

JOURNAL

OF THE

Tennessee Academy of Science

VOL. IV

APRIL, 1929

NO. 2

JUPITER'S CHANGING BELTS

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The planet Jupiter in 1927 and 1928 was unusually favorably placed for visual and photographic work with the writer's eleven-inch reflecting telescope. Early October oppositions bring Jupiter about 42,000,000 miles closer than when opposition occurs in April, and though the average distance of Jupiter is as great as 390,000,000 miles, a near approach makes a difference in the clearness with which the markings of the planet's disk may be seen. On October 30, 1928, Jupiter's equatorial diameter was 49.56 seconds, the planet's north pole was inclined almost its maximum toward us, and was then 3.31 degrees. Opposition in 1927 occurred September 22; in 1928 it occurred on October 29. During the weeks preceding and following each opposition the planet was systematically observed, drawings being made of the disk as revealed with magnifications of 153 to 300 diameters. A number of photographs on plates sensitive to blue-violet were obtained.

A characteristic feature of the 1927 apparition was the unusual brightness of the south tropical zone of Jupiter, a zone normally located between south latitude 28 degrees and south latitude 15 degrees. During 1927, this zone reached a breadth of about 18 degrees and was more intensely bright than any part of the planet, possessing strong actinic light and presenting a background against which Jupiter's longest-observed marking, the celebrated Red Spot, was distinctly visible. No other conspicuous markings were seen in the south tropical zone during the interval Jupiter was observed here in 1927; nor in 1928, until September 3, at 6h 35m, G.C.T., when a curved rift extended southward from the northern border of the zone, forming a narrow grey line, bisecting the bright zone nearly half-way across the disk. This is important, for it was the first seen here of a new belt which within a few weeks became a prominent feature. A detailed description of the planet's general aspect is omitted for brevity, since nearly everyone has seen Jupiter at one time or another through a telescope and knows that its most salient feature is the striped appearance it presents, white and yellow bands; and red, dusky and slate-grey lines, often notched or dotted with dark spots, or globular-

or rather dark slanting lines, or curved ones which enclose large areas of brighter mosaics in the equatorial zone, are by no means uncommon. But on September 4, at 7h 49m, G.C.T. (longitude of central meridian 296° for System I; 323 , for System II), a very dark rift occupied the center of the equatorial zone extending from a dark spot in each of the bordering equatorial belts. The Red Spot, located in the southern tropical zone, was then near the central meridian. This rift was seen again in about the same longitude of System I, on September 6, and traces of it were followed until it changed form and was lost as it was apparently swept along by the equatorial currents. It should be explained that the zone from south latitude about 8 degrees to north latitude 10 degrees, having an average rotation period about five minutes less than the rest of Jupiter, is designated System I. Longitudes north and south of this zone are calculated from the transit of the adopted zero meridian of System II. The equatorial rifts were found to belong to System I, but the velocity of motion on the equator is slightly faster than System I, thereby soon altering the form of linear markings extending across it.

Some of the more conspicuous phenomena occurring during September and October are interesting to review briefly. The Red Spot, which has varied in visibility during the time since its discovery in 1878 and which when invisible has usually been located by a white curved indentation in the southern component of the south equatorial belt, was distinctly seen and photographed in August, 1928. On August 23 at 8h 0m, G.C.T., the longitude of the Red Spot was $322.^\circ 2$, System II. On September 26, at 5h 36m, the longitude of its center was $315.^\circ 2$. When longitude 316° was central at 3h 14m, September 29, no trace of this marking could be seen, but on October 1, at 5h 1m, two V-shaped markings were found in the place where the Red Spot should have been, extending into longitude $321.^\circ 8$. A dusky oval resembling the Red Spot but much longer than normal was central in longitude $313.^\circ 3$ on October 8, at 5h 25m, central meridian of disk $309.^\circ 1$. This was the last seen of anything resembling the Red Spot until December 20, 0h 47m, when a white oval about the size of the white marking which formerly characterized the place of the Red Spot, now occupied a position central in longitude $316.^\circ 1$. It was seen again on December 22, at 2h 28m, $317.^\circ 6$. Apparently the Red Spot, identified on these later dates as the Red Spot Hollow, had changed from $322.^\circ 2$ August 23, to $316.^\circ 8$ (mean), December 22, showing a rotation period of 9h 55m 38.5786s for the interval. From October 1, 1927, to August 23, 1928, the rotation, according to my observations, was 9h 55m 37.757s. The rotation is apparently becoming slower, according to the 44-year cycle. In 1918, the minimum of 9h 55m 33.5s was recorded. The last maximum was in 1900, when a rotation of 9h 55m 41.6s prevailed. The present rate seems to agree fairly well with the assumed cycle of change.

Peculiar darkening of a large area of Jupiter's southern hemisphere occurred in October. On October 25, at 3h 55m, longitude of the

central meridian, $291^{\circ}.7$ (II), a dark streak was seen extending southward across the southern hemisphere from a point located in the south equatorial belt, longitude of the central meridian $291^{\circ}.7$ (II). The southerly extremity of this strange dark line was about 30 degrees east of the pole in south latitude about 70 degrees. I had never seen such a marking on Jupiter and took care to verify it. It was seen faintly as it approached the eastern limb at 4h 50m ($324^{\circ}.9$ longitude of central meridian, II). A similar streak was seen on October 29, at 2h 40 m, $128^{\circ}.0$ (II), extending from the south temperate belt to about the same position of latitude as the other dark marking and to a position 30 degrees east of the south pole. Both these markings may have been the effect of a series of dark condensations in the southern belts, the whole hemisphere being darkened by a slate-grey color, which on the 25th almost obscured the belts. It is noteworthy that on both the 25th and 27th, the southern equatorial belt had lost its red tint and only the north equatorial belt possessed a strong red color.

An irregular belt had formed in the south tropical zone during September. In October, between the 25th and 29th, from longitude 120° (II) to 220° (II), this new belt occupied an irregular course ranging from south latitude 20 to 25 degrees. The rest of its course extended roughly along the parallel of 18 degrees south. The south tropical zone during October was undoubtedly suffering a conflict of violent currents. It was crossed by ephemeral dark markings and splashed with brilliant white areas resembling our own cloud-forms when they are frayed and shredded by contrary winds.

So little is known about that part of Jupiter underlying the visible surface that any attempt to interpret what we can see through telescopes is at best mere speculation at present. There are signs of momentous events of which we can record only a small part. Jupiter is a laboratory in which intense heat, intense cold, and enormous pressure are struggling with the centrifugal force of rapid rotation. There is no earthly analogue by which we can compare the phenomena of Jupiter. New methods of investigation, such as photography in colors correlated with definite portions of the spectrum, may lead indirectly to a solution of some of the mysteries made visible through telescopes.