The Shifting of Position of the Earth's Poles.

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For many years past it has been a moot point, as to whether or no, the poles of the Earth remain in the same position; or in other words whether the axis of inertia varies from the axis of figure. It is obvious that if the latter supposition be true, the amount of the shifting of position of the poles must be very small. If it were great, the climates over the Earth's surface would be affected. The famous mathematician Euler had long since pointed out that there should according to theory exist a ten-monthly periodic oscillation of the poles. But observation had not corroborated his theory, for his theory was based upon an incorrect assumption. It is now known that a real shifting of the position of the Earth's poles *does* take place, although the amount is very small, having a radius from the mean centre of not more than 30 feet. This fact has been proved only lately with remarkable mathematical skill by S. C. Chandler of Cambridge, Massachusetts, in a series of very able papers. He took a series of exceedingly accurate observations throughout the year with the almucantar, which showed that the latitude of Cambridge, Massachusetts, varied. He proved that there was no personal or instrumental cause which could account for this variation. The variation was at its maximum in spring and minimum in autumn, and vanished in summer and winter. The period he found was not annual, but that of 14 months. The range was 0·7″ in the seven months. These facts he simply verified by further observations. These observations were moreover curiously confirmed by work which was being done, with quite other objects in view at German and Russian Observatories. It was thus proved that the Earth's axis of inertia (at the extremities of which are the poles) revolves about the axis of figure in a period of 427 days, with a radius of 30 feet. This motion, however, does not appear to be wholly regular, but is probably subject to secular change, and perhaps to irregular variations within short periods. By discussion of the observations made at Berlin, it was shown that, as should be expected, when the latitudes at Berlin and Petrograd were greatest, at Cambridge, Massachusetts, they were smallest. Again some highly accurate observations, that were being made at the Naval Observatory of America, in order to find out the exact value

of the constant of aberration, showed an unaccountable error, which caused a variation in this constant at different times of the year. Chandler was able to show that his discovery of the 427-days period of Earth's axial oscillation would account for the error. By further discussion of the American and Russian observations, he proved that the Earth's pole must be revolving from west to east, with a radius of 0·35″. He next investigated Bradley's famous series of observations, which led to his great discovery of aberration, and was able to show that his new theory of polar displacement could account for the discrepancies which were well known to exist in Bradley's calculations, and even in the value he gives for the constant of aberration. According to Bradley's observations the maxima and minima occur in spring and autumn, not in summer and winter, as would be the case were the variations due merely to temperature. But the very remarkable discovery was made that the periodic revolution of the poles in Bradley's time was not 427 days, as it is now but slightly over a year. The dynamical theory of Euler that the revolution must be exactly of ten-months periods was wrong, because it was based upon the wrong assumption that the Earth is a perfectly rigid body, whereas the Earth together with the oceans is possessed of a considerable degree of elasticity. Hence it can be mathematically shown that, if the axis of rotation be changed, the axis of figure will tend to confirm to the new position of rotation, and the period of revolution will be increased. We will conclude by quoting the summary of the argument as given by Chandler himself in regard to the general character of the law of rotation and the law of the variation of its period. He says —The observed variation of the latitude is the resultant curve arising from two periodic fluctuations superposed upon each other. The first of these and in general the more considerable has a period of 427 days and a semi-amplitude of 0·12″. The second has an annual period with a range variable between 0·04″ and 0·20″ during the last half century. During the middle portion of this interval, roughly characterised as between 1860 and 1880, the value represented by the lower limit has prevailed, but before and after those dates the higher one. The minimum and maximum of this annual component of the variation occur at the meridian of Greenwich, about ten days before the vernal and autumnal equinoxes respectively, and it becomes zero just before the solstices. As a resultant of these two motions, the effective variation of the latitude is subject to a systematic alternation in a cycle of seven years' duration, resulting from the commensurability of the two terms. According as they conspire or interfere, the total range varies between two-thirds of a second at a maximum,

to but a few hundredths of a second, as a minimum. In consequence of the variability of the coefficient of the annual term above-mentioned, the apparent average period between 1840 and 1855 approximated to 380 or 390 days ; widely fluctuated from 1855 to 1865; from 1865 to 1885 was very nearly 427 days, with minor fluctuations; afterwards increased to nearly 440 days, and recently fell to somewhat below 400 days.

An Enquiry into the Equilibrium and Stability of the Solar System.

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The mechanism of the solar system is independent of forces from without and is self-sufficing. And this, because it is surrounded on all sides by an immense void, which effectually shuts off any gravitational interference of sensible amount on the part of the hosts of heaven. The solar system is under the almost absolute sway of the Sun, except for the small mutual perturbations of his attendant satellites. It is well known that the prevailing view of sciene at present is in the main in accord with the theories of Laplace, that the mass of the solar system was in remote ages an enormous globe of nebulous matter, revolving very slowly from west to east. By cooling it contracted, and because its moment of inertia became thereby diminished, its rotational velocity increased, and when its rotational velocity exceeded a certain critical point, centrifugal force overpowered centripetal, and rings were thrown off to form planets. The present distances therefore of the planets represent the lengths of the radii of this primitive nebula at the moment when each particular planet was abandoned. Their periods also represent the period of rotation of the nebula at the moment of their birth. It has generally been held, judging from the Sun's present period of rotation, that when it was as wide as the various planets' orbits, it would have rotated with like periods. Thus when it extended out to Neptune's distance it rotated once in 164 years, when as wide as Saturn's orbit or Jupiter's orbit once in 30 years and 12 years respectively. There would have been the same equilibrium between centrifugal and centripetal forces as exist now, for a globe attracts as if it were condensed