orbit, before that to fill the orbit of Jupiter, earlier it filled the orbit of Saturn, still earlier that of Neptune. There seems no escape from this. In the present state of our knowledge it is unavoidable.

Then if the present conditions make it appear that the Sun has contracted from a nebula having a diameter as great as the orbit of Neptune, and when we see the uniformity of the movements of the planets and the Sun, we are naturally attracted to the belief, no matter what its difficulties, that the planets were somehow formed during the contraction of the Sun from a great nebula engulfing the whole of the solar system, although it is questionable how far the present uniformity of movement can be regarded as proof of original uniformity.

Extracts from Publications.

A Simple Eclipse Experiment.—The phenomena of an eclipse may be well reproduced by a simple experiment made as follows :—

Make a smooth round hole, about one-eighth of an inch in diameter, in a visiting card or thin sheet of metal, and allow the rays from the Sun or other source of light to pass through the hole and fall on a sheet of white paper held parallel to the card, and at right angles to the rays. Take a pin with a round head of black glass, of a diameter very little less than the hole in the card, and holding it about an inch from the card, pass it very slowly across the hole. The bright image of the Sun will then pass through all the stages of an eclipse, commencing with the "first contact" as the head of the pin first emerges into the rays at the edge of the circular disc of light, and forming all the successive crescent phases until it lies co-axially with the hole in the card, when the appearance of an "annular eclipse" is reproduced. Further movement of the pin in the same direction will reproduce the phases which occur after totality has been reached, giving, finally, the phase of "last contact."

If the bright annular ring of light be examined carefully, when the eclipse is at its maximum, it will be seen to be free of blurs or blemishes if the edges of the hole and the head of the pin are both clean and free from projecting particles. Now coat the head of the pin with fine dust, such as flour or the pollen of a flower—even fine tobacco ash will suffice—and repeat all the above operations. No roughness, or only a very little, will be seen on the dark image of the "Moon"—the pin's head—until the annular stage is reached, when quite suddenly there will appear black spots and streaks in the bright ring of light, giving one the impression that "Baily's beads" have been produced. Whatever may be the true cause of the latter phenomenon during an annular eclipse of the Sun, such as was witnessed on April 17th last at some places, the effect in the experiment above cited may be produced in one of three ways; first by roughening the surface of pin's head; secondly, by dust on the edges of the hole; thirdly, by both the causes stated in the first and second cases acting simultaneously.—W. G. ROYAL-DAWSON.

[*The Mechanic.*

A simple method of correcting the Sun's declination for refraction.—In "Field Manual of Engineering Instruments" by Professor L. S. Smith is described a method of making the above correction, which requires, in addition to a transit theodolite, nothing except a watch with a second-hand, dispensing entirely with the use of tables.

Having focussed the eye-piece and object-glass of the theodolite so that a clear image of both the Sun's disc and the cross-wires can be seen on a piece of white paper held behind the eye-piece, set the horizontal circle of the theodolite to read some integral ten minutes and point on the Sun by the lower motion.

The Earth's diurnal motion will carry the Sun across the vertical wire of the instrument. Note the time to the nearest second when the Sun is tangent to the vertical wire. Keeping the lower plate clamped, unclamp the upper and turn the telescope in the direction of the Sun's movement—*i. e.*, towards the West and set the Vernier to read the next ten minutes. Note again the time when the Sun is tangent to the vertical wire. Also read the vertical angle to the Sun. Then if we call n the interval of time elapsed in seconds, while the Sun (really the Earth) was passing through ten minutes of arc, and call h the vertical angle in degrees, the refraction d (in minutes) is given by the equation :—$d = 2{,}000/h \times n$.

Experience in using this formula has shown that its maximum errors will not exceed 15″ when the Sun is above 10° altitude, while its average error is less than half this amount. As the refraction correction, as ordinarily computed, is based upon average conditions of temperature and barometric pressure, seldom exactly realised in any given case, the author has not been surprised to find that results obtained by the use of the above formula are quite as good as those obtained from the more complicated and portentous formulæ and tables.

A still more accurate determination of the refraction can be made by the use of the following equation :—$d = 100 \times \frac{N}{n}$ where d and n stand for the same quantities as before, and N is obtained from the following table by entering it with the measured altitude of the Sun as an argument :—

H	N	Diff. for 1°	H	N	Diff. for 1°
10°	.. 131	.. 9	30°	.. 36	1·4
15	.. 86		40	.. 22	
20	.. 62	.. 5	50	.. 13	.. 0·9
25	.. 47	.. 3	60	.. 7	.. 0·6
30	.. 36	.. 2	70	.. 3	.. 0·4

The altitude of the Sun need only be observed to the nearest half-degree.

The tabulated values of N correspond to a temperature of 50° F., and a barometric pressure of 30″. They may be adopted to any other temperature by diminishing d by one per cent. for each 5 degrees by which the temperature exceeds 50° or by increasing one per cent. for each 5° below 50°.

This correction and the correction for variations of the barometer can usually be neglected. At great elevations, however, the barometric pressure becomes so much reduced that its variation must be taken account of, and this is done by diminishing d by one per cent. for each 300 feet of elevation above the sea.—COSMO.

[*The Mechanic.*

The Speciroscopic Discovery of the Rotation Period of Uranus.—The primary work of the Lowell Observatory is the study of the planets of our solar system, their present state, and, from that the principles of their evolutionary careers—a subject I have ventured to call planetology. In this one planet is as important as another, since each represents a stage in development through which, more or less, all must pass. Popular interest is largely limited to Mars, for self-evident reasons of affinity ; not so ours. Personally, I must disclaim a certain philanthropy with which I have been credited and which I do not possess—the desire to people the orbs about us. No such incentive is mine, but the broader one to learn what is.

Of the planets, the latest to contribute something new to this our search is Uranus, and this on a matter which has long been a desideratum and has largely remained obstinately hid—the rotation period of his spin. It was wanted because it was the only one of his bodily elements about which we knew practically nothing and a knowledge of which was essential in the problem of his density distribution. The blankness of expression of his face seemed to preclude any visible insight into his movements, and the direction of his axial tilt negatived spectroscopic determination. For ever, since the spectroscope became capable of putting the question, his south pole has been turned toward us in a way to render relative approach or recession of his surface sensibly nil.

For some years, one of my assistants, Dr. V. M. Silpher, had been trying in vain to get it, had recognised its then unfeasibility, and temporarily dropped it, when the thought of a certain trigonometric relation induced me to hope that perhaps success might now follow. This relation was the fact that the cosine of an angle changing from 90° to 0° increases much faster than the angle itself during the early stages, and that therefore, through the Uranian pole had only got half-way in its course toward righting, its cosine had reached seven-tenths of its full amount, and the cosine, not the angle, enters into the velocity equation.

The event justified the supposition. In August 1911 Dr. Silpher attacked the planet again with apparatus which he had himself improved for the problem and secured eight spectrograms. As a check upon possible error, half of the number were taken with the spectroscope to the east of the telescope-tube, half with it to the west. Other experiments proved flexure to have been eradicated. The spectroscope was attached to the 24-inch objective, and the exposures made as near the meridian culmination as possible considering their length.

The slit was placed parallel to the longer axis of the satellites' apparent orbits. This was done in accordance with the only hint we have of the planets' equatorial plane. The inference seems justified by the behaviour of the satellites of Jupiter and of Saturn. For the orbital planes of these satellites approach coincidence with the equatorial plane of their primaries in proportion as the satellites themselves stand near, the only exceptions to this general law being those of tiny mass. The probable explanation of this is that the planets originally revolved retrogradely and are now in process of righting, carrying their satellites over with them, their power to do so being more instant on the nearer ones. The fact and its explanation I have pointed out in my "Solar System" and "Evolution of Worlds."

In the spectrograms the spectrum of Uranus lies enclosed between two comparison spectra, taken the one before the other after the Uranus exposure. Were the planet not rotating, the lines in the three spectra would be theoretically parallel, practically affected by a slight general curvature. In consequence of any rotation the approaching edge of the planetory lines is shifted toward the violet, the receding toward the red, with the result of tilting the Uranian lines with regard to their flanking comparison counterparts. Positives of two of these spectrograms are here exhibited, enlarged so that they may be examined by any one without the use of a microscope or measuring machine. The one was taken with the camera to the east, the other with it to the west of the telescope itself. The tilt of the Uranian lines is evident in each, and the opposite sense of them in the two, the lines being tilted upon the right in the one, on the left in the other, the red end of the spectrum being at the bottom of the plate in both cases. Furthermore, with care the greater inclination of the lines toward the violet end may be detected, which, of course, should be the case.

In examining them, the consensus of all should be considered, because any particular one may be injuriously affected by the grain of the plate. One of the grains may be larger and more darkened than another, and as the size of the grains bears an appreciable ratio to the size of the lines, the result is to shift the apparent direction of the line itself. By considering many we eliminate this source of error. The effect of the grain in deforming or masking original linearity has an important application for those who would examine delicate planetory photographs. It is the integrated, not the disintegrated, appearance which reveals the reality, as these Uranus plates themselves point out. For their spectroscopic lines, which show anything but regular, are, we know, the plates' representations of a slit as linear and geometric as man can make. This granular defect, which superior visual observation rectifies in the one case, also rectifies in the other.

The great care which Dr. Silpher gave to avoid error in the taking of the spectrograms, he no less took in measuring them. To show with what accuracy his plates were made, measures of the comparison lines may easily be relied on to within 3″ of arc. I speak from memory, and it may be less. The Uranian lines are much more difficult. His measures, however, are conclusive and are borne out by my own, though I am far from ascribing to mine the value I could wish with more time.

The result of both gives for the rotation period of Uranus 10¾ hours in a retrograde direction.—PERCIVAL LOWELL.

[*The Observatory.*

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the month of August 1912.

Sidereal time at 8 p.m.

	H.	M.	S.
August 1st	16	39	19
,, *8th*	17	6	55
,, *15th*	17	34	30
,, *22nd*	18	2	6
,, *29th*	18	29	42

From this table the constellations visible during the evenings of August can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

		H.	M.
August 6th	Last Quarter	9	48 A.M.
,, *13th*	New Moon	1	28 A.M.
,, *19th*	First Quarter	10	27 P.M.
,, *28th*	Full Moon	1	29 A.M.