

The "Great Red Spot" on Jupiter appeared in the year 1878, although from earlier drawings it seems to have been visible at intervals on many former occasions. In 1878 it caused considerable interest, and observatories all over the world were asked to watch it. Although constantly changing in outline, it has persisted in the same locality ever since, but it now seems to be growing fainter, as though about to be hidden again for another period beneath Jupiter's thick blankets of cloud. Within the last year, it has again come into view, although it is not yet as conspicuous as in 1878.

*RECENT CHANGES IN THE SURFACE OF JUPITER.* By H. C. Russell, B. A., F. R. A. S. (Read before the Royal Society of New South Wales, 1 December, 1880). Sydney: Thomas Richards, Government Printer.—1881.

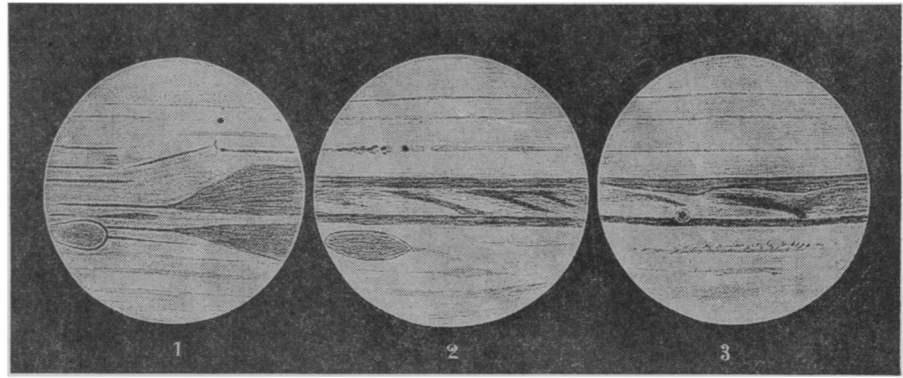
### *Jupiter's Belts*

Some four years since I received a circular from the Royal Astronomical Society requesting my co-operation in the work of systematically observing Jupiter for the purpose of interpreting, if possible, the changing features which the planet presents from time to time to our gaze.

The Sydney 11½-inch equatorial is well adapted for such purpose, owing to its fine defining powers and freedom from uncorrected colour; and in May, 1876, I therefore began a series of observations, making many drawings and notes. At that time the markings were sufficiently remarkable to enlist observers at once, and in the changes which have been going on ever since, sufficient alteration in form has taken place to keep up the interest and make the observer wish that Jupiter were always in the midnight sky, so that these changes might be followed in detail.

Before proceeding to the discussion of my own work, I shall perhaps be forgiven if I detain you a few moments by a very short account of the most important theories which have been put forward in explanation of Jupiter's belts.

In a paper published by Cassini, in Paris, in 1691, he says that the two equatorial belts of Jupiter were first seen in 1630, and he adds that they were remarkably permanent, for he watched them for forty years without seeing any change. Other observers, however, are of a different opinion, and assert that they are not always there. Hevelius says that in 1647 these belts were not visible, although he could see clouds upon the surface clearly, and Sir W. Herschel saw the planet once in 1793 without any sign



THE GREAT RED SPOT OF JUPITER as Russell drew it on three occasions about a month apart

of belts. In 1834 and 35 the northern belt was invisible, and (coming to my own experience) once in 1863 I saw his face covered with cloud-like forms from pole to pole, the usual equatorial belts being absent.

Cassini and others, judging of the condition of Jupiter from the periods of rotation derived from different markings, came to the conclusion that, since these times differed, the spots used in determining them must have a motion of their own, or that they were simply clouds.

Sir William Herschel in 1793 wrote: "I suppose that the bright belts of Jupiter included between the faint belts are zones wherein the atmosphere of the planet is most densely filled with clouds. The faint belts correspond to the regions in which the atmosphere is perfectly serene, and allows the solar rays to reach the solid portions of the planet, where according to my opinion the reflection is less powerful than from the clouds."

Mr. Proctor, who has made a careful study of the conditions under which Jupiter exists, thinks that since Jupiter, owing to his great distance from the sun, only receives 1/25 part of the light and heat which reach the earth, it is impossible that his atmosphere should be loaded with clouds as we see it, resulting from sun heat alone, and that it is therefore extremely probable that the giant planet is now in the condition which geologists say evidently existed at one period of the earth's history, that is, that Jupiter is "still a glowing mass, fluid probably throughout, still bubbling and seething with the intensity of primeval fires, sending up continu-

ally enormous masses of clouds to be gathered into bands under the influence of the swift rotation of the giant planet." Not otherwise, Mr. Proctor thinks, can one understand whence his atmosphere is loaded with vapour masses.

The observed facts which I have to bring before you tonight have an important bearing upon these theories, in part tending to confirm them, and in part contradicting. It will be necessary, however, for us to bear in mind the extreme difficulty of observing the details upon the surface of Jupiter, owing to his enormous distance and the many difficulties which the terrestrial atmosphere puts in our way. It is only the most patient and trained observing, aided by powerful telescopes, that enables us to detect those minute markings on the planet which are all-important in the discussion before us.

There are markings, and even changes, which the possessor of a small telescope may see; but, to study Jupiter to advantage, requires the use of large instruments and very close scrutiny, if we are to arrive at any solution of the question whether there is anything permanent on the surface of the planet or not. The result of my own observation has convinced me that there is, and I think what follows will show that I have some grounds for thinking so. . . .

### *The Great Red Spot*

Next to the great girdles which encircle Jupiter, "the red spot" is certainly the most remarkable feature that has ever been detected upon it; 30,000 miles long by 8,500 miles wide, it covers a surface very much greater than that of the (*Turn to next page*)

## Surface of Jupiter—*Continued*

whole of the earth, and is easily seen with good telescopes, but in a powerful one it is a most striking object, and brighter coloured than anything else on the planet; but why that mass of flame-like light is red, and why a different red from any other marking, are questions not yet answered.

It is generally looked upon as a recent marking, and I have been at some trouble to trace its history, and shall, I think, be able to show you that it is much older than many suppose. . . .

I was not long in recognizing it as an old friend that I had frequently seen in 1876, at which time it was involved in the equatorial colour band, and somewhat different in shape but not in colour. . . .

These facts amount to very strong evidence, if not to proof, that the red spot is a fixed feature of Jupiter, or in other words solid ground and not clouds; that it seems to change a little in form is no proof to the contrary, where clouds have so much influence upon visible outline, and the changes in form are really not great. At present both ends are blunt-pointed; in 1876 the preceding end was round and the following pointed; and from Earl Rosse's drawings it appears that the preceding end was pointed and the following end rounded; and such changes are not important. I confess, however, that before I collated my measures the impression produced upon me by observing it was that the dimensions did change considerably. This does not, however, seem to be the case, for the measures show the contrary. . . .

### *Small White Spots*

While writing about the persistent position of this spot, I may mention that on August 6, 1878, at 10 h. 10 m. p. m., I saw a small white spot of striking brilliance, much brighter, in fact, than anything else visible on Jupiter; it was on the northern side of the south equatorial belt, and a little in advance of the red spot. At the time there was a great development of colour between the belts, and this spot presented a clearly defined disc. It was seen again under similar circumstances on October 5, 1878, and thence not again until October 11, 1880, when it seemed to have started into being more brilliant than I had ever seen it before; it looked like some shining white substance laid on the dark belt, which it seemed to

cut half in two. . . . I have observed that in four instances certainly, and I think in every one, where a spot is visible, there is always to be found on the preceding side of it a cloud-like form. . . . This evident connection between the two markings, and their fixed positions on the surface suggests the idea that the white spots are snow-covered mountains, from which the clouds have for a time lifted; and the diagonal bands similar in colour to the north belt would be clear spaces taking their direction from the mountains. The proof is insufficient to convince one, but quite enough to make the suggestion, and to lead to the hope that we shall know more about it soon. . . .

### *Earth as Seen From Jupiter*

The impression which a close study of Jupiter during the past four years has left upon my mind is that we see on the great planet very much the same phenomena as an observer placed upon Jupiter would see upon the earth; to him our planet would have a very different aspect from that by which we know it. On the polar sides of latitude 40° he would see an almost uninterrupted belt of clouds, shining white in the sunlight, probably almost as white as the snow caps; on the equatorial sides he would see the clearer regions of the trade winds, at times marked by persistent clouds or haze, which would hide every feature of the earth below, at best only visible by light that had passed twice through our atmosphere; and should he be fortunate enough to find the terrestrial air clear at the same time as his own, it would still be next to impossible to distinguish forest-covered earth from ocean; he would carefully note certain white points occasionally seen, and find they were constant in position; and if fortune favoured him, he would look when some terrestrial volcano shot up its ponderous cloud bank, black enough to obliterate everything beneath it, and perhaps, most conspicuous of all, would be the brilliant white cloud ring which generally surrounds the equator, somewhat broken and irregular in outline though it be. Watching these cloud features, he would see them travel north and south with the changing declination of the sun, and wonder whether the few bright points could be the only fixed things on the planet.

Just so, I think it is, that we see Jupiter. Our attention is arrested by the belts. We see on the polar sides of latitude 38° almost uninterrupted bright zones, where there is but little change; but from these latitudes towards the equator the case is different. At one time we find white zones covering everything from 38° to 18° on each side of the equator, as we see it at the present time; at another time all this is changed, and their place is occupied by ever-changing light-red-coloured rings as in 1876. On the equator at one time we see the brightest cloud zone on the planet, and at another a faint red one, which like that between the terrestrial trades is ever changing its features. On each side of this are situated the darkest rings to be found on the planet, and through these probably is our only chance of seeing the true surface.

**Henry Chamberlaine Russell** (1836-1907), director of the astronomical observatory of Sydney, New South Wales, was an enthusiastic student of the science of his part of the world. His books cover the heavens, the rocks, the plants and the weather of his homeland, and he was the first president of the Australasian Association for the Advancement of Science.

**Jupiter** is the fifth planet from the sun, not counting the asteroids. It is next beyond Mars, and the nearest of the outer or major satellites of the sun. To the eye it usually appears larger and brighter than any of the stars or planets, except Venus, and it is frequently visible all night. Its mean distance from the sun is 483,200,000 miles. Its distance from the Earth varies from 367,000,000 to 600,000,000 miles. Jupiter's year is nearly 12 of our years, but its day is only about 10 of our hours, for it has the fastest rotation of any of the planets. It is also the largest planet—larger than all the other planets of the sun combined. Its diameter through the equator is 88,640 miles, that through the poles is 82,880 miles. The great equatorial bulge, combined with its size and its density (which is about  $\frac{1}{4}$  that of the Earth) show that its heavy core must be surrounded by much lighter surface material than that of our planet. Red and brown cloud-like masses seem to float on the surface of Jupiter. The temperature of the surface is about -140° C. or 220° below zero F. It is certain, therefore, that this great planet cannot be the home of life as we know it. Conditions on the four chief satellites seem less strange to us, for their surfaces appear to be rough, possibly mountainous like that of our moon. Like our moon also, they keep one side constantly toward their planet. The two satellites nearest Jupiter are believed to be masses of rock; but the outer two, one of which is much more brilliant than the rest, or even than Jupiter, are thought to be perhaps giant snowballs of ice or frozen carbon dioxide. Five other very small satellites of Jupiter are known, making nine in all.