

ON THE INTERIOR CONDITION OF THE TERRESTRIAL GLOBE.

BY M. E. ROCHE.

Generally we admit that the earth is entirely fluid in its interior, with the exception of a thin crust, and most of the mathematical studies on the figure and the constitution of the earth assume this fluidity. Thus by attributing to this fluid a certain law of compression, Laplace has deduced a corresponding law of densities, which Legendre had already examined before him, and which permits the calculation of the flattening of the different surfaces *de niveau* of the terrestrial mass. I have myself proposed another law of compressibility, which conducts to a very simple formula for the increment of the density. The conditions which every hypothesis must satisfy, on the distribution of the mass in the interior of the earth, are that it must accord with the value of the superficial flattening, and also with a certain constant depending on the phenomenon of precession. These conditions are very approximately satisfied in the hypothesis of fluidity, if we admit that the terrestrial flattening is nearly $\frac{1}{230}$; but if this flattening is greater than $\frac{1}{235}$, as it seems to result from the most recent determinations, the agreement no longer exists.

There is need, therefore, of a new examination of these researches under a different hypothesis, for example, in considering the globe as formed of a nucleus or solid mass very nearly homogeneous, covered with a lighter shell whose density, from geological considerations, can be estimated as $\frac{1}{3}$ with respect to water. This constitution of the globe being supposed, I find that it is possible to conciliate the actual values of the precession and of the flattening, if we take account of this, that the interior nucleus of the globe solidified and has taken its definitive form under the influence of a rotation less rapid than that with which the earth is now animated.

In every case the contraction due to this cooling of the globe must lead to a progressive acceleration of its angular velocity. But if this globe is fluid the figure of the different strata adapts itself continually to the rotation which has place at each instant, in such a way that finally there remains no trace of the successive variations which their flattening have undergone since the origin. If, on the contrary, at a certain epoch of the cooling the interior strata have passed to a solid state, these strata have taken and preserved a flattening very different from that which would be attributed to them by the general equation of hydrostatics applied to a mass entirely fluid and possessing a rotation common to all its parts. The formulæ calculated in the hypothesis of a solid nucleus contains at the same time the constant g , the actual ratio of the centrifugal force to the equatorial gravity, and value g_0 , of the same ratio at the epoch of the solidification of the central mass. This last element, not being determined, we can give to it a value such that the superficial flattening accords with the coefficient of precession. It is necessary for this to suppose g_0 less than g , whence it results that the terrestrial rotation has undergone an acceleration since the consolidation of the interior nucleus.

The physical and astronomical conditions of the problem permit also the determination, with some precision, of the dimensions and specific weight of this central mass. If we leave out of consideration the crust purely superficial, as also a slight condensation towards the centre where the heavier materials would be collected, the constitution of the globe will be as follows: a nucleus, of which the density is nearly 7, covered with a shell of density 3, whose thickness does not attain one-sixth of the entire radius.

The central terrestrial mass is therefore in specific weight analogous to meteoric iron, while the stratum that envelops it is comparable to aerolites of a stony nature, where iron enters only in a small proportion.

BOOKS RECEIVED.

THE MICROSCOPE AND ITS RELATION TO MEDICINE AND PHARMACY. Edited by CHAS. H. STOWELL, M. D., and LOUISA REED STOWELL. Published monthly. Ann Arbor, Michigan, 1881.

There are already two journals published monthly which are devoted to microscopy, it is therefore with some surprise that we find a third journal of the same description appealing to the patronage of Microscopists.

"*The Microscope*" claims to supply a want in offering physicians a journal which treats exclusively of Medical and Pharmaceutical Microscopy, thus differing from the two former microscopical journals which cover the whole field of Microscopy.

We believe that the success of "*The Microscope*" will depend upon that journal being conducted strictly within the limits of its own programme. Undoubtedly the majority of American microscopists are members of the medical profession and, therefore, "*The Microscope*" may look for a numerous constituency.

"*The Microscope*" has been produced in an excellent form, is well printed, and illustrated with good illustrations, and if the editors will confine the columns to *Microscopy*, to the exclusion of facetious "items" clipped from their exchanges, they may hope to place their journal on a firm basis.

CORRESPONDENCE.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

To the Editor of "SCIENCE."

Permit me to suggest a few questions that should be answered by the author of "The Great Primordial Force." (See "SCIENCE," p. 405.)

Let me introduce my questions by announcing my *belief* in the conservation of energy and in the unity of force and by expressing a *hope* that the time will come when the phenomena peculiar to the different *manifestations* of force may be comprehended and their identity demonstrated.

The following questions are respectfully suggested:

1. When, and by whom, has it been demonstrated that gravitation is resolvable into light or heat?
2. If all force "is substance," or matter, (see "SCIENCE," p. 405, last paragraph), then, at least some matter is force. What then is the distinction between matter and force?
3. On p. 406, it is asserted that the two elements, "*Motion and Magnetism*," "develop all known forces of the universe." How can motion exist without a *prior* force, and what *is* magnetism?
4. What produces the revolution of the revolving celestial armatures?

The foregoing questions may be sufficient for the present, but it is due to science that statements claiming to be scientific should be *truths*. Let us examine some of the author's statements.

It is asserted that "if gravity acts inversely as the square of the distance, then the earth at aphelion could not, without the aid of some other force, return to perihelion." It is to be feared that the author of the above question is not aware that the inertia of matter is an experimental fact, and is entirely sufficient to bring back the planet from aphelion to perihelion.

As to the law of inertia, all matter, if not acted upon by some external force, will continue in its present state, whether of motion or rest, and because while a planet is passing from perihelion to aphelion the tangent to its orbit makes an obtuse angle with its radius vector; therefore its inertia counteracts, and to a certain extent,

opposes its centripetal force, from perihelion to aphelion, and because at aphelion, the tangent of its orbit, is at right angles with its radius vector, and from aphelion to perihelion the angle between the tangent and radius vector is acute, therefore, the inertia of the planet co-operates with the centrifugal force from aphelion to perihelion.

Hence, *inertia*, in conjunction with the centripetal force, is sufficient in all cases of elliptic motion, to bring back the planet from aphelion to perihelion.

Again, the writer says, (p. 407) "the degree of ellipticity of each planetary orbit is due to the inclination of its axis." That the reader may judge how much weight should be allowed the author's statement, let this statement be compared with known facts.

The eccentricity of the earth's orbit is .0167922; that of Venus is .0068618. The inclination of the earth's axis is about $23\frac{1}{2}^{\circ}$; that of Venus 75° . That is, the inclination of the earth's axis to its orbit is less than one-third that of Venus; whereas, the eccentricity of the earth's orbit is more than twice that of Venus.

The author's statement, therefore, is not only not supported by the facts, but is in conflict with the facts.

J. E. HENDRICKS.

DES MOINES, Sept. 3, 1881.

To the Editor of "SCIENCE":—

The prevailing scientific ideas of any period are regarded by the common people, and even by the scientists of that period as indubitable facts, without due examination of their origin or their foundation. But further thought and observation often compel a reluctant retreat therefrom. Thus present conceptions have all the weight of perfect truth. We call them "*facts*."

The rapid discoveries of the present age, and the unprecedented freedom of thought are disturbing all theories that are not well founded. The new law of Conservation of Force will cause the final destruction of every theory that is not in harmony with it. The paper upon the "Great Primordial Force" was but an effort to bring the explanation of the physical forces into consistency with that all-governing law.

That the paper should give rise to such questions as those proposed by our critic was most natural, and we shall endeavor to answer them in the same candid spirit in which they were asked.

1. Bodies fall by force of gravitation. Resistance to such fall of course produces light and heat, precisely as resistance to the motion of the electrical current produces the same. If we admit that the electrical current is convertible into these forms, by parity of reasoning, so is gravity.

2. The relations of matter and force seem adequately set forth in the paragraph referred to. (See "SCIENCE," p. 405.) Electricity, which in its tenuity pervades all matter, is abundantly demonstrated to be itself matter in varied form, as in the thunderbolt, the fire ball, and in the St. Elnios fire.

3 and 4. The only rational explanation, whether to us satisfactory or unsatisfactory, of the origin of force, is found in the hypothesis and admission of already existing force, the *primum mobile*. HELMHOLTZ says, that a body set in motion around the sun in vacuous space, and with a certain velocity will continue to move with the same velocity to all eternity. It is sufficient for us to know that the motion *is*, and the magnetism *is*, and thus we have the "celestial armatures" already in revolution,—the effects of which it is for us to observe. To us the effects are, and are called, the "physical forces."

Our critic is disturbed by our questioning of the dogma that "gravity acts inversely as the square of the distance,"—on the ground that if that force is weakened by the earth's being removed to aphelion, it could not again bring back the body to perihelion. We re-affirm FARADAY'S position; "The received idea of gravity appears

to me to ignore entirely the principle of the conservation of force, and by the terms of its definition, if taken in an absolute sense, 'varying inversely as the square of the distance' to be in direct opposition to it." But we would not rest the assertion upon any great name. It is evident that inertia can "bring back" nothing, that inertia, or momentum, or centrifugal force, or whatever other expression is used, may effect only motion in a straight line. Momentum, (which evidently is what the critic means by "inertia,") has no tendency towards circular motion. It is attraction, gravity, centripetal force alone that draws, or "brings back," and if that force is *weakened*, how can it make itself stronger? If once diminished (as the principle, "gravity acts inversely as the square of the distance" necessitates,) then the opposite force has the balance of power, has destroyed the equilibrium, and except some favoring force steps in to restore the lost ground, momentum, ("inertia") must forever send it farther and farther into space.

Finally, our critic in order to show that the electrical theory, which makes the inclination of a planet's axis to govern the ellipticity of its orbit, is not true to fact, adduces the instance of Venus. This asserted "*fact*" (?) that Venus' axis has an inclination of 75° , is wholly unfounded, Astronomers to-day are not so ready to assert it. The dazzling brilliancy of this planet prevents any positive disclosures as to the period of its daily revolution, to say nothing of the more delicate and difficult determination of the inclination of its axis.

Our distinguished astronomer NEWCOMB says:—The latest physical observations on Venus, with which I am acquainted are those of Dr. VOGEL, "Bothkamp Observations, 1873." The result to which these observations point is that the atmosphere of Venus is filled with clouds so dense that the solid portion of the planet cannot be seen, and no time of rotation can be determined." HERSCHEL said that he was never able to see any permanent markings on Venus,—but it is only by such markings that these determinations are made.

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MEDICAL CONGRESS NOTES.

(London, 1881.)

At the close of Professor Huxley's address, Mr. MacCormac followed with a statement, the most important items of which were that the number of members amounted to 3,210; that the sections had held 11 meetings, extending over 293 hours; that there had been delivered 464 written papers and 360 oral addresses. The attendance at the sections had been large, and had not shown signs of falling off even quite to the close. The museum was referred to as a great success, and the demonstrations of living patients had been attended by crowds each morning.

ENDORISING VIVISECTION.

Sir James Paget then presented the following resolution forwarded by Professor M. Foster, from the Physiological Section: "That this Congress records its conviction that experiments on living animals have proved of the utmost service to medicine in the past, and are indispensable for its future progress; that, accordingly, while strongly deprecating the infliction of unnecessary pain, it is of opinion that, in the interest of men and animals, it is not desirable to restrict competent persons in the performance of such experiments." Pointing out that it was impossible to discuss such a resolution then, the President asked those who were opposed to it to record their names and votes at the close of the meeting. The resolution was then adopted with loud cheers, and no hand was held up in opposition to it.