ON THE NEW VARIABLE *U ORIONIS.*

$5^h\ 47^m\ 13^s\ +20°\ 8'.8$ (1855.0.)

BY EDWIN F. SAWYER.

This long-period variable, discovered by GORE, in 1885, has recently passed through another, although very faint, maximum.

The star was first seen on November 17, and found 5+ steps < DM. 20°,1171, or about $8^M.7$. The increase of light must have been very rapid, for at the next opportunity of observing the star, which occurred on November 29, it was found 4 steps > DM. 20°,1171 and 5 steps < DM. 19°,1106, or $7^M.5$. The light remained apparently stationary from November 29 to January 2, 1888, a period of 34 days. A careful inspection of the light-curve, assigns a maximum for about December 14. The strong moonlight, which prevailed near maximum, precludes a sharp determination of this phase, although the time as determined cannot be more than a day or two out of the way. The observations of last year and this would indicate a period of almost exactly one year. At its maximum this year, the star was about one magnitude fainter than last year.

The star is very slowly decreasing, and is now 5+ steps < DM. 19°,1106 and 2 steps > DM. 20°,1171, or about $7^M.7$. The following are the light-values observed on each evening:

		Light.			Light.
1887	Nov. 17	3.2	1887	Dec. 22	11.2*
	" 29	11.2*		" 23	11.2*
	Dec. 3	11.2*	1888	Jan. 2	11.2:
	" 5	11.2		" 3	10.9
	" 6	11.2		" 5	10.9
	" 12	11.2		" 11	10.2
	" 13	11.2		" 16	9.9
	" 16	11.2			

* = Moonlight.

Cambridgeport, 1888 *January* 16.

The need of a definite notation for this well-established variable is such that, in the absence of any systematic arrangement of the nomenclature since the publication of SCHÖNFELD's catalogue, it is denoted here by the letter *U*. The letter *T* is left for assignment, hereafter, to some one of the other three unnamed stars in *Orion*, whose variability seems beyond question, although their periods are yet undetermined. — G.

THE MOTION OF *HYPERION.*

BY PROF. A. HALL.

In the *Comptes Rendus de l'Académie des Sciences*, Aug. 30, 1886, M. TISSERAND has given an ingenious transformation of the formulas of the *Mécanique Céleste*, *Livre II*, No. 50, for the case where the motions of two planets or satellites, *P* and *P'*, are nearly commensurable. The result he obtains is as follows: *If the motion of P' was at first circular and uniform, the perturbations caused by the planet P would have for their principal effect the transformation of this motion into one that would be very nearly an elliptic Keplerian motion, with a uniform rotation of the major axis.* The two satellites of *Saturn*, *Titan* and *Hyperion*, furnish an example of the case considered by M. TISSERAND. But since his formulas are a transformation of those given by LAPLACE, which I have applied (*Monthly Notices*, *R.A.S.*, XLIV, p. 364), the result ought to be the same if the secular terms and those depending on the eccentricities are omitted. I have, therefore, recomputed the terms independent of the eccentricity, by the formulas:

$$\frac{\delta r}{a} = \frac{m'n^2}{2}\sum \frac{a^2\,\dfrac{\partial A^{(i)}}{\partial a} + \dfrac{2n}{n-n'}\,aA^{(i)}}{i^2(n-n')^2 - n^2}\cos i(l'-l)$$

$$\delta v = \frac{m'}{2}\sum\left[\frac{n^2}{i(n-n')^2}aA^{(i)} + \frac{2n^3\left(a^2\dfrac{\partial A^{(i)}}{\partial a} + \dfrac{2n}{n-n'}\,aA^{(i)}\right)}{i(n-n')\,[i^2(n-n')^2 - n^2]}\right]\sin i(l'-l)$$

where l, l', n, n' are the mean longitudes and mean motions of the satellites. By assuming that the coefficients of $3(l-l')$ result from the action of *Titan* alone, the apparent eccentricity found by observation gives the mass of *Titan*

$$m = \frac{1}{10765},$$

the mass of *Saturn* being unity. Hence the expression for the radius vector and true longitude of *Hyperion* are as follows:

$$r' = a' \left[1 - 0.00043 \cos(l-l') - 0.00141 \cos 2(l-l') + 0.09967 \cos 3(l-l') + 0.00078 \cos 4(l-l') + 0.00022 \cos 5(l-l')\right]$$

$$v' = l' + 0^\circ.160 \sin(l-l') + 0^\circ.222 \sin 2(l-l') - 11^\circ.396 \sin 3(l-l') - 0^\circ.072 \sin 4(l-l') - 0^\circ.018 \sin 5(l-l')$$

These coefficients agree nearly with those given by TISSERAND. If we infer the mass of *Hyperion* from that of *Titan* by means of their relative magnitudes, we have for the mass of this satellite,

$$m = \frac{1}{4162150}$$

The largest terms in the motion of *Titan* produced by *Hyperion* would be therefore,

$$\delta r = -0.00025 \cos 4(l'-l)$$
$$\delta v = -0^\circ.038 \sin 4(l'-l)$$

In order to test this theory the longitude of *Hyperion* has been carried forward from 1852, the epoch of LASSELL's observations, assuming the mean motion I have given before, the terms in $3(l-l')$ only have been applied, and Lieut. ALLEN has compared with the observations made at Malta in 1864, and with those made at Washington in 1886. It happens that the nine angles observed at Malta are fairly well represented. In the case of the more complete observations at Washington the residuals show that other terms must be considered; but for such an imperfect theory the result is good, and it seems possible by this simple method to make a tolerable ephemeris of this satellite. By this method of considering the question the eccentricity of the orbit of *Hyperion* is nearly destroyed. The residuals of 1886 would give an eccentricity less than 0.02, but from such a theory nothing definite can be inferred concerning this element. The next step would be to introduce the term depending on the eccentricity of the orbit of *Titan*.

Washington, 1888 *January* 25.

ON THE PERIOD OF *ALGOL*.

BY S. C. CHANDLER, JR.

Somewhat more than a century has elapsed since the recognition by GOODRICKE of the character of this star's variation. During this interval about fifty astronomers have taken part in its observation, and nearly seven hundred minima have been recorded. Various investigations have been made, from time to time, upon the fluctuations to which the period of the star is subject; and, principally, as the result of the labors of ARGELANDER and SCHÖNFELD, their general character has been pretty closely ascertained. The law according to which they proceed, however, has not yet been successfully developed, and ARGELANDER was of the opinion that the search for the mathematical form of its expression must be long postponed, until sufficient light is thrown upon the matter by later observation. Nearly twenty years have passed since this was written, and now, although the watch upon the minima of recent years has unfortunately been somewhat relaxed, it seems worth while to renew the attempt to discover the law in question. The effort has now greater chance of success, because meanwhile SCHÖNFELD's classical memoir on the light-curve of *Algol* has appeared, affording the means for reducing homogeneously a large portion of the data anew, a condition essential to justify the expectation of advancing our present knowledge. The results of this endeavor will be given in the following pages, and appear to be reasonably satisfactory. The apparently highly complicated anomalies in the period are amenable to a comparatively simple law, more closely than I had dared to hope. This law comprises two inequalities—the first having a period, rather uncertainly determined, of 141.3 years and a coefficient of 173.3 minutes of time, and the second a period of 37.7 years and a coefficient of 18.0 minutes. There is also evidence of a third irregularity, with a cycle of 17 years, but its coefficient of only 3.5 minutes brings its range so nearly within the limits of the observation-errors, that its existence must await further verification.

Before proceeding to the account of the collection and treatment of the material which forms the basis of the present investigation, it is proper to recite briefly the results of previous writers. The first of any importance was that of WURM, who, from 50 or 60 minima, recorded by various observers between 1783 and 1818, deduced by least squares the value of the period, $2^d\ 20^h\ 48^m\ 58^s.50$. Comparing this with his determination from sixteen months' observations, twenty years previous, namely $2^d\ 10^h\ 48^m\ 58^s.69$, he does not undertake to distinguish whether, in the interval, the period has really changed. The diminution which his calculations seem to indicate, however, was put beyond all possible doubt by ARGELANDER, who first demonstrated its existence, as well as the fact that the shortening was not proportional to the time, at least down to about the middle of the present century. ARGELANDER's attempts to develop the constants in a formula, either with secular or periodical