.

— In the case of narrow bands, bright spots appear first below the bands, these latter being projected in front of the bright spots ; in their ascending motion the bright spots break the bands up.

— Dark bands are broken up by bright spots being in lateral motion. (Fig. 5 and 6).

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— Dark nodes created at the boundaries of brilliant spots are the emanation points of narrow strips of a spiral aspect. Such brilliant spots and strips as a whole characterize a vortex system.

Dark matter being at the vicinity of bright spots in vortical motion is attracted towards the bright spots as by a suction effect.

— Filamentary strips connected with brilliant spots in vortical motion are visible up to the circumpolar areas of Jupiter, more pronounced in the equatorial and adjacent areas, less pronounced in high latitudes due to absorption. Such formations on Saturn, thanks to the favourable inclination of the axis of rotation of this planet, are visible up to the poles.

Strips develop under a screw-like form. Strips created in one hemisphere are sometimes crossing the equator and ride belts in the opposite hemisphere ; they are moving at higher levels than the belts ; proper motion of these items is peculiar.

— Strips characterize an epigenic stage of activity in the cells after maximum.

Strips created at the boundaries of bright spots are deviated and attracted towards new bright spots emerging at their vicinity.

— Evolution of strips is rather slow. Their life-time ranges from a few days to three months.

— Strips remain visible after disappearance of the brilliant spots from which they emanate. They seem to be the residue of decreasing activity.

Strips having vanished by decreasing activity may suddenly become stronger than previously as a result of revival of the activity at the same area of the cell. (Fig. 7 to 12).

— Their fine structure shows that strips consist of discontinued dark blocks ranged a screw-like form.

— The Red Spot or Pseudo-Red Spots show by starting activity an alternation of brilliant and dark matter followed by pressional effects, vertical, vortical and lateral motions ; by decreasing activity they become dark. Their fine structure shows fractional dark masses in motion, vanishing progressively. (Fig. 13 to 23).

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— South Tropical Disturbance shows an alternation of bright and dark matter in longitudinal expansion along the axis of the corresponding cell.

— The Red or Pseudo-Red Spots and the South Tropical Disturbance seem to constitute one and the same disturbance phenomenon in the corresponding cell with various manifestations.

— Dark belts or bands after maximum darkening vanish progressively ; blocks of dark matter disappear and the belts take the form of a solenoid with two distinct components ; these components in turn become very faint and narrow ; they remain visible for a long time with intermittent disappearance by localities and vanish progressively as if they were seen through a transparent or semi-transparent medium of increasing thickness ; polarization measured on dark belts shows variation for the same angles of sight of the overlying absorbing atmospheric layer, due to descending motion of the dark matter in the cells. Ascending and descending motions in the cells speak for a meridian circulation.

— The drift of the belts (Fig. 4) of Jupiter in latitude during the period 1875-1961 shows the following periodicities :

Southern hemisphere	*System II*		*Deviation* (*M*—*m*)	
— S. S. T. B.	approx.	12-15 *y.*	approx.	6-8°
— S. T. B.	»	14-16 »	»	3-4
— S. E. B. south edge	»	4-6 »	»	3-4
Equatorial Zone	*System I*			
— S. E. B. north edge	approx.	12-16 *y.*	»	3-4
— N. E. D. south edge	»	12-16 »	»	3-4
Northern hemisphere	*System II*			
— N. E. B. north edge	approx.	3-6 *y.*	»	3-6
— N. T. B.	»	10-14 »	»	3-4
— N. N. T. B.	»	12?	»	4-8

The drift of the belts in latitude seems to be connected with the cycle of activity in the corresponding atmospheric cells ; criteria concerning the meridian circulation in the cells may roughly be established therefrom (Fig. 30).

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— The apparent amount of dark matter is the product of atmospheric activity on Jupiter. Observational material covering approx. nine revolutions of the planet (1857-1961) allows tentative conclusions as regards the cycle as per which the activity in the jovian atmosphere develops. (Figures 24 to 29).

— The minimum total activity for the whole planet is produced according to a 20-22 years cycle. During this cycle, activity in individual cells shows one or two maxima.

— An inversion is shown as regards the intensity of activity in adjacent belts at a given time ; when f. i. the S. T. B. is strong the S. E. B. is faint and vice-versa. The same is noted in the northern hemisphere.

— It seems that by starting cycle the activity propagates from the higher latitudes towards the equator and changes direction during the 20-22 years cycle. In the case of Saturn activity shows propagation from 45-50° latitude towards the pole.

— The total intensity of the activity seems to be slightly higher in the southern hemisphere of Jupiter.

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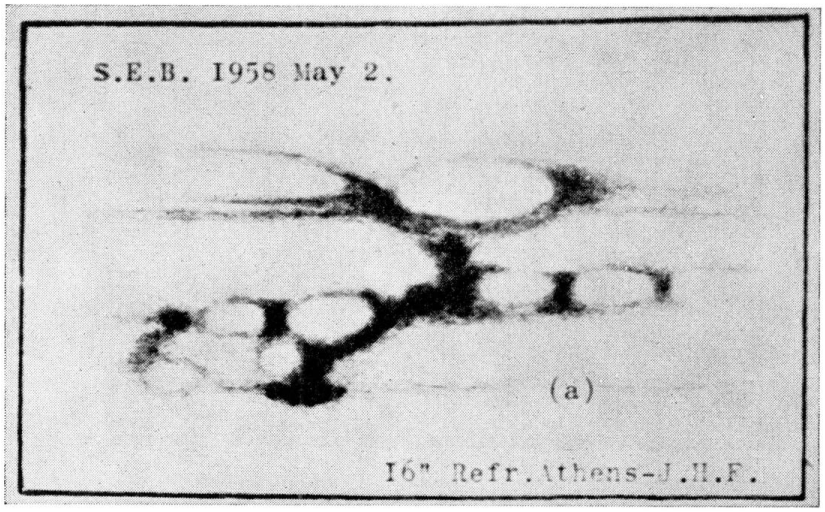

Fig. 1. — Within the remaining faint and narrow components Fig. 1 a) of the belt of the previous cycle, cataclysmic activity starts.

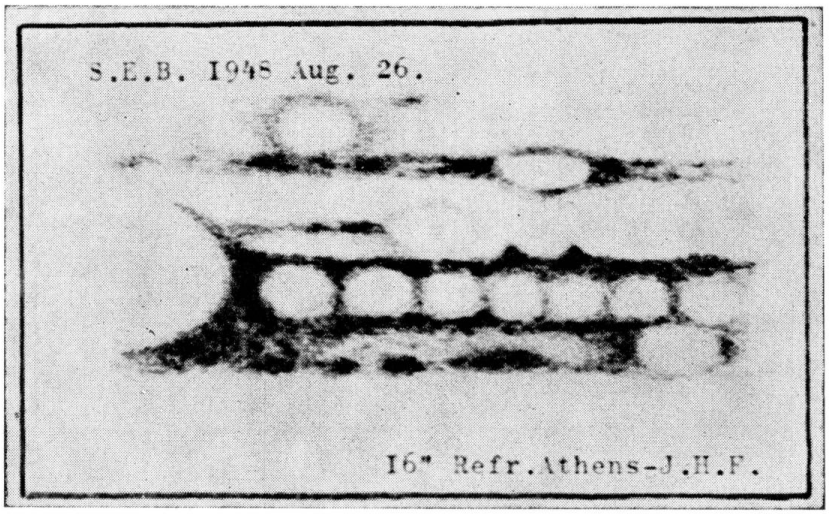

Fig. 2. — Brilliant isolated spots or groups of spots in ascending motion appear along the axis of the belt, followed by dark nodes.

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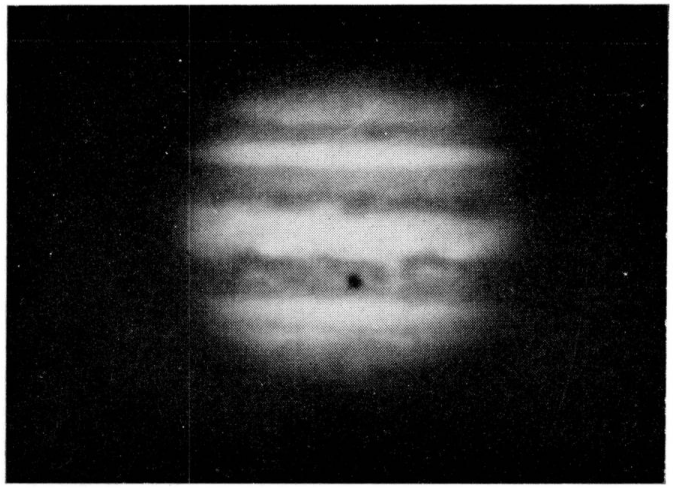

Fig. 3. — Strips and blocks of dark matter emanating from dark nodes, moving polewards oppositely to the direction of rotation of the planet, spread along the axes of the cells and form the belts.

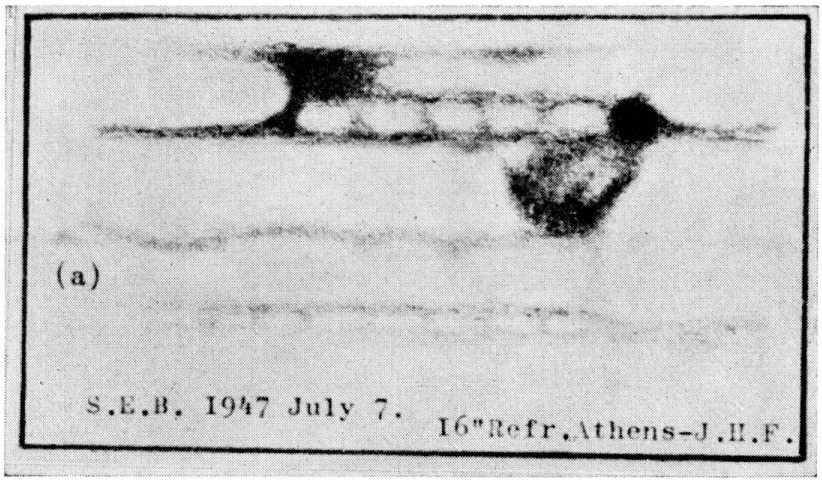

Fig. 4. — End of the activity in the S.E.B. (a). There remain traces of the components of the belt. A large bright area in ascending motion appears below the south component of the S.E.B. lying at a higher level.

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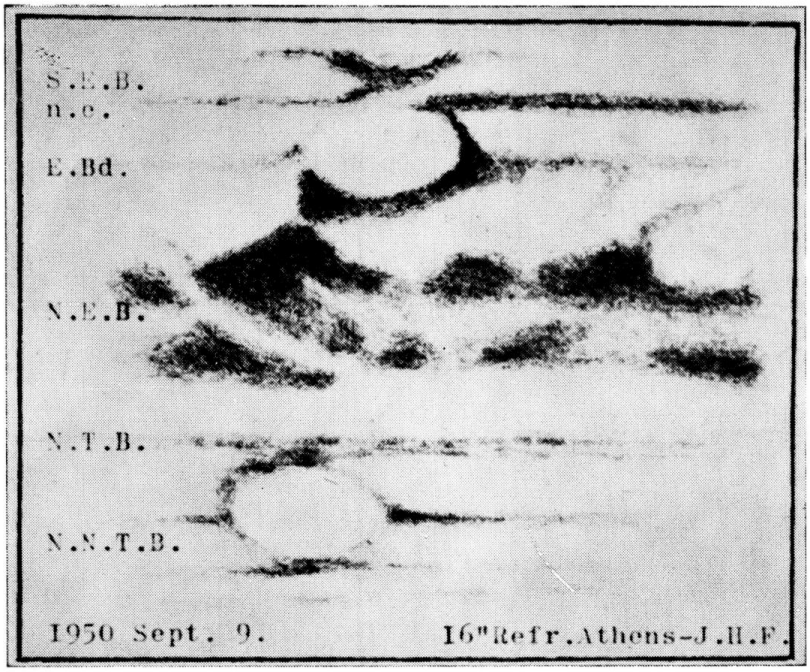

Fig. 5. — Brilliant spots in ascending motion broke up the Equatorial Band and the N.N.T.B. Deviation of dark matter as a result of the action of such brilliant spots is obvious.

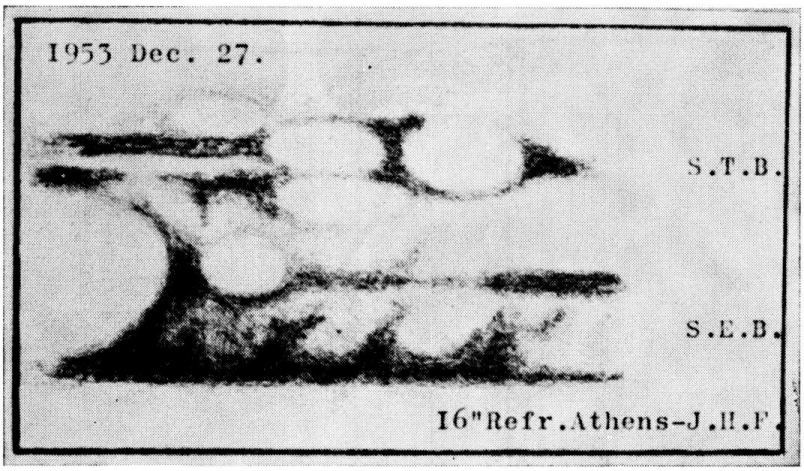

Fig. 6. — Brilliant spots in ascending motion broke up the S. T. B. and the S. E. B. s. e. provoking displacement of dark matter.

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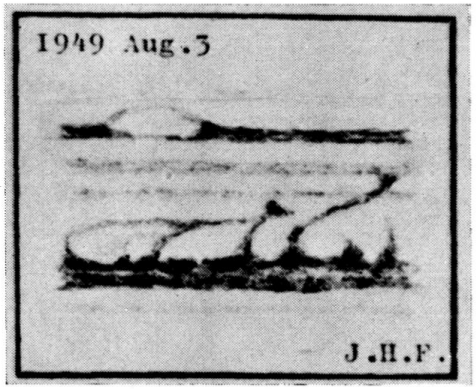

Fig. 7

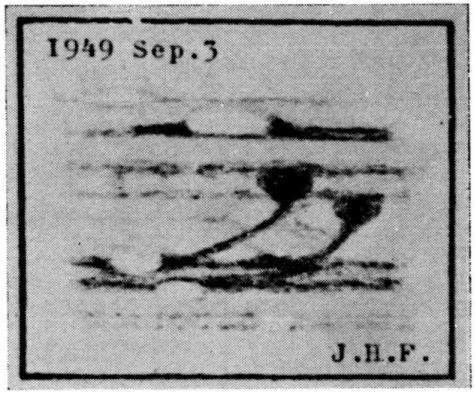

Fig. 8

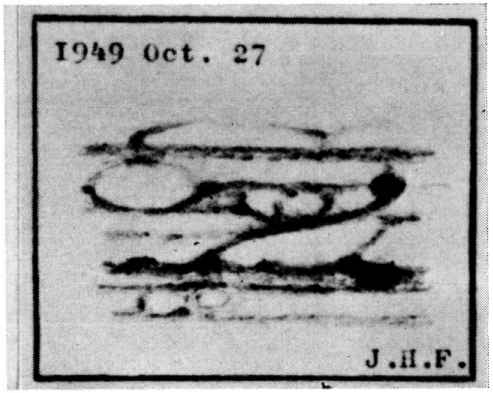

Fig. 9

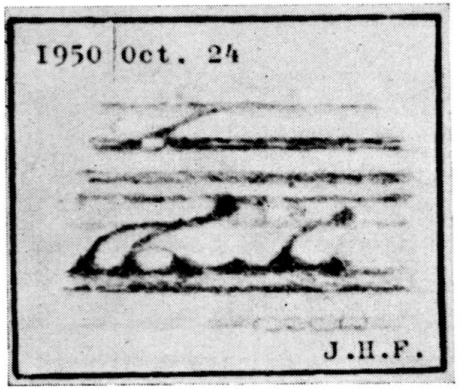

Fig. 10

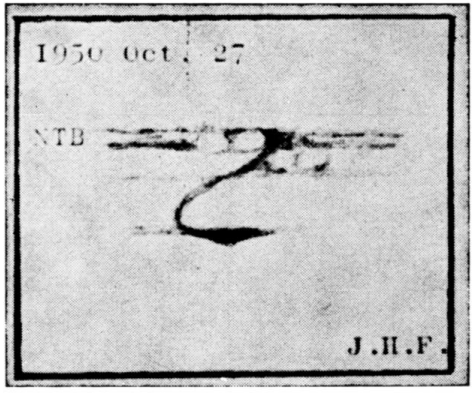

Fig. 11
16″ O. G. Athens

Fig. 12

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Fig. 7 to 12 :

Dark filamentary strips characterize an epigenic stage of activity in the cells (after maximum) ; they are recorded in active areas all over the planet. They emanate from dark nodes following brilliant spots emerging through the dark boundaries of the belts.

Strips develop under a screw like form, cross the equator and occasionally ride belts in the opposite hemisphere, moving at a higher level than the belts.

Strips are shifted over brilliant spots.

Strips remain sometimes visible after disappearance of the brilliant spots and nodes from which they emanate. — Revival of strips is often recorded.

The life-time of the strips ranges between a few days and 3 months.

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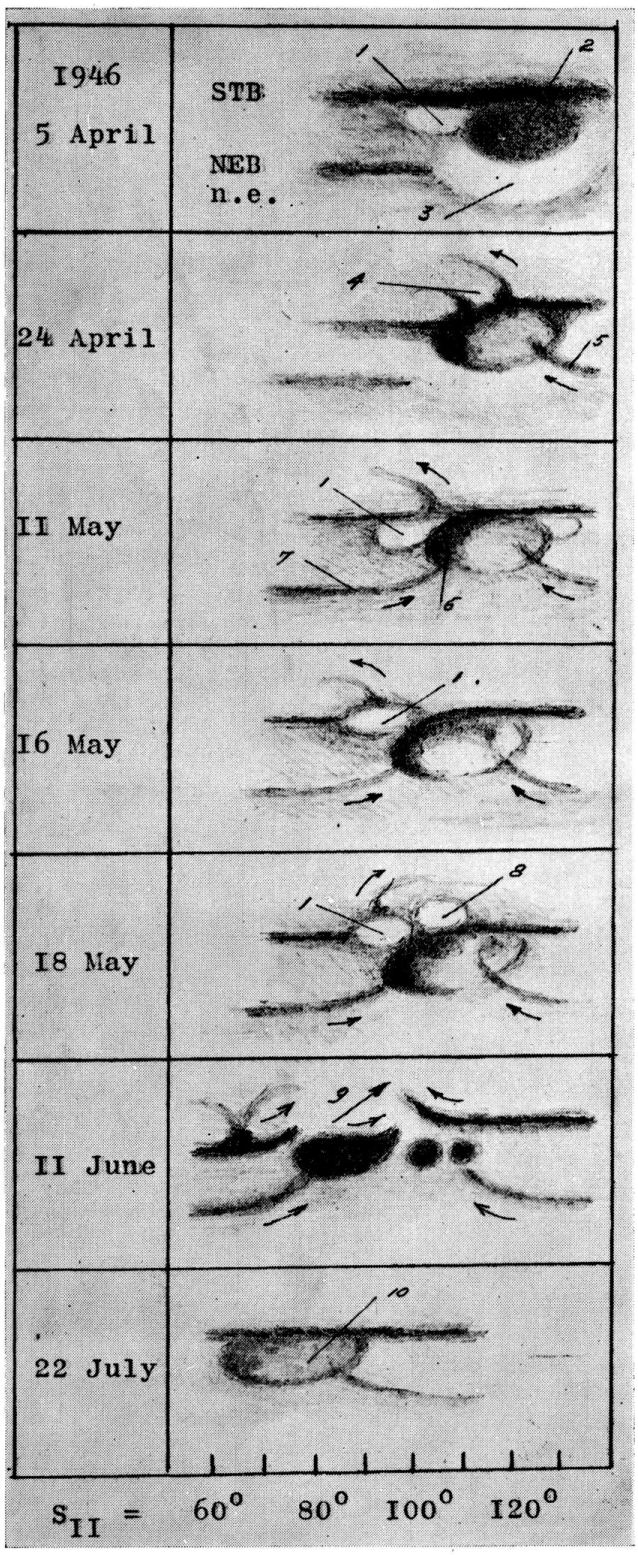
JUPITER : EVOLUTION OF A PSEUDO-RED SPOT IN THE SOUTH TROPICAL ZONE.
(TYPICAL EVOLUTION OF A CENTRE OF ACTIVITY ON JUPITER).

16″ O. G. Athens — J. H. F.



— Bright spot (1) is followed by dark matter (2) and a « hollow » is formed.

— Dark filamentary strips (4) in vortical motion appear at the disturbed centre. The S. E. B. s. e. (5 and 7) are attracted towards the disturbed area.

— Blocks of dark matter (6) are accumulated close to bright spot (1).

— The S. T. B. is broken up by bright spot (1) moving southwards (16 May).

— A new bright spot (8) appears close to (1) ; the disturbance centre seems to move in SW direction (18 May).

— Fragments of the S. T. B. and S. E. B. s. e. and blocks of the initial dark spot (2), converge towards the disturbance centre (9) moving in S. W. direction, (11 June).

— The activity ceases and the S. T. B. (10) takes its regular aspect again ; dark masses progressively vanishing persist at the place of the disturbance.

Fig. 13

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JUPITER : CYCLE (~ 11 YEARS) OF ACTIVITY IN THE RED SPOT'S AREA.
16″ REFRACTOR ATHENS.

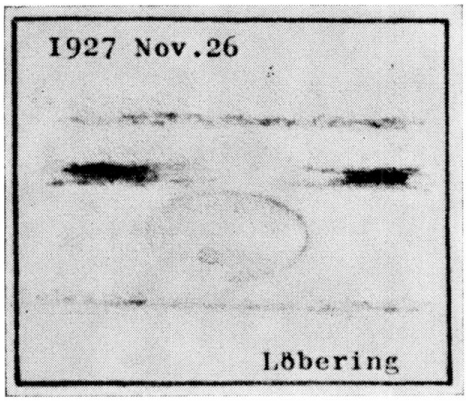

Fig. 14

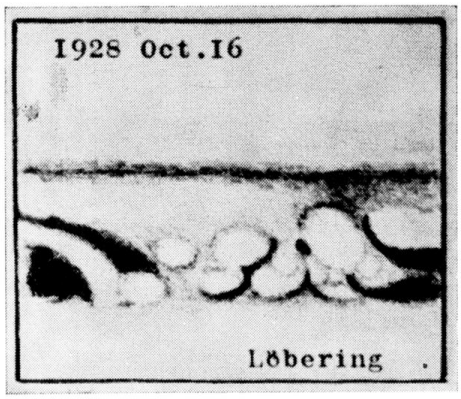

Fig. 15

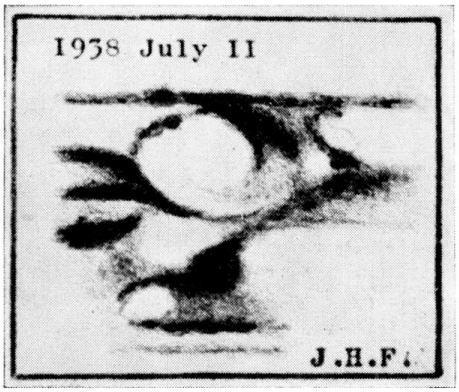

Fig. 16

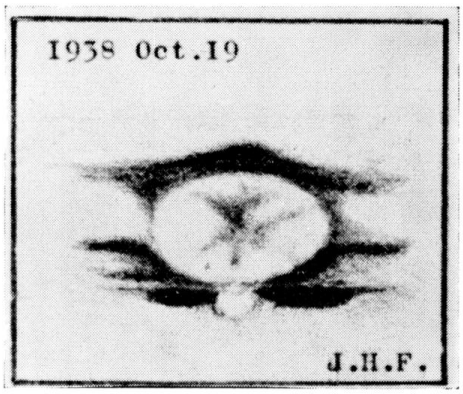

Fig. 17

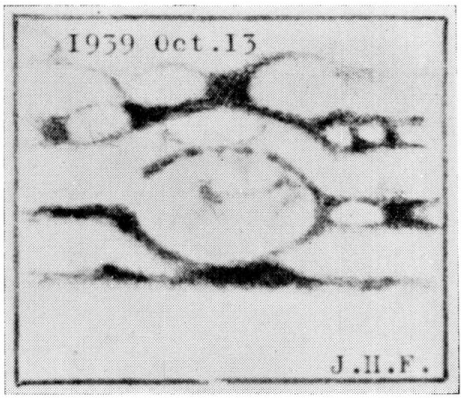

Fig. 18

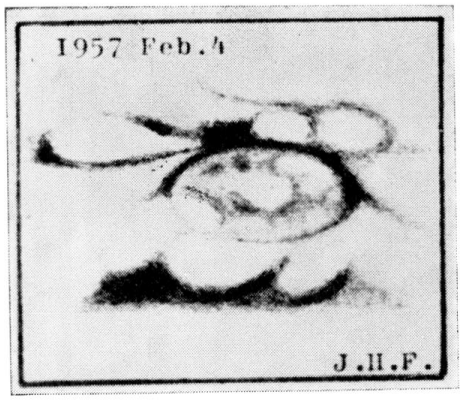

Fig. 19

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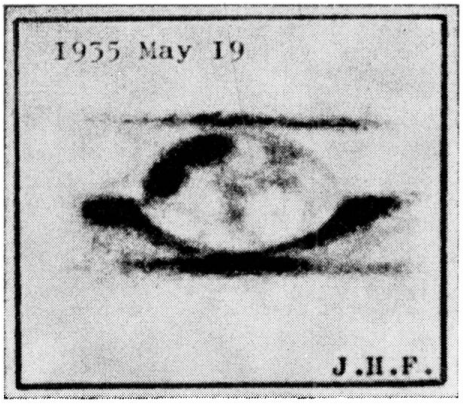

Fig. 20

Fig. 21

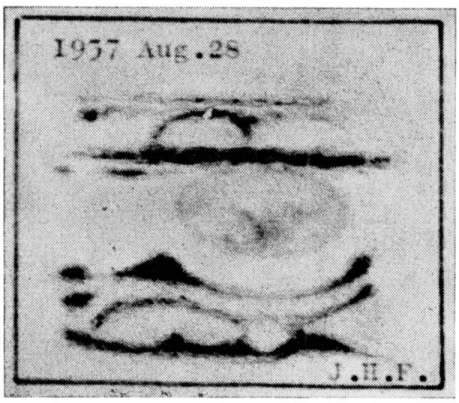

Fig. 22

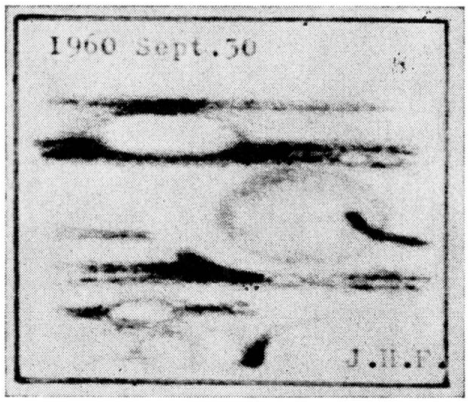

Fig. 23

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Fig. 14 to 23

The Red Spot's system is a centre of periodical (approx. II years) activity closely connected with the activity manifested in the corresponding atmospheric cell in which the south edge of the S. E. B. is produced ; it extends symmetrically eitherside of the S. E. B. s. e. (axis of the cell) and shows the typical alternation of brilliant and dark matter characterizing the activity throughout the planet.

By ending activity the R. S. is at limit of visibility or invisible, which is the case for the S. E. B. to (Fig. 14).

By starting activity, at the place of the vanished or disappeared R. S. appear brilliant spots and dark strips converging towards these latter, the S. E. B. being under formation as per the same mechanism (Fig. 15).

The evolution of the activity in the Red Spot's area shows pressional effects permanently on the S. E. B. s. e. (Hollow) and sometimes on the S. T. B. (curvature of the belt, meridian displacement of the centre of gravity of the system Fig. 17, 18, 19) attraction of dark matter towards the disturbed area as by suction effect and vortical motions of dark strips around brilliant spots (Fig. 17, 18, 19 and 23) as well as displacement of blocks of dark matter in the Red Spot (Fig. 20 and 21).

The pinkish-red or rosy aspect of the Red Spot of a rather uniform tonality is the residue of the activity in the area (Fig. 22 and 23).

The manifestations of the activity in the Red Spot's area characterize a long-lived vortex system with peculiar proper motion in longitude. Pseudo-Red Spots (Fig. 24) occasionally appearing in the same atmospheric cell, characterize a rather short lived (a few months) vortex system developing as the classical Red Spot.

(The above aspects belong to different cycles ; they are destined to illustrate roughly the evolution of the activity in the R. S. area during an average cycle).

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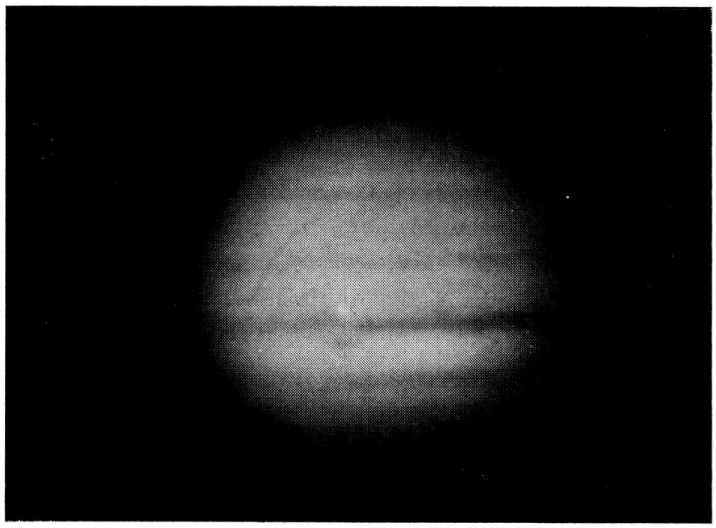

Fig. 24. — *Minimum activity*. 1943 Dec. 17 — 25″ O. G. Pic-du-Midi B. Lyot

Fig. 25. — *Maximum activity*. 1945 March 20. — 25″ O. G. Pic-du-Midi
H. Camichel

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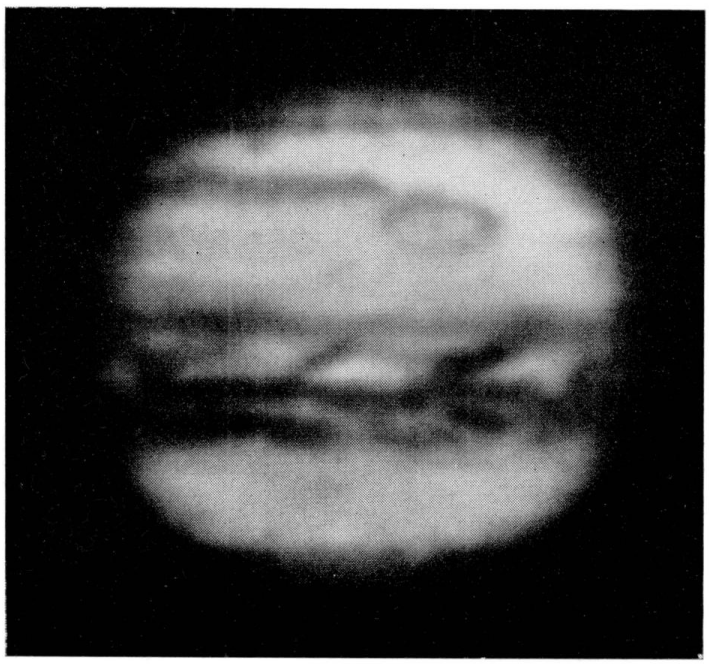

Fig. 26. — *Activity approaching minimum.* 1961 August 4. — 25″ O. G. Pic-du-Midi. — M. Marin.

(displacement of the activity in the Equat. Zone. The S. T. B. is attracted towards the southern boundary of the Red Spot)

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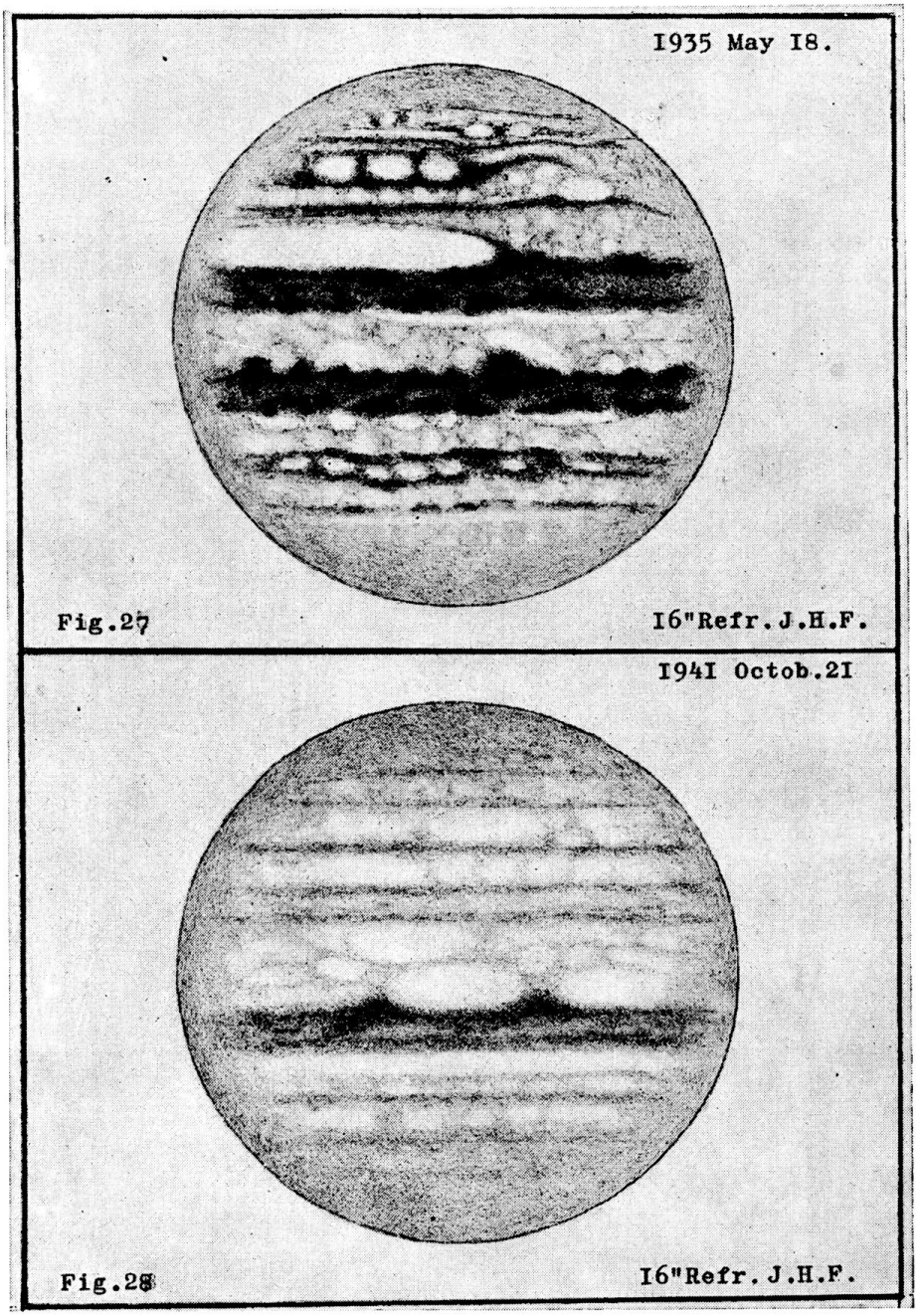

The varying amount of brilliant and dark matter on the planet is a criterium of the intensity of atmosph. activity.

Fig. 26. — Maximum activity.

Fig. 27. — Minimum activity (whole planet) ; every 20-22 years.

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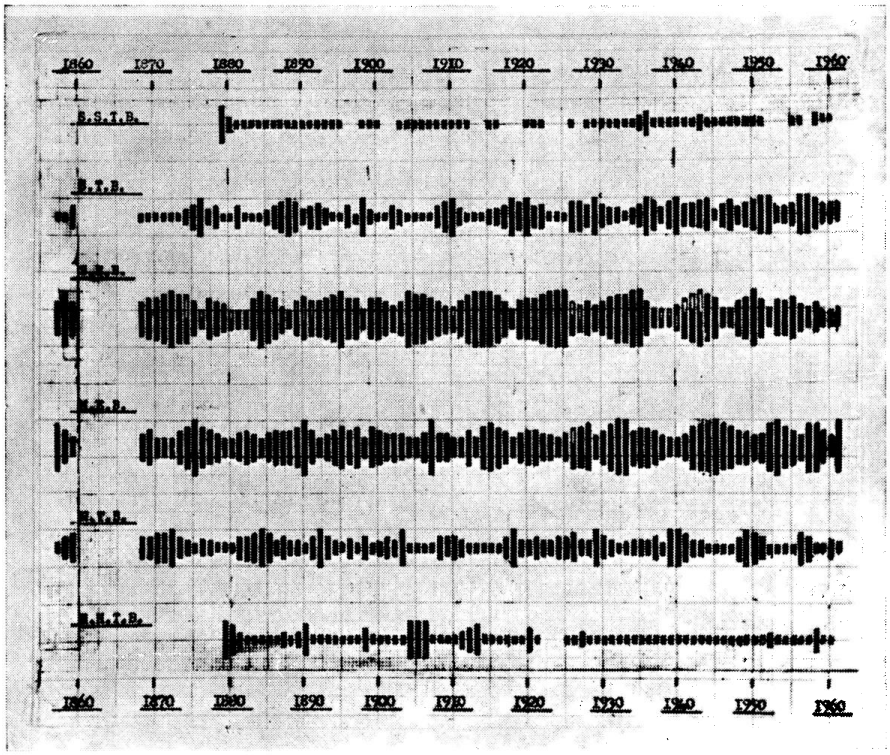

Fig. 29

The above graph is a tentative illustration of the variation of the intensity of the atmospheric activity in the two hemispheres of Jupiter ; it shows roughly the average annual intensity of the belts.

A minimum total activity for the whole planet seems to occur every 20-22 years. During this cycle, the activity in the main atmospheric cells shows one or two maxima. An inversion is noted regarding the intensity of activity in adjacent belts (S. T. B. strong — S. E. B. faint or N. T. B. faint — N. E. B. strong and vice-versa). It seems that by starting cycle the activity propagates from the higher latitudes towards the Equator.

Localization of the activity in the Equatorial Zone has been noted in 1881-1883 (Equatorial Zone including the S. E. B. the N. E. B. being faint) and in 1961-1962 (Equatorial Zone including the N. E. B. the S. E. B. being faint).

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JUPITER : DRIFT OF THE BELTS IN LATITUDE

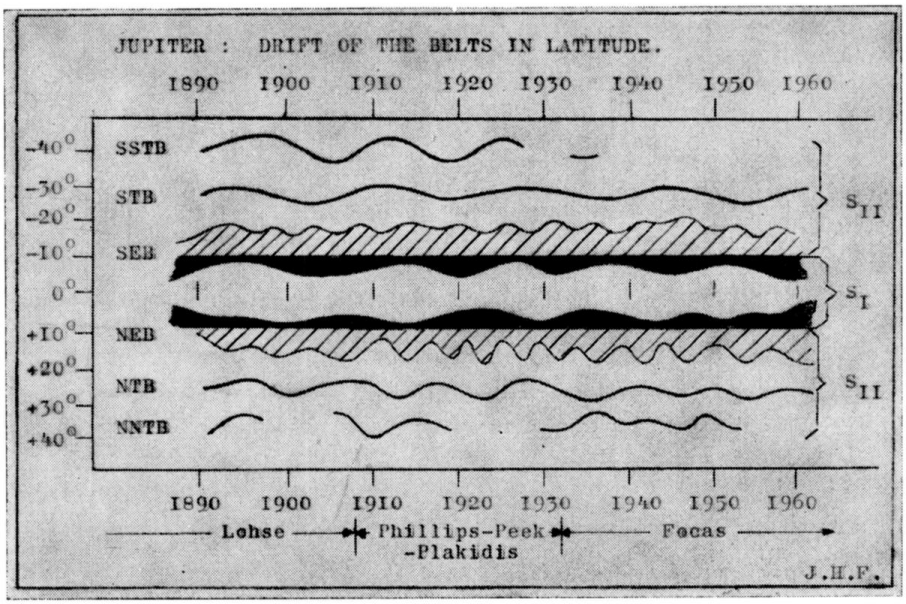

Fig. 30

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