AN HYPOTHESIS REGARDING THE SURFACE MARKINGS OF JUPITER.

Popular Astronomy #79. Nov 1900

A. E. DOUGLASS.

No planet presents such rapid changes in its surface markings as the largest of them all, Jupiter. The great red belts which are visible in the smallest telescope are constantly changing in minute detail. This is apparently because the belts are on the dividing line between the temperate zone currents and a swifter moving equatorial stream of perhaps twenty thousand miles in width and a velocity of two hundred and fifty miles an hour greater than the regions on each side of it. The markings where these two currents adjoin are literally torn to shreds as Mr. Stanley Williams describes them (Pub. A. S. P., Vol. XI, No. 70). Seemingly the only immovable object is the great red spot and that is not absolutely stationary, for its period of rotation has changed since its first discovery. What then produces this swift equatorial current that rends apart and joins in new forms the red and gray patches along its border?

The polar compression of Jupiter is in the neighborhood of one-sixteenth; that is the polar regions are about six per cent nearer the center of internal heat than the equator. Now owing to the very great reflecting power of Jupiter's atmosphere (albedo 0.62) and its distance from the Sun (mean distance 5.2 or 483,000,000 miles), it is the internal heat that governs the circulation of the atmosphere rather than solar energy and we have an atmospheric circulation the reverse of ours.

Permit the digression in saying that that appears to be the meteorological distinction between a cloudy and a non-cloudy planet. The former controls its own atmospheric movements, producing a convectional current over its hottest parts; the latter has its atmospheric movements controlled by the Sun, with upward currents near the equator. This has a bearing on the rate of cooling of planets.

Upon Jupiter, therefore, the ascent of air occurs at the poles. The masses of warmed air or gases then spread toward the equator. But as their linear velocity about the axis of rotation is not so great as that of the regions nearer the equator, they act as a retarding surface current. On this hypothesis therefore it is the equatorial current that represents nearly the true rotation of the planet, and the temperate zone currents that show us

the retarding action of this planetary circulation, namely two hundred and fifty miles an hour.

Let us in imagination follow the course taken by a mass of air or gas or cloud in this retarding current. In mid northern latitudes the low-level winds far below the visible surface move toward the north pole. Somewhere beyond latitude 60° or 70°, perhaps, a mass gets sufficiently warmed to rise. It does so. Then it commences to move southward toward the equator, but immediately it turns toward the right as its velocity in its new latitudes is not great enough for it to keep pace with the planetary surface beneath it, therefore almost at once begins to retard the velocity at the apparent surface. Its maximum turning force occurs at the start. The latitude of its maximum retardation depends upon the actual rate at which it turns in direction. Now, on the earth, the trade winds are supposed to be composed of masses of air that have actually turned about and are on their way back to the equator. This suggests that on Jupiter the return currents to the pole are down too deep in the atmosphere for us to see them and that the masses that do not turn back are the ones that finally get near the equator. So just as we have on the earth a polar whirl blowing in advance of the actual rotational velocity, so on Jupiter we find an equatorial, or as it happens, a sub-tropical retarding current, opposing the rotational motion.

If these north and south retarding currents actually met at the equator, we would practically be unaware of their existence, for we would have nothing to compare them with and they would hardly show sensible change in rate for many degrees on each side of the equator. But we find an equatorial zone largely unaffected by this retardation, although subject to rapid changes in configuration of detail. There may be at least two causes for the existance of this equatorial zone unaffected by retardation. First, the equatorial retarding currents may be simply not strong enough to reach the equator, for they have turned to an east-and-west direction and have little force left to push on north or south. Second, the effect of heat received from the Sun, even though very weak, would be to expand the air over the equator and cause it to spread north and south, thus interfering with the approach of the retarding currents to the equator, and also causing the slight seasonal change that has been suspected.

Above the actual visible surface that reflects solar light there must be considerable atmosphere for the limb of Jupiter is very dark all around. But as the polar and equatorial zones are also

much darker than the temperate regions, except in small spots, we infer that the gases freshly brought to the surface in the regions of convection have less reflecting power than those in other parts of the planet. The red marks of all kinds act like some kind of cloud condensation, light because they float high in the atmosphere, yet differing from the other visible materials, and showing a strong tendency to accumulate and last longest in the region that upon the hypothesis given above, must be the coldest part of the planet's visible surface.

Perhaps it is presumption to suggest more definitely the nature of the red spot. But the spot can be attributed to some special uprush of the same gas that forms the red belts, but to an uprush which occurred within the colder borders of the retarding current. A strong condensation ensued in the upper levels of the retarding current, followed by a gradual dissolving or falling downward of the red material. As the under side of the red mass is nearer the warm surface of the planet than the upper side, the most rapid breaking up of the mass would, we can infer, occur on the under side. We can therefore conclude that with the breaking up of the red spot and its becoming more and more confined to the upper levels only, of the retarding current, we are getting more and more accurate measures of the surface velocity of the retarding current. As the rotational velocity of the red spot has been decreasing since 1878, we conclude that the surface of the retarding current is moving more rapidly than the lower levels; and that is precisely the effect that friction produces.

At the present time, therefore, the red spot appears to be floating quietly in the retarding current, possibly held in place by an eddy, very slowly breaking up, perhaps already partly covered by other cloudy material and yet still dense and strong enough to preserve its form and size.

LOWELL OBSERVATORY, Flagstaff, Arizona, Oct. 16, 1900.

NOTE—At the Geodetic Congress which met at Paris at the end of last month, Sir David Gill, director of the Cape Town Observatory, reported the progress made in measuring an arc of meridian of 104 degrees from the Cape to Alexandria. They were passing by permission through German East Africa. Five degrees had been already measured in Rhodesia and three and a half in Natal. The measurement by international co-operation of an arc from French Congo to German East Africa was considerrd. A report was also made to the effect that the measurement of the geodetic line between Malta and Sicily had been successfully carried out under the superintendence of Dr. Guarducci, the chief of the geodetic division of the Italian Geographical Institute. The Malta station was at Gozo, and the chief Sicilian stations were on the mountains of Etna and Cammarata. The distance between Malta and Sicily is about 125 miles, and signals were exchanged at this distance by means of the oxyacetylene search-light.—*Science, October 19, 1900.*

JAMES EDWARD KEELER.

BY J. A. BRASHEAR.

"God did anoint thee with odorous oil,
To wrestle, not to reign, and He assigns
All thy tears over like pure crystallines
For younger fellow-workers of the soil
To wear for amulets. So others shall
Take patience, labor, to their heart and hand
From thy hand, thy heart and thy brave cheer."

—ELIZABETH BARRETT BROWNING.

A great soul has gone from us, "our" dear Keeler has finished his work among the stars. There is universal sorrow at his taking away; his colleagues on the mountain, his friends everywhere, say, how can it be that so great and promising a life has been blotted out and we left to mourn his loss. A colleague upon the mountain writes: "We are inexpressibly sad, are inconsolable, every one of the fifty people regarded Mr. Keeler as his personal friend! You most assuredly can say that he was liked by all his associates. There was never any unpleasantness in those two years. He made a great success of his own work, and saw that every body else had all the opportunities in the world to do the same. He never questioned or interfered with our plans, with the result that we all kept him posted as to the state of our work. Socially, he and his family were simply delightful. You may say that he established ideal conditions in this ideal place."

One who knew him only to love him writes: "My heart is heavy for Keeler, our dear friend Keeler, the bright, lovable, genial Keeler, who died last night. All day I have been like one in a dream; Keeler, our Keeler, gone." A colleague at the University writes: "All the professors at the University have words of kindness for him, and the deepest sympathy for Mrs. Keeler and the dear children." Another life-long friend writes: "Yes, our Keeler has passed away, well may you and I and Professor Brown call him our Keeler, and all who knew him could call him the same for all his energies and all his marvellous fund of information was ever at the disposal of his friends. I have never met a man in all my life who was more willing and anxious to assist others in every way than he, and how my heart goes out for his dear companion and the children."

Were I to write only of the kindly words that I have received in letters from friends who have known this great man, it would