

SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC
PROGRESS.

JOHN MICHELS, Editor.

TERMS:		
PER YEAR,	- - - - -	FOUR DOLLARS
6 MONTHS,	- - - - -	TWO "
3 " "	- - - - -	ONE "
SINGLE COPIES,	- - - - -	TEN CENTS.

PUBLISHED AT

TRIBUNE BUILDING, NEW YORK.

P. O. Box 8838.

LONDON, ENGLAND, - - - - 150 LEADENHALL ST.

SATURDAY, NOVEMBER 26, 1881.

THE SATELLITES OF MARS.

The outer satellite of Mars was seen here on Nov. 15th, and by an observation of Nov. 20th its position was

WASHINGTON, M. T.

	<i>h.</i>	<i>m.</i>	<i>p.</i>	<i>s.</i>
1881. Nov. 20,	13	15	71°.7,	45".6.

This satellite is therefore near the predicted place. An hour later Phobos seemed to be visible, also near the computed position, but the sky had become a little thick and I could not be certain of seeing this satellite.

The planet will continue to approach the earth until December 21, and the satellites will become brighter. It is possible, therefore, that they may be observed for nearly two months during the present opposition.

A. HALL.

WASHINGTON, D. C., Nov. 22, 1881.

THEORY OF THE MOON'S MOTION.*

About a year ago the Vice-President of the Physical Section of our chief scientific association remarked, in his farewell address: "there are many subjects in astronomy that need investigation, but in most cases the labor required is very great, and the completion of the work would occupy a long time. * * * The lunar theory has been a vexed question for the last two centuries, and may remain so for a long time to come." If persistent, painstaking, and conscientious effort have aught to do with such a matter, we must add to the list of distinguished lunar theorists, including Plana, Damoiseau, Hansen, and Delaunay, the name of Stockwell. We cannot say that his researches have yet met with that notice to which they are perhaps rightly entitled. Mr. Stockwell has published a num-

ber of monographs on many points connected with the lunar theory during the last six or seven years; and his works show great familiarity with, and expertness in, the involved computations of this sort of astronomical research.

If we may judge from the appearance of the pamphlet before us, Mr. Stockwell has now quite terminated his lunar investigations, and intends to complete the publication of his finished theory of the moon's motion at some early date. In his Introduction he has sketched the early historic development of the question with that explicitness which we should expect rather to have seen in some thorough elementary text-book; strangely, he devotes twice as much space to the ante-Newtonian aspect of the problem as to the most remarkable developments of the mathematical theory which have occurred since his time. He makes no mention of Damoiseau, who takes high rank not only among pure lunar theorists, but among the constructors of tables of the moon. His tables are well known to have been the first ever constructed from pure theory.

Though the age of the great lunar investigators is now gone, there are some very surprising results of Mr. Stockwell's "new method of analysis" to which the attention of the few theorists now working at the moon's motion might well be directed. He instances several comparisons of the values of his co-efficients with those obtained by Delaunay in his very refined development; in one case he obtains, by a rapidly-converging series of four terms, a result identically the same with that of Delaunay's series of seven terms; and remarks, "the four terms of my development are more accurate than the seven terms of Delaunay's, since the seventh term of the latter series is thirty times greater than the fourth term of the former." There is nothing new in the fact that the sum of a very small number of terms should come out equal to a very large series, but if theorists can be brought to acknowledge the essential accuracy of the "new method," Mr. Stockwell must no doubt be credited with effecting an enormous advance in mathematical astronomy. Mr. Stockwell has shown satisfactorily to himself the correctness and value of his method, and the facility of its application—he must now address himself to the equally difficult task of making others see it in the same light.

It seems a wholesale assertion on the part of Mr. Stockwell that there are "several terms of considerable magnitude in the theories of La Place, Plana, Pontécoulant and Delaunay, which are not functions of the disturbing force;" and we should, at first blush, be inclined to place much confidence in his demonstration that the general integral assumes the indeterminate form in special cases which occur in those theories. It is certainly a most important oversight, and leads us to believe that the lunar theorists who followed La Place would have done much better to have built up theories of their own with entire independence of what anyone else had done. It is a remarkable fact if this discovery has been left for Mr. Stockwell to make. He concludes: "if the computations of the present work are correct, astronomers have carried their approximations to terms of the *fifth*,

* John N. Stockwell, Ph. D. (Introductory.)

sixth, and seventh orders of magnitude, before those of the third and fourth had been correctly computed. This seems to be a sufficient reason for the nearly stationary condition of the lunar theory during the past three-quarters of a century, notwithstanding the great efforts which have been made to perfect its solution. Its advancement has been blocked by the obstacles thrown in its path by analysis itself; and we may therefore reasonably hope for substantial improvement in the theory and tables when they are no longer embarrassed with equations which have no existence in nature."

We may remark that there are two ways in which the correctness of Mr. Stockwell's conclusions may be tested: first, a mathematical expert competent to pronounce upon his theoretic processes should go over his work with the most searching criticism in every detail; and second, his theory should be compared with observations. But this latter would be a task of such immensity that no astronomer unassisted would hope for its completion.

NEW YORK ACADEMY OF SCIENCES.

Oct. 31, 1881.

The President, Dr. J. S. Newberry, in the Chair.

Twenty persons present.

The following paper was read by Mr. John H. Furman:

"The Geology of the Copper Region of Northern Texas and the Indian Territory."

The well-marked taceous beds of Parker County, Texas, extend for 30 miles north of west from Weatherford, on the road to Graham. They consist of strata of shelly limestone, sandstone and shaly clay, the latter grayish or reddish in color. An occasional thin seam of soft coal is found; and the water is strongly impregnated with lime. A stratum of sandstone stretches for thirty miles N. W. from Fort Worth. In this rock springs are found containing sodic carbonate, similar to the waters of the artesian wells of Fort Worth, Tarrant County, at a depth of about 270 feet. Towards Graham, the country assumes a semi-mountainous appearance, and, for twenty-five miles or more, sandstone ridges alternate with prairies, the hills being covered with scrub oak. Some of the ridges attain an elevation of two or three hundred feet above the prairies. The strata are horizontal, and large portions of the original surface have been carried away by erosion. The upper stratum is in many places a conglomerate, made up of small pebbles. In this region the seams of coal met with are generally soft, and the only workable bed known is one about three feet thick, yielding a fair quality of bituminous coal, which crops out and has been traced for several miles near the Clear Fork of the Brazos river in Young County. This supposed coal region has a general N. E. and S. W. direction.

Approaching Graham the prairies begin to resemble the plains; and the ridges, capped with sandstone, show bases of mottled reddish-colored shales, or clay; salt springs and salt streams are found, indicating the border of the great alkaline region. From Graham to Fort Griffin in Shackelford County, thence north in Throckmorton County, the country rises. Every few miles a steppe is mounted, the face of the escarpments showing horizontal thin limestone strata. The same features continue, and then the country slopes towards the Brazos river.

Turning westward through Haskell County, the surface lowers again towards the Brazos, the river coursing south to north, and a plain is crossed, the ground differing from any observed. The soil is mixed and covered with gravel, in many places several feet deep. The pebbles vary in

size from half an inch to an inch and a half in diameter, and consist of feldspar quartz, porphyry, and basalt. On the western side of Haskell County the copper bed is reached not far from the Brazos river; and west of the copper a great belt of gypsum hills, several miles in width, extends northward, parallel with the copper bed, into the Indian Territory. Gypsum occurs there in most of its forms, including selenite which has been locally mistaken for mica.

On reaching a scene of attempted mining operations in search of supposed veins of copper, a very short examination convinced me that no vein would ever be discovered. Denudation has laid the bed bare, sweeping away the larger portion uncovered and leaving only patches; but these were sufficient to give a clear conception of the mode of occurrence. The copper-bearing stratum is an ashy-colored clay shale, more or less tinged with green, the upper portion showing the deep green carbonate of copper, usually two or three inches thick. Overlying this stratum is a cap-rock of gypsiferous sandstone, about three feet thick, with a layer $\frac{3}{8}$ to $\frac{1}{4}$ inch thick impregnated with carbonate of copper, as though it had soaked it up from below. Underneath the gray or green bed an intensely red clay shale is generally found. Nuggets of copper are scattered over the surface of the red bed, with pieces of cuprified wood and nuggets of iron pyrites. In the wood the original structure in many instances is perfectly preserved, also appearing cuprified in all stages of decay, as though it had become half rotten before the petrification was effected. The overlying sandstone frequently contains biscuit-like concretions of gypsum. Juniper trees abound and also cover the gypsum hills, the perfectly preserved cuprified wood, with its knots and bark, showing a fac-simile of that growth. I found in the gray bed fragments of wood partially unaltered, as though it had just commenced to absorb copper; also large pieces of coal, three or four inches or more in diameter, the cracks of the same piece being filled with crystalline carbonate of copper, or with white gypsum, thus appearing veined with copper and gypsum. In parts of the bed remaining the resemblance to piles of ashes and charcoal is strikingly deceptive; in one shaft, sunk to a depth of about thirty feet, the horizontal position of the strata was confirmed, the shaft passing through the cupriferous gray bed, and then through a succession of layers of red shale and soft red sandstone, in which not a trace of copper was found. The gray stratum extends seventy-five feet or more under a point of the gypsum hill. In a tunnel traversing this stratum I noticed occasionally pebbles belonging to the gravel drift. This copper formation has a general north and south course, usually less than fifty yards in width, and was traced for a distance of eight or ten miles to the southern boundary of Haskell County.

At one point the gray bed lies between beds of sandstone; the red bed does not appear, and the underlying sandstone strata are almost white, laminated, and very hard. The bed is more than two miles distant from the gypsum hills; the gravel drift is noticeable and even abundant. Observing the nuggets of copper ore and the drift pebbles lying about in places on the red bed, the idea forced itself upon me that there might be a remote connection between the two. However, the nuggets of ore are evidently concretions, and no pebbles occur in the gray bed. The gypsum range extends several miles across, with a western declivity similar to that on the eastern side. A plain, a little over one hundred feet below, reaches beyond to the foot of the great Llano Estacado. On these hills and on this western plain the gravel drift is wanting.

The copper bed was traced five miles further to the north; also in Knox county, not far from the Wichita river, and forty miles or more north of the southern portion of Haskell county, besides learning its supposed occurrence north of the Wichita river. The copper band