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A RAPIDLY MOVING SPOT ON JUPITER'S NORTH TEMPERATE BELT

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A very rapid drift in the longitude of a small dark spot on the south edge of Jupiter's North Temperate Belt (NTBs) has been determined from measurements of 51 photographic plates taken in blue and ultraviolet light at the New Mexico State University Observatory between 7 July 1964 and 1 April 1965. During this interval of 268 days the NTBs spot made 7 complete circuits of the planet relative to System II, i.e., the system which normally applies to atmospheric currents in the planet's temperate latitudes. The mean daily drift of the spot was $-9^{\circ}.4056$ relative to System II, and $-1^{\circ}.7756$ relative to System I. This corresponds to a mean rotation period of $9^h 49^m 18^s.5$. A more detailed study of its motion disclosed a nearly sinusoidal displacement with respect to its mean position. A period of 300 days and an amplitude of 4° in longitude would best describe this oscillatory motion. The center of the spot remained stationary near zenographic latitude +24°, within the probable error of the measures. This solitary spot apparently represents the fifth observed outbreak of

activity in the well-known but rarely observed North Temperate Current "C", a current which has produced the shortest rotation periods ever recorded on Jupiter. There is evidence that the outbreak of rapidly rotating spots in this latitude may be periodic, as the spots tend to appear at twelve-year intervals when the North Temperate Belt lies nearest to the planet's equator. An outstanding characteristic of the most recent NTBs spot was its almost complete invisibility to the visual observer, and that it could be photographically recorded only on plates taken in blue and ultraviolet light.

DESCRIPTION OF THE NTBs SPOT

In early November 1964, while comparing a pair of photographs of Jupiter taken in blue light and separated by an interval of only two days, one of us (B. A. S.) noticed that a small dark spot on the south edge of the North Temperate Belt (NTBs) had shifted about 18° in longitude relative to a pair of round white spots in the North Tropical Zone (Smith and Reese, 1965). This unusual motion suggested that the dark spot was in the well-known but rarely observed North Temperate Current "C" which has produced the shortest rotation periods ever recorded on Jupiter. The first outbreak of rapidly rotating spots in this current was observed by W. F. Denning in 1880. Since Denning's discovery there had been only three additional recorded outbreaks. The NTBs spot was immediately placed on the photographic observing schedule, and a thorough search was made of earlier photographic plates. As a result, it soon was found that the spot had been recorded regularly on blue and ultraviolet plates since 7 July 1964. The derived rotation period definitely established its association with the North Temperate Current "C".

Both the spot and the North Temperate Belt were much darker in blue light than in green light. Moreover, the spot and even the belt were virtually invisible in red light (compare Figures 1 and 2). Thus, these features were obviously quite deficient in blue light; this was confirmed by the deep orange color observed visually in the North Temperate Belt by C. W. Tombaugh and one of the writers (E. J. R.) with the former's 16-inch Newtonian reflector. Time-lapse photographs in blue and ultraviolet light indicate that the spot darkened more rapidly than the North Temperate Belt as the limb of the planet was approached (see Figure 3). This would suggest that the spot was situated at a relatively high level in the Jovian atmosphere.

The actual appearance of the NTBs spot on blue photographs varied somewhat during the life of the spot (see Figure 4). The appearance was sometimes that of a small, dark condensation--usually somewhat diffuse--situated on the southern part of the North Temperate Belt, and projecting somewhat into the North Tropical Zone. A thin, dusky wisp or festoon frequently was recorded, extending southward across the North Tropical Zone from the projecting spot. On other occasions the spot did not appear darker than adjacent portions of the belt, but appeared merely as a small hump on the south edge of the belt, with or without an appended festoon. Frequently, on dates when the spot was not dark against the belt as it crossed the

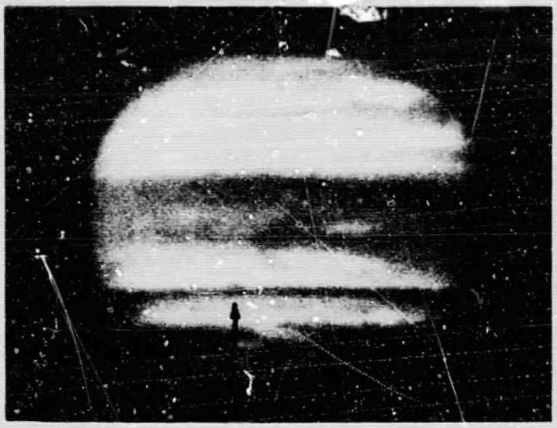

Fig. 1. Composite photograph of Jupiter in blue light, 25 November 1964, 0637 U.T., $\omega_1 = 340°$, $\omega_2 = 215°$. The rapidly moving dark spot (marked by an arrow) along the south edge of the North Temperate Belt has just passed conjunction with one of the north tropical white spots. The photographs on this page were taken at the 66-foot Cassegrain focus of the 12-inch Fecker reflector and are oriented so that south is at the top.

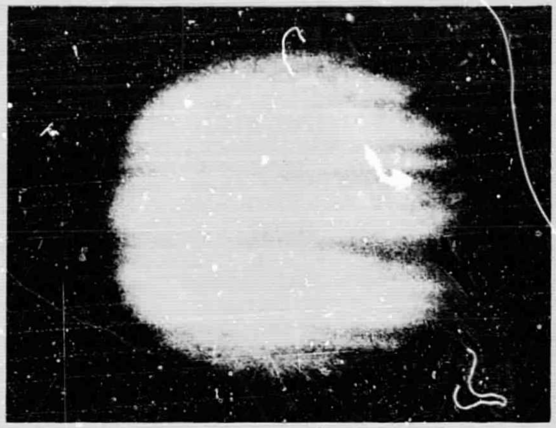

Fig. 2. Composite photograph of Jupiter in red light, 25 November 1964, 0646 U. T., $\omega_1 = 346°$, $\omega_2 = 221°$. The NTBs spot is quite invisible in this red light photograph--even on the original negative.

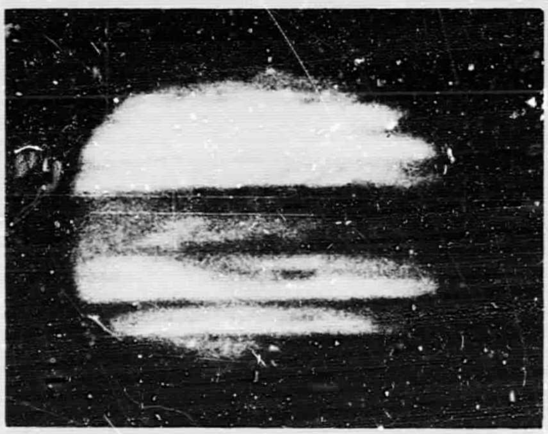

Fig. 3. Composite photograph of Jupiter in blue light showing the NTBs spot as very dark near the terminator, 25 November 1964, 0446 U. T., $\omega_1 = 273°$, $\omega_2 = 148°$. The original plate reveals detail on the planet as small as $0''.4$.

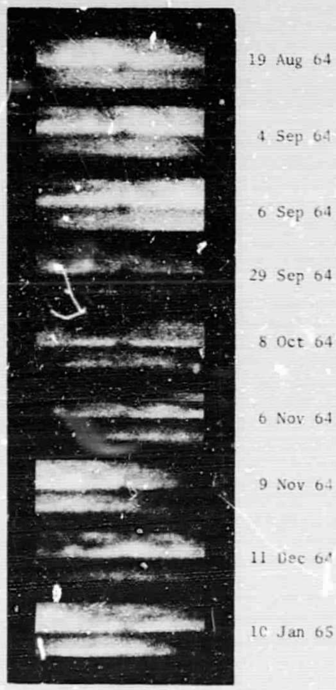

Fig. 4. A series of photographs of Jupiter in blue light showing some of the changing aspects of the NTBs spot, which is positioned near the center of each strip. The rapid motion of the dark NTBs spot relative to a bright spot in the North Tropical Zone is shown on the photographs for 4 September and 6 September. The dark belt extending horizontally across the middle of each strip is the North Temperate Belt.

central meridian, it would nevertheless appear quite dark against the belt when near the limb of the planet.

The NTBs spot was darker and more conspicuous during August, September, and October 1964 than it was later in the apparition; however, for a few days around 25 November the spot was nearly as conspicuous as it was at any time during the earlier interval. A progressive fading or loss of contrast of the spot began in early December and resulted in the complete disappearance of the spot, first in blue light and finally in ultraviolet. The last plate recording the spot in blue light was taken on 17 January 1965. The final record of the spot was made in ultraviolet light on 1 April 1965.

Because of the diffuse outline of the NTBs spot and the difficulty of resolving its northern edge against the dark background of the North Temperate Belt, determinations of its length and width were subject to considerable uncertainties, both through measuring error and the ambiguity of its boundary. However, it is believed that the measured variations in its dimensions (tabulated in Table III) are fairly reliable indications of real variations. The average length and width of the spot were each about 6000 kilometers or a little more than 5° of longitude and latitude respectively.[1]

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[1]The length and width of the spot were computed in degrees of longitude and zenographic latitude respectively. Conversions from degrees to kilometers made use of the following derived formulas:

$$1° \text{ of longitude (in kilometers)} = 1266.2 \cos \beta'' - 21.7 \cos 3 \beta''.$$

$$1° \text{ of zenographic latitude, } \beta'', \text{ (in kilometers)} = 1204.? - 124.3 \cos 2 \beta''.$$

A few secondary features apparently associated with the NTBs spot were observed occasionally. A very diffuse preceding end of a slightly darker section of the North Temperate Belt, which preceded the NTBs spot by about 25°, was observed visually and recorded on photographs taken in green and red light. This feature persisted from 9 November 1964 to 15 February 1965. Photographs taken in blue light from 19 August 1964 to 2 September 1964 recorded a short, faint section of the North Temperate Belt immediately following the dark NTBs spot. During February and March 1965, when the NTBs spot was recorded as a dark spot only on plates taken in ultraviolet light, photographs taken in green light revealed a short, lighter section of the North Temperate Belt centered at the longitude of the invisible NTBs spot. The longitudinal drifts of these secondary features closely paralleled the drift of the NTBs spot.

DRIFT OF THE NTBs SPOT IN LONGITUDE

The longitudes of the NTBs spot have been measured with a Mann measuring machine by H. G. Solberg and one of us (E. J. R.) on 51 blue and ultraviolet plates taken between 7 July 1964 and 1 April 1965 inclusive. The method by which precise Jovian longitudes and latitudes are measured is described elsewhere (Reese and Solberg, 1965). The results of these measurements are tabulated in Table I. Because the drift was so rapid even in System I, it was found advantageous to compute the longitudes (fourth column in Table I) in a special system having a rotation period of $9^h49^m18\overset{s}{.}491$, which is identical to the mean rotation period of the spot. The left side

TABLE I

MEASURED LONGITUDES OF THE RAPIDLY MOVING NTBs SPOT

Date 1964-65	λ_1	Probable Error	λ_s	$\Delta\lambda$	J.D. 2438000+
Jul. 7.46	210°0	0°25	-3°2	+0°7	583.96
14.45	196.6	0.23	-4.1	-0.4	590.95
16.45	194.1	0.23	-3.1	+0.6	592.95
23.44	181.5	0.70	-3.5	-0.1	599.94
Aug. 5.50	158.8	- -	-2.8	-0.1	613.00
17.39	137.2	0.32	-3.3	-1.4	624.89
19.44	135.1	0.10	-1.7	0.0	626.94
30.50	116.2	0.15	-1.0	-0.1	638.00
Sep. 4.40	108.4	0.20	-0.1	+0.4	642.90
6.46	105.0	0.21	+0.2	+0.5	644.96
17.51	85.8	0.18	+0.6	0.0	656.01
22.43	76.8	0.20	+0.3	-0.7	660.93
26.49	69.9	0.15	+0.6	-0.8	664.99
29.39	66.3	0.23	+2.2	+0.6	667.89
Oct. 1.46	61.4	- -	+1.0	-0.7	669.96
3.47	58.4	0.29	+1.5	-0.4	671.97
6.36	54.4	0.15	+2.7	+0.6	674.86
8.38	51.1	- -	+2.9	+0.7	676.88
10.45	47.8	0.40	+3.3	+0.9	678.95
17.41	34.9	0.08	+2.8	0.0	685.91
21.43	27.5	- -	+2.5	-0.6	689.93
26.38	19.4	0.26	+3.2	-0.1	694.88
31.29	11.5	- -	+4.0	+0.5	699.79
Nov. 6.44	0.3	0.04	+3.7	0.0	705.94
7.25*	358.6	0.16	+3.5	-0.3	706.75
9.28	354.3	0.21	+2.8	-1.0	708.78
13.39	347.1	0.26	+2.9	-1.0	712.89
18.30	338.1	- -	+2.6	-1.4	717.80
25.28	324.0	- -	+0.9	-3.1	724.78
29.35	317.0	- -	+1.1	-2.9	728.85
Dec. 2.22	311.4	- -	+0.6	-3.3	731.72
4.28	308.4	- -	+1.3	-2.6	733.78
11.23	296.8	0.15	+2.0	-1.7	740.73
13.27	293.0	- -	+1.8	-1.9	742.77
15.32	289.3	- -	+1.8	-1.8	744.82
17.[illegible]3	286.7	0.56	+2.7	-0.8	746.83
21.0[illegible]	281.1	- -	+3.7	+0.3	750.54
22.27	278.3	- -	+3.1	-0.2	751.77
Jan. 3.13	256.6	0.15	+2.5	-0.2	763.63
10.10	244.6	0.12	+2.9	+0.7	770.60
17.04	231.7	0.25	+2.3	+0.6	777.54
Feb. 4.08*	197.8	0.13	+0.4	+0.2	795.58
6.11*	193.8	0.66	0.0	-0.1	797.61
22.06*	165.9	0.84	-1.6	-0.4	813.56
Mar. 14.09*	127.7	0.39	-2.2	+0.5	833.59
19.07*	117.4	0.14	-3.7	-0.7	838.57
21.09*	114.4	0.14	-3.1	0.0	840.59
23.12*	111.8	0.79	-2.1	+1.1	842.62
28.06*	102.3	0.14	-2.8	+0.6	847.56
30.08*	97.8	0.44	-3.7	-0.2	849.58
Apr. 1.10*	94.2	0.71	-3.7	-0.1	851.60

λ_1 = longitude in System I

λ_s = longitude in a special system = $\lambda_1 + 1°7756$ (JD - 2438704.0)

$\Delta\lambda$ = deviation of observed longitude from the adopted sinusoidal motion. The longitude of the adapted sinusoidal drift is defined as $\lambda_s - 4°0 \sin [1°2 \text{ (JD - 2438643.5)}]$.

* = ultraviolet plate. All others were taken in blue light.

of Figure 5 shows the measured longitudes plotted in this special system, and it is immediately obvious that the drift in longitude was not linear.

A preliminary analysis of the drift was made by dividing it into a number of essentially linear sections and determining the slope and position of each section by a least squares solution. Table II, which summarizes the results of such an analysis, shows that the rotation period varied by a little less than 11 seconds.

A closer examination of the drift, however, suggests the presence of a regular oscillating component. Indeed, it was found that a sine curve having a period of 300 days and an amplitude of 4° would fit the observed drift remarkably well, except for one obvious anomaly centered on 29 November 1964. This sine curve is shown as a broken line on the left side of Figure 5. The right side shows the deviations of the measured longitudes from the sine curve. These deviations are listed in the fifth column of Table I. The standard deviation of the individual measures from the adopted sinusoidal motion is only $\pm$ 0°.14 even when the large anomaly of 29 November is included.

The longitude of the axis of the sine curve at any time, T, (expressed in Julian days) can be computed in either standard system of longitude by one of the following formulas:

$$\lambda(\text{System I}) = 108^\circ.5 - 1^\circ.7756\ (T - 2438642.90)$$

$$\lambda(\text{System II}) = 247^\circ.8 - 9^\circ.4056\ (T - 2438642.90)$$

The significance of a sinusoidal component in the longitudinal drift of a Jovian spot could lie in the possibility that it reflects

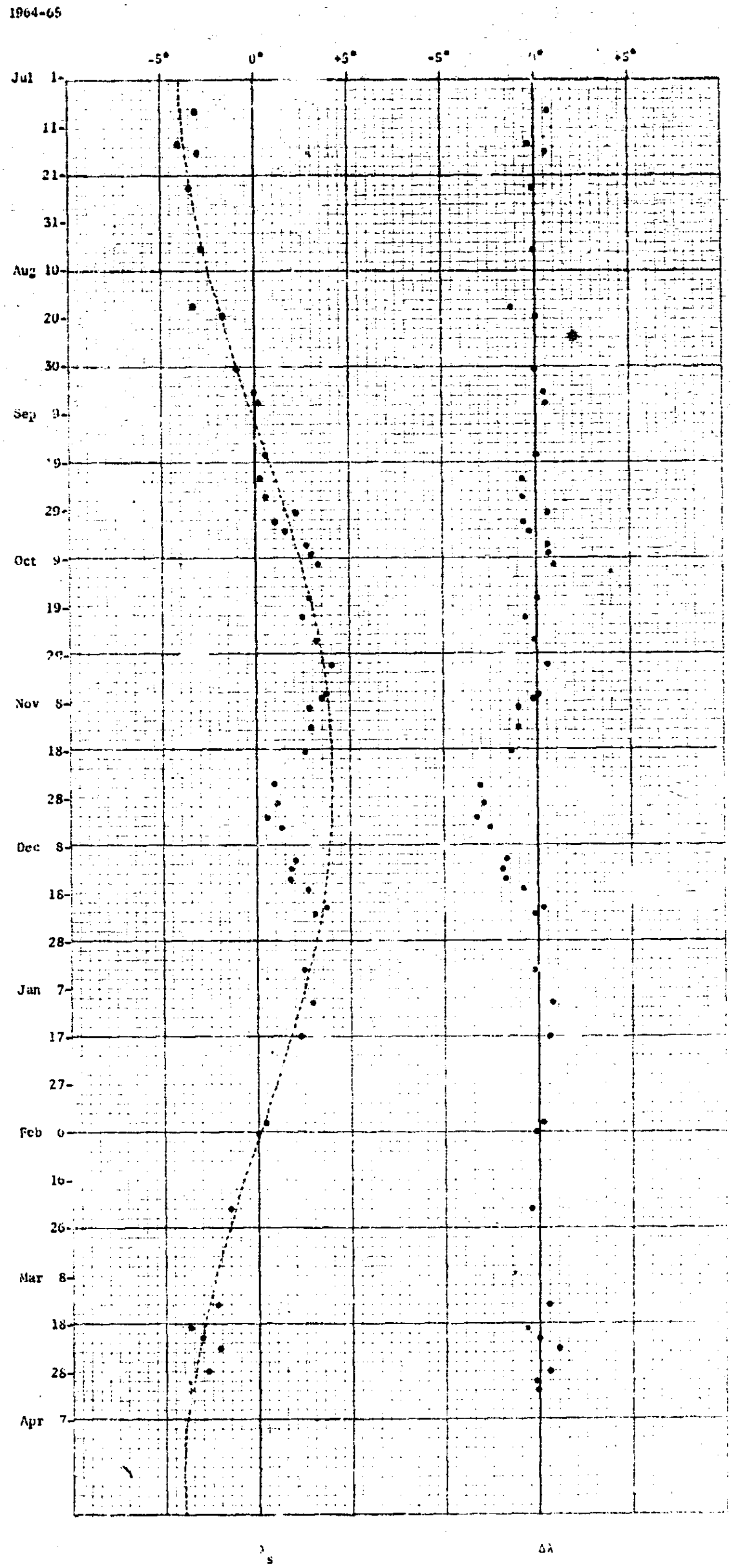

Figure 5: Motion in longitude of the NTBs Spot.

$\lambda_s = \lambda_1 + 1^\circ.7756$ (JD - 2438704.0)

$\Delta\lambda$ = deviations of the observed longitude from the adopted sinusoidal motion (dashed line, left side).

TABLE II

LINEAR APPROXIMATIONS OF THE LONGITUDINAL DRIFT
OF THE NTBs SPOT
(Least Squares Solutions)

Limiting Dates (1964-65)	Limiting λs	Daily Drift in Special System*	Rotation Period	Interval (days)
Jul. 7 Nov. 2	$-4\overset{\circ}{.}4$ +3.9	$+0\overset{\circ}{.}070 \pm 0\overset{\circ}{.}004$	$9^h49^m21\overset{s}{.}3 \pm 0\overset{s}{.}16$	118
Nov. 2 Dec. 2	+3.9 +0.6	-0.110 ± 0.008	$9^h49^m14\overset{s}{.}1 \pm 0\overset{s}{.}32$	30
Dec. 2 Dec. 19	+0.6 +2.8	$+0.129 \pm 0.016$	$9^h49^m25\overset{s}{.}7 \pm 0\overset{s}{.}64$	17
Dec. 19 Jan. 18	+2.8 +3.0	$+0.007 \pm 0.012$	$9^h49^m18\overset{s}{.}8 \pm 0\overset{s}{.}48$	30
Jan. 18 Feb. 18	+3.0 -1.2	-0.135 ± 0.008	$9^h49^m13\overset{s}{.}1 \pm 0\overset{s}{.}32$	31
Feb. 18 Apr. 1	-1.2 -3.4	-0.052 ± 0.011	$9^h49^m16\overset{s}{.}4 \pm 0\overset{s}{.}44$	42
	MEAN**	$+0\overset{\circ}{.}004$	$9^h49^m18\overset{s}{.}7$	268

* $\lambda_s = \lambda_1 + 1\overset{\circ}{.}7756$ (JD - 2438704.0)

** Weighted Mean of the Six Least Squares Rotation Periods.

an oscillation of the spot either in latitude or in depth. If the nature of the spot would allow it to be considered as a system conserving angular momentum, then it can be shown that a vertical oscillation having an amplitude of 3.1 kilometers, or an oscillation in latitude having an amplitude of only 0°.007 (8 kilometers) could produce the observed oscillations in longitude. Thus, these observed oscillations in longitude could be caused by variations in latitude far smaller than the probable errors involved in our measures.

It is well known that many features in the atmosphere of Jupiter do not behave as closed systems conserving angular momentum, at least where relatively long-term latitude changes are concerned. The Great Red Spot is a case in point (Peek, 1958, p. 137). Moreover, it is entirely possible that many of the spots visible on Jupiter may not be clouds of matter floating in its atmosphere, but are perhaps manifestations of cyclonic or other secondary wind systems having considerable interchange of angular momentum with their surroundings. With regard to small, rapid changes in latitude, however, the question of conserved angular momentum remains open and requires further investigation.

DRIFT OF THE SPOT IN LATITUDE

Measurements of 16 plates taken from 14 July 1964 through 28 March 1965 do not indicate any significant variations in the zenographic latitude of the NTBs spot (Table III). The mean latitude of the center of the spot for the entire interval was +24°.15, with a standard deviation of ±0°.36 for the latitude on any single date.

TABLE III

ZENOGRAPHIC LATITUDE, β", OF NORTH TEMPERATE BELT AND DARK SPOT

Date 1964-65	Center β"	Width km.	Length km.	S. Edge β"	Center β"	N. Edge β"
Jul. 14	+24°.5±0°.5	7000	8300	+23°.0	+25°.4	+27°.9
Aug. 19	24.0	6300	6300	23.6	25.6	27.6
Sep. 4	24.6±0.1	7100	6700	23.7	25.3	26.5
Sep. 6	24.0	6000	6700	23.6	25.3	27.5
Sep 17	23.9±0.1	5800	6800	23.4	25.2	27.1
Sep. 29	23.9±0.2	6300	6900	24.1	25.5	27.5
Oct. 8	24.4±0.1	4600	5400	23.9	25.2	27.2
Oct. 31	24.3	5700	- -	23.0	25.3	27.5
Nov. 6	23.9	5000	3500	23.5	25.3	27.4
Nov. 9	24.4	6500	4600	23.5	25.3	27.0
Nov. 18	23.9	5700	6700	23.4	25.1	27.0
Nov. 25	24.0	4200	6100	23.3	24.9	26.4
Dec. 11	23.9±0.2	5000	6400	23.4	25.4	27.7
Jan. 10	23.6	4400	4000	23.2	24.8	26.5
Feb. 4	24.5	6500	- -	23.2	25.1	27.0
Mar. 28	24.6	5800	- -	- -	- -	- -
MEAN	+24°.15	5700	6000	+23°.4	+25°.2	+27°.2

A least squares solution, however, would indicate a very slight drift from +24°.18 on 14 July 1964 to +24°.11 on 28 March 1965; nevertheless, the standard deviation for the latitude on any single date from the least squares line was found to remain unchanged at ±0°.36. Since the probable error of the measured latitude for each date is of the order of ±0°.2, we cannot be certain of any real variations in the latitude of the spot.

CONJUNCTIONS WITH NORTH TROPICAL ZONE WHITE SPOTS

The rapid drift of the NTBs spot carried it completely around Jupiter once every 40 days relative to several round white spots, which nearly filled the entire width of the adjacent North Tropical Zone. Latitude measures indicated that the projecting southern portion of the NTBs spot and the northern portion of some of the larger white spots should have overlapped when their differential motion brought them into conjunction. Since observations of this phenomenon would have provided an excellent opportunity to learn something of the relative levels of two atmospheric features, an effort was made to record several of these conjunctions photographically. It was also hoped that photographs might show how the dusky festoon appended to the southern edge of NTBs spot would get from one side of a white spot to the other.

Unfortunately, we did not succeed in recording the mid-point of a single conjunction. In most cases, the NTBs spot would appear to just barely touch either the north-preceding or the north-following edge of a white spot without either feature being definitely obscured or distorted. However, on two occasions, 1 October 1964 at 1059 U.T. and 21 December 1964 at 0054 U.T., the dark spot did appear to encroach upon a white spot, thereby suggesting that the dark spot was at a higher level than the white. Close conjunctions were recorded on 14 July, 6 September, 26 September, 1 October, 3 October, 17 October, 9 November, 25 November, and 21 December 1964.

The behavior of the dusky festoon when very near a white spot was rather unexpected. The festoon seemed to "avoid" the white spots as though being repelled from actually encroaching upon their borders. As the NTBs spot approached a white spot, the festoon would slant backwards, away from the bright feature. Later, after the NTBs spot had passed, the festoon would be found inclined forward, well ahead of the white spot! During the two very close conjunctions on 1 October and 21 December, the festoon was quite invisible, except for a diffuse duskiness in the North Tropical Zone, both preceding and following the white spot.

PREVIOUS OUTBREAKS OF RAPIDLY MOVING SPOTS ON THE NTBs

An excellent account of observations of previous activity along the south edge of the North Temperate Belt is given by Peek (1958, Chapter 9).

As mentioned earlier, this remarkably rapid current was discovered by W. F. Denning in 1880 when a number of dark spots were observed to have a rotation period of approximately 9^h48^m. Some pertinent facts concerning the various outbreaks of rapidly moving spots are listed in Table IV.

TABLE IV

OUTBREAKS OF RAPIDLY MOVING SPOTS ON THE SOUTH EDGE
OF JUPITER'S NORTH TEMPERATE BELT

Outbreak	Apparition	Average Rotation Period	Number of Spots	Limiting Dates of Observation	NTB Color	NTB Intensity	Zenographic Latitude Center NTB	Maximum Observed Life of a Spot	References
1	1880	9^h48^m+	- - -	- - -	- - -	- - -	- - -	- - -	- - -
2	1891	9^h49^m+	- - -	- - -	- - -	- - -	- - -	- - -	- - -
	1892	9^h49^m+	- - -	- - -	- - -	- - -	- - -	- - -	- - -
3	1926	$9^h49^m03^s$	1	15 Jun-21 Sep	blue-gray	dark	+25°.1	98^d	a
	1929-30	$9^h49^m17^s$	21	27 Sep-3 Mar	blue-gray	very wide and dark	+25.2	152^d	b
	1930-31	$9^h49^m10^s$	5	18 Sep-21 Mar	blue-gray	wide and dark	+26.4	152^d	c
4	1939-40	$9^h48^m57^s$	11	25 Sep-14 Feb	gray	dark	+26.4	109^d	d
	1940-41	$9^h49^m11^s$	13	1 Jul-2 Mar	brown	dark, narrow	+24.8	209^d	e
	1942-43	$9^h49^m06^s$	2	5 Oct-9 Mar	gray	dark	+27.0	155^d	f
5	1964-65	$9^h49^m18^s$	1	7 Jul-1 Apr	orange!	narrow, dusky	+25.2	268^d	- - -

a. Phillips, T. E. R. (1930). Twenty-fifth Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 29, Part 3, 63-86.
b. Phillips, T. E. R. (1937). Twenty-eighth Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 32, Part 4, 1-22.
c. Phillips, T. E. R. (1937). Twenty-eighth Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 32, Part 4, 23-37.
d. Peek, B. M. (1942). Thirty-first Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 35, Part 1, 33-48.
e. Peek, B. M. (1944). Thirty-second Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 35, Part 3, 1-21.
f. Peek, B. M. (1946). Thirty-second Report of the Jupiter Section. *Memoirs Brit. Astron. Assoc.* 35, Part 4, 1-30.

The mean zenographic latitude of the center of the North Temperate Belt for all apparitions between 1908 and 1947 was +27°8, with the values for individual apparitions varying between +24°8 and +32°2 (Peek, 1958). It may be significant that the North Temperate Belt was near its minimum latitude north of the equator during each outbreak of rapidly rotating spots. We might speculate on the existence of a limited region of ascending vertical currents near latitude +24° which can lift masses of dark-colored clouds into a rapidly rotating zonal current well above the average level of the cloud deck. The periodic nature of the outbreaks might then be directly related to the availability of dark colored material. Such material might be available only at those times when the south edge of the dark North Temperate Belt approaches sufficiently near to latitude +24° to become involved in the region of the ascending current.

POSSIBLE PERIODICITY

A possible periodicity in the appearance of rapidly moving spots on the south edge of the North Temperate Belt was suggested by W. F. Denning in 1898. Peek (1958, p. 79) notes that a period of roughly 10 years would fit, without excessive elasticity, the eruptions of 1880, 1891, 1929-30, and 1939-40; but he believes that it is quite certain that the major phenomena were not repeated during the apparitions between 1892 and 1929-30.

Outbreaks of activity during the present century do seem to confirm Denning's suggestion; however, rather than the 10-year interval suggested by Peek, a period of almost exactly 12 years seems to be indicated in Table V.

TABLE V

CHRONOLOGICAL RELATIONSHIP BETWEEN THE LATITUDE OF THE NORTH TEMPERATE BELT AND THE OUTBREAKS OF NTBs SPOTS

12 Year Period	NTB at Minimum Latitude South	NTBs Spots Observed
1880	- - - -	1880
1892	- - - -	1891, 1892
1904	- - - -	- - - - -
1916	1916 (+25°.8)	(see text)
1928	1928 (+25°.0)	1926, 1929, 1930, 1931
1940	1940 (+24°.8)	1939, 1940, 1941
1952	1952 (+25°.1)	(see text)
1964	1964 (+25°.2)	1964

It is just possible that the rapidly moving current was active in 1915, 1917, and again in 1952 and 1953. In a report by the British Astronomical Association dealing with the apparition of 1915, some drawings by Phillips and Thomson clearly show typical dark spots on the south edge of the North Temperate Belt (Phillips, 1917). In a later report of the British Astronomical Association it is stated that some dark spots were seen on the south edge of the North Temperate Belt by Ainslie, Sargent, and Phillips during August and September of 1917 (Phillips, 1923). The North Temperate Belt was moderately dark and bluish in 1915 and 1917 with its center near latitude +26°.3. Some dark spots were seen on the south edge of the belt by Burrell, Adcock, and E. J. R. between December 1952 and February 1953 (Alexander, 1954) when the North Temperate Belt was rather faint and gray with its center near latitude +25°.1.

Although we cannot be certain that <u>every</u> spot visible on the south edge of the North Temperate Belt near latitude +24° must have a rotation period much shorter than that of neighboring latitudes, there seems to be no published record of such a spot possessing a period even close to that of System II. If the implication is correct, it would seem even probable that a number of rapidly moving spots did exist on the south edge of the North Temperate Belt in 1915, 1917, and 1952-53.

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