earth's mass. Each pound of the earth's mass reacts with an equal vigor of attraction upon the body. We must add all these separate attractions together to get the whole sum of attraction in either case, and these whole sums are necessarily equal. The body, therefore, attracts the earth with as much vigor as the earth attracts the body, and necessarily, therefore, they must approach each other with equal energy. Of course not with equal speed. Under the above supposition their respective weights were as a million to one, and a million pounds falling one inch would be equivalant to one pound falling a million inches. Their acceleration in speed must likewise, in both earth and body, obey the law of gravitative acceleration.

It is well, therefore, to bear strictly in mind, that in gravitation, as in every other form of force, action and reaction are always equal and opposite.*

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PRIMEVAL ROTATION AND COSMICAL RINGS.

II.

To the Editor of "SCIENCE":—

Prof. A. Winchell, recounting the history of formation of the solar system from a sphere of incandescent gas, says: "The cooling and contraction of this vapor inaugurated a rotation." [1]

Matter is governed by law, hence the ball of gas must have obeyed laws governing gases. Men have detected several laws of nature, while doubtless there are others eluding research. The globe of gas was dominated by known or unknown laws; if by unknown, no scheme of planetary evolution can be outlined; by known, hypotheses are tested by their application. There exists a doctrine, the Nebular Hypothesis, and we take it for granted that its advocates conceive the gaseous sphere to have been wrought by known laws.

But no law of nature yet discovered is able to cause a sphere of gas to rotate.

Contracting by cooling did not begin rotation, for, by dynamic laws, the mass was not hot, but cold. If hot, contracting would not cause rotary motion, but would give rise to two motions, centripetal and peripheral, both radial instead of circular. The heaviest atoms, gravitating towards the centre, would displace the lightest towards the circumference.

Repulsion did not exist; this force can only obtain in matter *not* dissociated. Repulsion causes dissociation and vanishes, gravity reasserting dominion. Hence, repulsion is more ancient than that gravity which caused the mass to develop a solar system; else the first state of matter was in dissociation.

These things are unknowable; therefore, with adherents of the hypothesis, we dismiss repulsion, leaving the mass subject to no known energy but gravity. If repulsion did act it could not cause rotation. Gravity could never cause the ball to turn; it would bring every atom to a rest. The whole mass would arrange itself in concentric strata, whose distance from the centre would depend on specific gravity. Calm would ensue unless pressure was sufficient to force atoms within range of chemism. Chemical reaction would have no power to start axial revolution. It would evolve heat, repulsion and temporary expansion, which, waning, would leave the mass smaller through combination, no sign of rotary motion having appeared. The mass extended half way to α Centauri, it being equal in mass to the sun. Helmholtz has shown that if the matter in the solar system expanded to Neptune, "it would require several cubic miles to weigh a single grain." [2] But the same matter filled a sphere whose radii were half the distance of the stars in length. Estimation of its tenuity indicates that a space as large as the moon only contained a grain. Yet it was "intensely heated." [3] It is not known how many atoms make a grain; counting them by the million, they were yards apart, in frigid voids—hot! Obeying gravity, they descended with slowest conceivable motion; at no point in their fall displaying tendency to move in arcs of circles at right angles to their radial movement, which they must do to begin rotation in the cosmic sphere. In the present state of knowledge, judging from laws at work in the Universe, it can be safely asserted that the ball had no rotary motion. Ignoring these considerations, we will assume with Winchell that it was in revolution.

"The cooling and contraction of this vapor inaugurated a rotation which was inevitably accelerated to such an extent that a peripheral ring was detached which became a planet. The same process continued and other rings were detached which became other planets in due succession. Similarly, the planetary masses detached rings which became their satellites." [4]

Conceiving the mass to have cut loose from 61 Cygni and other cosmic masses; admitting cooling, contraction and acceleration, then the sphere would be unable to cast off by any law of nature hitherto discovered, the least particle, to say nothing of a massive ring. The ball had dwindled to the orbit of Neptune, acquiring such volocity as to no longer remain intact, so it cast off equatorial matter enough to form that planet.

The rate of motion on the equator was only 3.36 miles a second; and a vacuum as made by Crookes is as a solid compared with the density of the ring; yet Neptune's mass is nearly 102 sextillions of tons [5]. The material, being exterior, was of the lowest specific gravity of any in the mass; thence its volume was enormous; so great as *not* to be peripheral. The word periphery alludes to the surface, and Winchell says the ring was peripheral. It was not,—it was formed of gas torn up from a depth of hundreds of millions of miles, in order to secure substance sufficient to form Neptune. If not,—the mass was piled above the level of the equator, an impossibility, as gravity would bring it down. As soon as force raised a line of atoms above the equatorial level, around the ball, the next line of atoms below would ascend, then the next, and so on. The poles would depress causing the mass to assume lenticular form. This would retard rotation, allowing central attraction to regain control, bringing the mass to a sphere as in the beginning. This oscillation must take place so long as the mass remained a gas. Should it become fluid, then the alternations would be between a sphere and spheroid, and the mutation would obtain until solidification sets in. No atom at any period had power to overcome gravity, the stability of the mass being assured by inhering laws. The mass of the solar system, the mass of any planet, the direction and velocity of the planet's original motion, determine what orbit it shall traverse.

The orbit of Neptune is determined; it makes regular revolutions, hence the centre of the assumed ring that formed it, when abandoned coincided with the present track of the planet's centre. Therefore the ring was not detached when the mass was lenticular, for its edge then extended far beyond where Neptune now revolves; if it had been the planet would now describe our orbit much *farther* from the sun.

The mass reached the present path of Neptune when spherical, and that world was thrown off where it now makes circuit, the mass being a sphere when it parted with its first ring.

*In my previous article, above referred to, there is a typographical error, which slightly confuses the meaning. On page 167, line 49, the phrase "this force is increasing," should read, "this force is unceasing."

[1] Geology of the Stars, p. 260.
[2] Youman's Correl. and Con. Forces, p. 231.
[3] Geology of the Stars, p. 279.
[4] Geology of the Stars, p. 279.
[5] Chambers' Astronomy, p. 898.

Then a segment half way to Uranus was torn away entirely around the ball, and the rupture took place along the chord of the arc. A section of this ring would be flat inside and curved outside; else a ring lifted out of the equator quite around the sphere, whose sections were circular, leaving concave walls of gas in north and south latitude. Neptune would condense somewhere on a line in the centre of gravity of the ring. In either case the orbit of the first world would be *nearer* the sun than now. It could not have been thrown off the surface, as there was not material enough; nor from the edge of the lens-shaped mass, nor from beneath the surface of the sphere, for from either place the orbit would not be where it is. It could not have been cast off at all. EDGAR L. LARKIN.

NEW WINDSOR OBS., *May 11th*, 1881.

BOOKS RECEIVED.

THE HUMAN BODY.—An Account of its Structure and Activities and the Conditions of its Healthy Working. By H. NEWELL MARTIN, D.Sc., M.A., M.B. Henry Holt and Company, 1881.

This book is the fourth of the "*American Science Series*" of manuals prepared under the direction of Messrs. Holt and company, and will be found of equal value, as a popular guide to the subject treated, to the three works which preceded it. It is a reliable work, being compiled from the best authorities, and is not intended for specialists, but for general readers and students.

In an age when the Physician is called upon to explain to his patient, the *raisen d'etre* of the treatment suggested, and even to describe the peculiar condition of the organs affected, some knowledge of Human Anatomy and Physiology appears essential to those who desire to act as consulting physician in their own cases.

To meet such a demand for a popular work on the human body, Dr. Martin has prepared the present volume, which is free from technicalities, or scientific terms requiring interpretation. The reader has the advantage of one hundred and sixty-five excellent illustrations, and as Dr. Martin's style of writing is both clear and comprehensive, the task of the reader is an easy one.

The earlier works of this series have been reviewed in "SCIENCE" and comprise the following manuals: *Astronomy*, by Professors Simon Newcomb and Edward S. Holden: *Botany*, by Professor C. E. Bessey: *Zoology*, by Professor A. S. Packard, Jr.

OSTEOLOGY OF SPEOTYTO CUNICULARIA Var. Hypogæa, and of Eremophila alpestris, by R. W. SCHUFELDT, U. S. A.—Extracted from the Bulletin of the U. S. Geological and Geographical Survey—Washington, Feb. 11th, 1881.—Four full page illustrations.

ABSTRACT OF TRANSACTIONS of the Anthropological Society of Washington, D.C., with the annual report of the President.—For the year ending Jan. 20, 1880, and for the second year ending January 18th. 1881. Prepared by J. W. POWELL.—Washington, 1881.

THE TWELFTH ANNUAL REPORT of the American Museum of Natural History—Central Park, New York City—Dated February 15th, 1881.

REPORT of the Cruise of the U. S. Revenue Steamer *Corwin* in the Arctic Ocean, by Capt. C. L. HOOPER, U. S. R. M,—November 1, 1880—Washington, 1881.

REPORT of the Director of the Detroit Observatory of the University of Michigan—October 1, 1879, to January 1, 1881, Ann Arbor, Michigan, 1881.

ABSTRACT of some Paleontological Studies of the Life History of Spirifer lævis H. by, Professor H. S. WILLIAMS of Cornell University, Ithaca, N. Y.—Reprinted for American Journal Science.

OBSERVATIONS on Jupiter by L. TROUVELOT—Presented March 9th, 1881.—Reprinted from the proceedings of the American Academy of Arts and Sciences.

PROCEEDINGS of the U. S. National Museum, 1881. Check List of Duplicates of Fishes from the Pacific coast of North America (221 Species) distributed by the Smithsonian Institution in behalf of the United States National Museum.—Prepared by DAVID S. JORDAN and PIERRE L. JOUY.—April 13, 1881.

DESCRIPTION of a new species of Squalius (Squalius aliciæ from Utah Lake, by PIERRE LOUIS JOUY.

DESCRIPTION of a new Gobioid Fish (Othonops eos) from San Diego, Cal. by ROSA SMITH.

ON a Duck new to the North American Fauna, by ROBERT RIDGWAY.

ON Amazilia yucatanensis (Cabot) and A. cerviniventris, Gould, by ROBERT RIDGWAY.

DESCRIPTIONS of new species of Fishes (Uranidea marginata, Potamocottus Bendirei) and of Myctophum crenulare, J. and G.—by TARLETON H. BEAN.

NOTES on the Fishes of the Pacific Coast of the United States by DAVID S. JORDAN and CHARLES H. GILBERT.

In this paper descriptions are given of 109 species of fishes known to occur along our Pacific Coast between the Mexican boundary and that of British Columbia, with notes on the distribution, habits, size, value, etc., of each species, in advance of the publication of a general descriptive work.

AMERICAN KINDERGARTEN MAGAZINE.—Edited by Emily M. Coe, Bible House, New York.

We have pleasure in recognizing the sterling merit of this excellent little Monthly, a leading feature of which appears to be an attempt to popularize science in a form suitable for children. The present number contains articles introducing the young readers to the best methods of classification of the Animal Kingdom. The journal is in its third volume, and is sold for one dollar a year.

NEW APPLICATION OF THE SUB-PRODUCTS OF COAL-TAR.—Mr. Sanders, of St. Petersburg, has succeeded in producing from the heavy oils of coal-tar, a new substance which, in many cases, takes the place of india-rubber with advantage. It is prepared in the following manner. A given weight of a mixture in equal parts of wood-oil and coal-tar oil, or of coal-tar and hemp-oil, is heated for several hours, at a temperature of about 318° Fahr., so as to disengage the injurious substances and increase the viscosity of the mass, until it may be drawn out in threads. A second quantity, equal to the former, of linseed-oil, preferably thickened by boiling, is now added, and also from one-twentieth to one-tenth per cent. of ozocerite with a little spermaceti. In the meanwhile, the mass is kept at a uniformly high temperature for some hours, when from one-fifth to one-half part of sulphur per cent. is added, after which the product is moulded or otherwise worked in the same manner as india-rubber. The proportions of the three oils named above may be varied so as to obtain a harder or more elastic substance, as may be required. The product is elastic and tenacious, standing the weather better than india-rubber, and is not deteriorated by great pressure or a high temperature. It is said to be specially suitable for the insulation of telegraph wires, and may be employed alone or mixed with india-rubber or similar resinous substances.

ELECTROLYSIS.—Mr. E. F. Smith finds that a black hydrated oxide, $Ur_3 O_4$, is precipitated when a galvanic current is passed through a solution of uranium acetate, formate, or nitrate.