JUPITER AND HIS SURFACE CURRENTS.

BY THE REV. T. E. R. PHILLIPS, M.A., F.R.A.S.

The general aspect in the telescope of the planet Jupiter is well known. His markedly elliptical disk, which is distinctly brighter in the center and gradually fades off toward the limb, is traversed by a series of dusky belts which vary from time to time both in width and position. These belts frequently show great irregularities at the edges, being broken up or indented by a number of light and dark spots, while dusky wisps are often to be seen projecting from them across the bright zones which separate them. The accompanying drawings will serve to illustrate the general arrangement of the surface features and also the great and rapid changes of aspect to which they are subject. Thus it will be seen from the illustrations that in the years 1896 and 1898 (Figs. 1 and 3)—as was also the case in 1901 and 1903—the belt lying north of the equator was quite narrow, but that at other times it was broad, and exhibited numerous condensations and white spots at its edges. It not infrequently happens that the general aspect of the planet undergoes a marked alteration even in the course of a single apparition. Thus Fig. 6 represents a view of Jupiter in June, 1902, but by the latter part of the autumn the appearance of the disk had materially changed. The equatorial regions were intensely white—a very striking contrast to the rich, warm, coppery tone which was so marked a feature of the planet a few years ago—and the whole of the disk north of the N. temperate belt was deeply shaded with a delicate bluish gray.

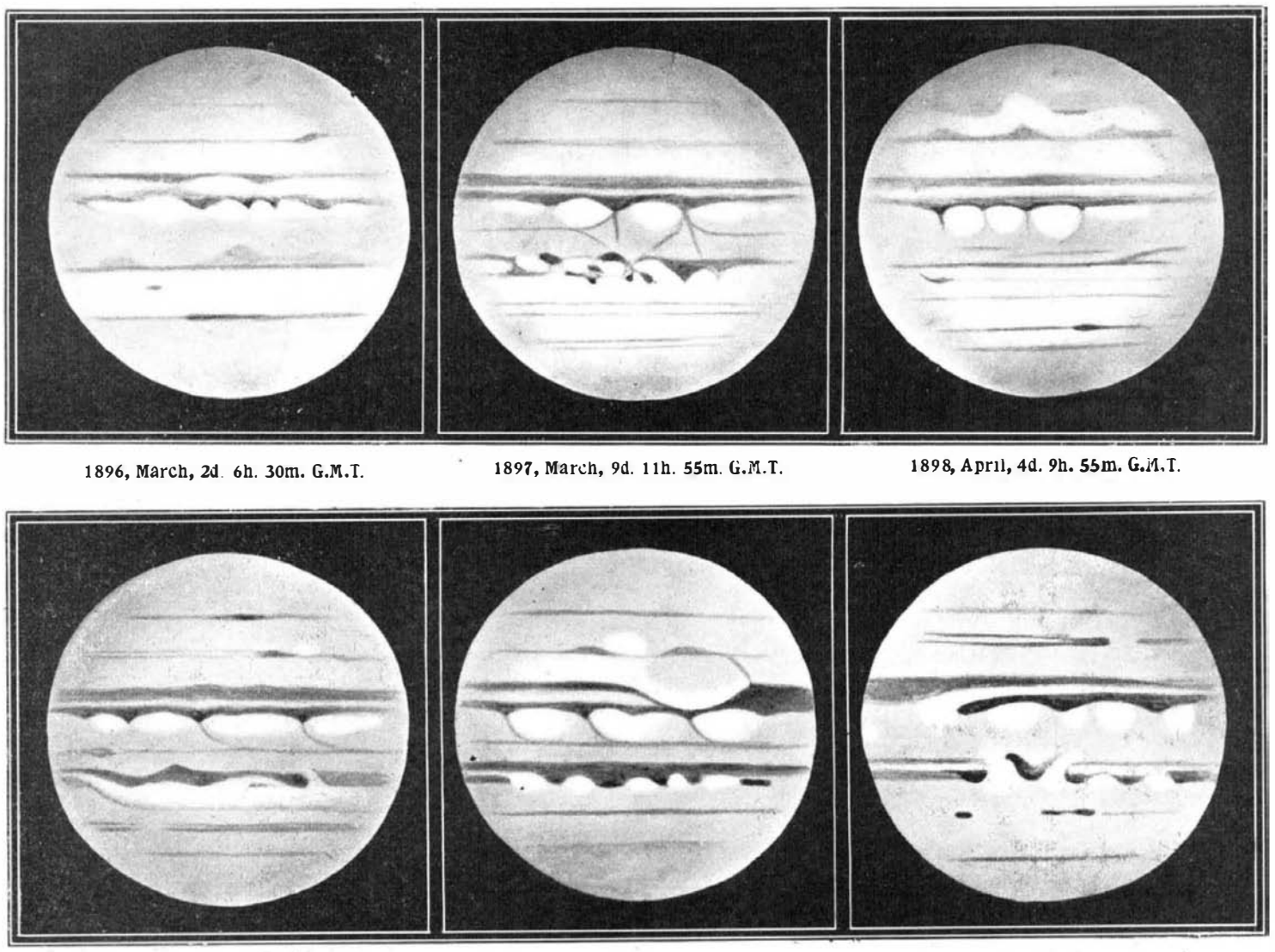
It is probable that some of the changes on Jupiter are of a cyclical or seasonal character. Mr. A. Stanley Williams in a valuable paper communicated to the Royal Astronomical Society in April, 1899, showed from a discussion of a large number of observations extending over many years that there is a remarkable variation in the color of the two principal equatorial belts. Thus, when the S. equatorial belt is at a maximum of redness, the N. equatorial belt is at a minimum, or even bluish in tone, and *vice versa*. The mean period of these variations is found to be about twelve years, and as this corresponds with the length of a sidereal revolution of Jupiter round the sun, it is probable that the change observed is of a seasonal character. The maximum redness occurs soon after the vernal equinox of the particular hemisphere in which the belt exhibiting it is situated. In accordance with the interesting conclusion at which Mr. Williams has arrived, the N. equatorial belt has lately been intensely red, and the S. equatorial belt almost colorless, except in the region immediately following the Red Spot bay.

But, perhaps, the most interesting and instructive feature hitherto observed in connection with Jupiter is the difference of speed with which his spots and other markings are drifting. So long ago as the latter part of the seventeenth century, Cassini found that the markings in the neighborhood of the equator performed a rotation in nearly six minutes less time than was required by objects further north and south. Sir William Herschel, Schröter, and other observers confirmed this result, but as the outcome of the labors of more modern investigators, a considerable number of distinct currents are now known to control the movements of Jupiter's surface material. There can be no doubt that many recorded changes on Jupiter are in reality due to the great proper motions of the objects observed, which quickly cause them to become relatively displaced.

With one or two exceptions these surface currents are pretty constant. Their velocity varies within certain limits, and the latitude of their boundaries is not always the same, but whenever definite spots or observable condensations appear their movements of rotation are nearly always found to conform more or less closely to the normal speed of that latitude.

But interesting as is the investigation of these surface currents, the real nature of Jupiter's physical condition is the problem which students of the planet must endeavor to solve. It has generally been agreed that the belts and spots of Jupiter are of the nature of clouds and atmospheric vapors; that the true globe of the planet has never been seen; and that its real rotation period is consequently unknown. But whatever view may be adopted as to the vaporous character or otherwise of the visible features of the disk, it is probable that the internal body of the planet rotates in a period somewhat longer than any markings we can observe—possibly in a period just a minute or so less than 10 hours. As regards the relative altitudes of the various markings, there seems good reason to suppose that the more swiftly moving objects are situated at a greater height than those which move more slowly. Of course, it must be remembered that the planet may have no solid or definite surface divided off from the vapors which form its belts and spots. It is highly probable—bearing in mind the very low density of Jupiter—that the whole globe is still in an intensely heated, semi-molten, and viscous condition, and that what we see is but the outermost shell of visible material. Prof. Hough, in his important and valuable paper already referred to, suggests that the visible boundary of Jupiter has a density of about one-half that of water, is of the nature of a liquid, and that in it are immersed the Red Spot and others whose motion in longitude and latitude are slow and gradual, and which are tolerably permanent or long enduring. He considers that the equatorial and other belts may be at the surface of this liquid or at a higher level than the Red Spot, and that the equatorial regions may be concealed by overlying vapors at a much greater altitude, in which openings and irregular condensations give rise to the appearance of white and dark spots.

No doubt there are many interesting questions in connection with Jupiter of which the solution must be left for future students; but this much, at any rate, we may suggest with some confidence: We look at Mars and our own satellite; in them we see a forecast of physical conditions to which some day the earth must at least approximately attain. We look at Jupiter, and, in the constant agitation of his heated globe, we catch a glimpse, though on a giant scale, of our own world in the dim recesses of the past.—Abstracted from Knowledge.



1896, March, 2d. 6h. 30m. G.M.T. 1897, March, 9d. 11h. 55m. G.M.T. 1898, April, 4d. 9h. 55m. G.M.T.

1899, April, 15d. 12h. 10m. G.M.T. 1900, April, 20d. 14h. 15m. G.M.T. 1902, June, 26d. 14h. 31m. G.M.T.

CHANGES IN THE ASPECT OF THE PLANET JUPITER OBSERVED AT VARIOUS TIMES.

The Chord Galvanometer and the Human Electrocardiogram.

In the Archives Néerlandaises, W. Einthoven has indicated the principle of a novel galvanometer, made up of a silvered quartz thread, stretched like a chord in a strong magnetic field. As soon as an electric current was led through the thread, the latter will diverge at right angles to the direction of the magnetic flux, the amount of deflection being directly measured by means of a microscope with an eyepiece micrometer. Some important improvements of the instrument have been made, enabling the chord (a quartz thread 2.4 millimeters in thickness and 10,000 ohms in resistance) to be stretched strongly. Under certain circumstances, currents not higher than 10^{-12} amperes may be detected by the instrument. The chord may be stretched sufficiently to have a current of a given strength produce a predetermined deflection. The image of the middle of the chord, after being magnified 660 times, is thrown on a split perpendicular to the image of the chord. In front of the split there is a cylindric lens, the axis of which is parallel to the split, while behind a photographic plate is moved in the direction of the image of the chord. At the same time, a system of co-ordinates is projected on the sensitive plate according to Garten's method, where the horizontal lines are obtained by a glass millimeter scale, placed immediately in front of the sensitive plate, so that the sharp shadows of the division are projected on the plate, whereas the vertical lines are due to the spokes of a disk rotating uniformly intercepting intermittently the light falling on the split. From the photographic diagrams thus obtained it is inferred that the deflections, being aperiodical, are exactly proportional to the intensities of the current. This instrument is applied by the author to determining the human *electrocardiogram* discovered by A. D. Waller (Philoso. Transactions, vol. 180, 1889, B, p. 169). It is interesting to note the constancy in the form of this curve for a given person, the alterations occurring in the course of time being so small as to allow with little practice to recognize many persons by their electrocardiograms.

Russia and Korea's Non-Participation in the St. Louis Fair.

The American Ambassador at St. Petersburg has cabled to the State Department at Washington that the Russian government has notified him of its intention to withdraw from participation in the St. Louis Fair.

A similar notice of withdrawal has been sent by Korea.

To prevent further disasters, such as that which visited Galveston, Tex., in 1900, when 3,000 houses were destroyed and 8,000 lives were lost in the floods, it is proposed to raise the whole of the city. According to the present plan, earth is to be brought from along the coasts of the Gulf and banked upon the site of the city, so that it shall be at level of from 17 feet to 20 feet above the sea.