Schwanert * gives as 134°·3. The β pyromucic acid from fucusol crystallizes from its aqueous solution in small rhomboidal plates, whilst the acid which I had prepared from furfurol crystallized in flat needles.

Silver β pyromucate.—This compound was prepared from the pure β acid by boiling it for a short time with silver oxide and a sufficient quantity of water, filtering, and setting aside to crystallize. A single recrystallization from boiling water, in which it is only moderately soluble, rendered it quite pure. On cooling the hot aqueous solution, the silver β pyromucate is obtained in long flat needles, whilst the corresponding salt of the ordinary acid forms small crystalline scales: ·505 grm. of silver-salt gave ·330 grm. argentic chloride, which corresponds to 49·18 per cent. of metallic silver; the formula $C_5 H_3 AgO_3$ requires 49·32 per cent.

From this silver determination it will be seen that this compound is isomeric with the ordinary silver α pyromucate, $C_5 H_3 AgO_3$.

III. "On some recent Researches in Solar Physics, and a Law regulating the time of duration of the Sun-spot Period." By Warren De La Rue, D.C.L., F.R.S., Balfour Stewart, F.R.S., and Benjamin Loewy, F.R.A.S. Received October 12, 1871.

1. In the short account of some recent investigations by Professor Wolf and M. Fritz on sun-spot phenomena, which has been published lately in the 'Proceedings of the Royal Society' (1871, vol. xix. p. 392), it was pointed out that some of Wolf's conclusions were not quite borne out by the results which we have given in our last paper on Solar Physics in the Philosophical Transactions for 1870, pp. 389–496. A closer inquiry into the cause of this discrepancy has led us to what appears a definite law, connecting numerically the two branches of the periodic sun-spot curve, viz. the time during which there is a regular diminution of spot-production, and the time during which there is a constant increase.

It will be well, for the sake of clearness, to allude here again, as briefly as possible, to Professor Wolf's results before stating those at which we have arrived.

2. Professor Wolf had previously devoted the greater part of his laborious researches to a precise determination of the mean *length* of the whole sun-spot period, but latterly he has justly recognized the importance of obtaining some knowledge of the average character of the periodic increase and decrease. Hence he has, as far as he has been able to do so by existing series of observations, and his peculiar and ingenious method of rendering observations made at different times and by different observers comparable with each other, endeavoured to investigate more closely the nature of the periodic sun-spot curve by tabulating and graphically representing the monthly means taken during two and a half years before and after the

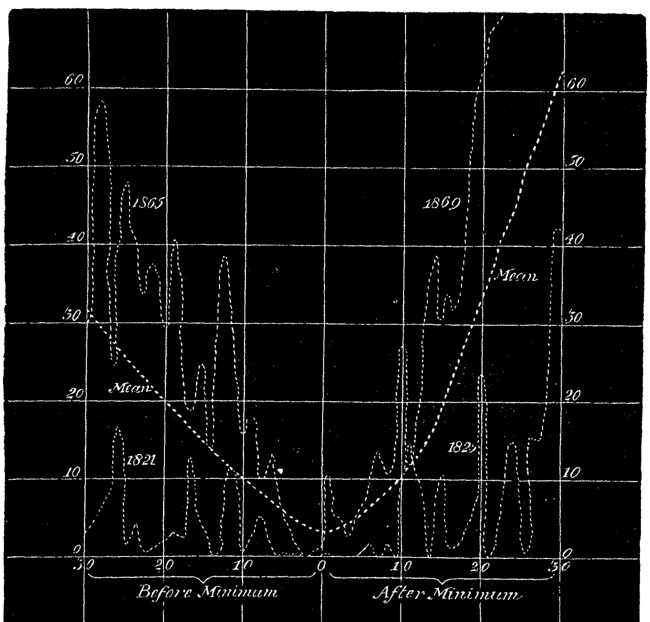
* Ann. Chem. Pharm. vol. cxvi. p. 257.

minimum, and applying this method to five distinct minimum epochs, which he has fixed for the following years:—

1823·2
1833·8
1844·0
1856·2
1867·2

3. In a Table he gives their mean numbers, expressing the solar activity, arranged in various columns, and arrives at the following results:—

(1) It is shown now, with greater precision than was previously possible, that the curve of sun-spots ascends with greater rapidity than it descends. This fact is shown in the subjoined diagram, which it may be of interest to compare with the curves given previously by ourselves in the above-mentioned place. The zero-point in this diagram corresponds to the minimum of each period; the abscissæ give the time before and after it, viz. two and a half years, or thirty months; the ordinates express the amount of spot-production in numbers of an arbitrary scale. The two finely dotted curves are intended to show the actual character of a portion of two periods only, viz. those which had their minima in 1823·2 and 1867·2; the strongly dotted curve, however, gives the mean of all periods (five) over which the investigation extends.



(2) Denoting by x the number of years during which the curve ascends,

and presuming that the behaviour is approximately the same throughout the whole period of 11·1 years as during the five years investigated, we have the proportion

$$x : 11{\cdot}1 - x :: 1 : 2,$$

whence

$$x = 3{\cdot}7,$$

or the average duration of an ascent is 3·7 years, that of a descent 7·4 years.

(3) The character of a single period may essentially differ from the mean; but on the whole it appears that a $\left\{\begin{array}{c}\text{retarded}\\\text{accelerated}\end{array}\right\}$ descent corresponds to a $\left\{\begin{array}{c}\text{retarded}\\\text{accelerated}\end{array}\right\}$ ascent. Thus the minimum of 1844·0 behaved very normally, but that of 1856·2, and still more that of 1823·2, shown in the above diagram, presents a retarded ascent and descent; on the other hand, in the minimum of 1833·8, and still more in that of 1867·2, also shown in the diagram, both ascent and descent are accelerated.

4. Finally, Professor Wolf arranged in the manner shown in the following Table the successive minima and maxima, in order to arrive at some generalization which might enable him to foretell the general character and length of a future period. Taking the absolute differences in time of every two successive maxima, and the mean differences of every two alternating minima, he shows that the greatest acceleration of both maximum and minimum happens together. This result strengthens our own conclusions, to be immediately stated, by new evidence, as it is derived from observations antecedent to the time over which our researches extend.

Minima.	Differences of alternating Minima.	Means.	Maxima.	Differences of successive Maxima.
1810·5				
			1816·8	
1823·2	23·3	11·65		12·7
			1829·5	
1833·8	20·8	10·4		7·7
			1837·2	
1844·0	22·4	11·2		11·4
			1846·6	
1856·2	23·2	11·6		11·6
			1860·2	
1867·2				

From this Professor Wolf predicts for the present period a very accelerated maximum—a prediction which seems likely to be fulfilled.

5. Comparing, now, M. Wolf's results with our own, it must not be overlooked, in judging of the agreement or discrepancy of these two independently obtained sets, that our facts have been derived from the actual measurement and subsequent calculation of the spotted area from day to day since 1833 recorded by Schwabe, Carrington, and the Kew solar photograms, which measurements are expressed as millionths of the sun's

visible hemisphere, while the conclusions of M. Wolf are founded on certain "relative numbers," which give the amount of observed spots on an arbitrary scale, chiefly designed to make observations made at different times and by various observers comparable with each other. This will obviously, in addition to the sources of error to which our own method is liable, introduce an amount of uncertainty arising from errors of estimation and the possibility of using for a whole series an erroneous factor of reduction. Nevertheless we shall find a very close agreement in various important results; and this seems a sufficient proof of the great value and reliability of M. Wolf's "relative numbers," especially for times previous to the commencement of regular sun observations.

6. The following is a comparison of the data of periodic epochs, as fixed by ourselves and M. Wolf:—

		I.	II.	III.	IV.
Minima epochs.	De La Rue, Stewart, and Loewy . .	1833·92	1843·75	1856·31	1867·12
	Rudolf Wolf . .	1833·8	1844·0	1856·2	1867·2

		I.	II.	III.
Maxima epochs.	De La Rue, Stewart, and Loewy	1836·98	1847·87	1859·69
	Rudolf Wolf	1837·2	1846·6	1860·2

It will be seen from this comparison that only one appreciable difference occurs, viz. in the maximum of 1847, which M. Wolf fixes nearly one and a quarter years before our date.

The mean length of a period is found by us to be 11·07 years, which agrees very well with M. Wolf's value, viz. 11·1 years.

7. We found the following times for the duration of increase of spots during the three periods, and for the corresponding decrease, or for ascent and descent of the graphic curve, beginning with the minimum of 1833:—

	Time of ascent.	Time of descent.
I.	3·06 years.	6·77 years.
II.	4·12 ,,	8·44 ,,
III.	3·37 ,,	7·43 ,,
Mean. . . .	3·52 ,,	7·55 ,,

Professor Wolf gives 3·7 years and 7·4 years for the ascent and descent respectively; and considering that he derived these numbers only from an investigation of a portion of each period, the agreement is indeed surprising, and would by itself suggest that the times of ascent and descent are connected by a definite law.

8. M. Wolf has expressed in general terms the following law with reference to this relation of increase and decrease of spots:—

"The character of a single period may essentially differ from the mean behaviour; but on the whole it appears that a $\left\{\begin{array}{c}\text{retarded}\\\text{accelerated}\end{array}\right\}$ descent corresponds to a $\left\{\begin{array}{c}\text{retarded}\\\text{accelerated}\end{array}\right\}$ ascent."

We, on the other hand, have, by an inspection of our curves (*vide* Phil. Trans. 1870, p. 393), been induced to make the following remark on the same question:—

"We see that the second curve, which was longer in period as a whole than either of the other two, manifests this excess in each of its branches, that is to say, its left or ascending branch is larger as a whole than the same branch of the other two curves, and the same takes place for the second or descending branch. On the other hand, the maximum of this curve is not so high as that of either of the other two; in fact the curve has the appearance as if it were pressed down from above, and pressed out laterally so as to lose in elevation what it gains in time."

Although both statements appear to lead up to the same conclusion, viz. that ascent and descent are connected by a law, still they differ essentially in this respect, that if A, B, C represent the three following consecutive events, descent, ascent, descent, Professor Wolf's law refers to the connexion between A and B, while our remark refers to B and C. We consider two successive minima as the beginning and end of a single period, while M. Wolf, at least in this particular research, places the minimum within the period, and compares the descent from the preceding maximum with the ascent to the next one.

9. We have considered the connexion thus indicated of sufficient importance to apply to it the following test. If, using the previous notation, a definite relation exists between A and B, the *ratio* of the times which the events occupy in every epoch ought to be approximately constant; similarly with respect to B and C; and this ratio should not be influenced by the *absolute* duration of the two successive events. It is clear that the greater uniformity of these ratios will be a test for their interdependence. The following is the result of the comparison:—

a. Professor Wolf's law: comparison of A and B.

	Periods.	Duration of descent (A).	Periods.	Duration of ascent (B).
I.	1829·5 to 1833·8	4·3 years	1833·8 to 1837·2	3·4 years.
II.	1837·2 to 1844·0	6·8 ,,	1844·0 to 1846·6	2·6 ,,
III.	1846·6 to 1856·2	9·6 ,,	1856·2 to 1860·2	4·0 ,,

	Ratio $\frac{A}{B}$.		Difference from mean.
I.......	1·265	Mean 2·093	−0·728.
II.......	2·615		+0·522.
III.......	2·400		+0·307.

These differences from the mean are so considerable, that in the present state of the inquiry a connexion between any descent and the immediately *succeeding* ascent appears highly improbable. A very new and apparently important relation seems, however, to result from a similar comparison of any ascent and the immediately succeeding descent, or between B and C.

b. Comparison of B and C.

	Periods.	Duration of ascent (B).	Periods.	Duration of descent (C).
I.	1833·92 to 1836·98	3·06 years	1836·98 to 1843·75	6·77 years.
II.	1843·75 to 1847·87	4·12 „	1847·87 to 1856·31	8·44 „
III.	1856·31 to 1859·69	3·38 „	1859·69 to 1867·12	7·43 „

	Ratio $\frac{C}{B}$.		Difference from mean.
I.......	2·212	Mean 2·151	+0·061.
II.......	2·044		−0·107.
III.......	2·198		+0·047.

The agreement of these ratios with each other, and the small differences from the mean of the single ratios, justify us in the mean time, until a greater number of periods are before us, to state the connexion between the two branches of the periodic curve from one minimum to another in the following more precise terms :—

If T *be the time of duration of sun-spot increase from a minimum to a maximum, then* $2{\cdot}15 \times T$ (*with a probable error of less than* $\pm 0{\cdot}05$) *will be the duration of the sun-spot decrease until the next minimum.*

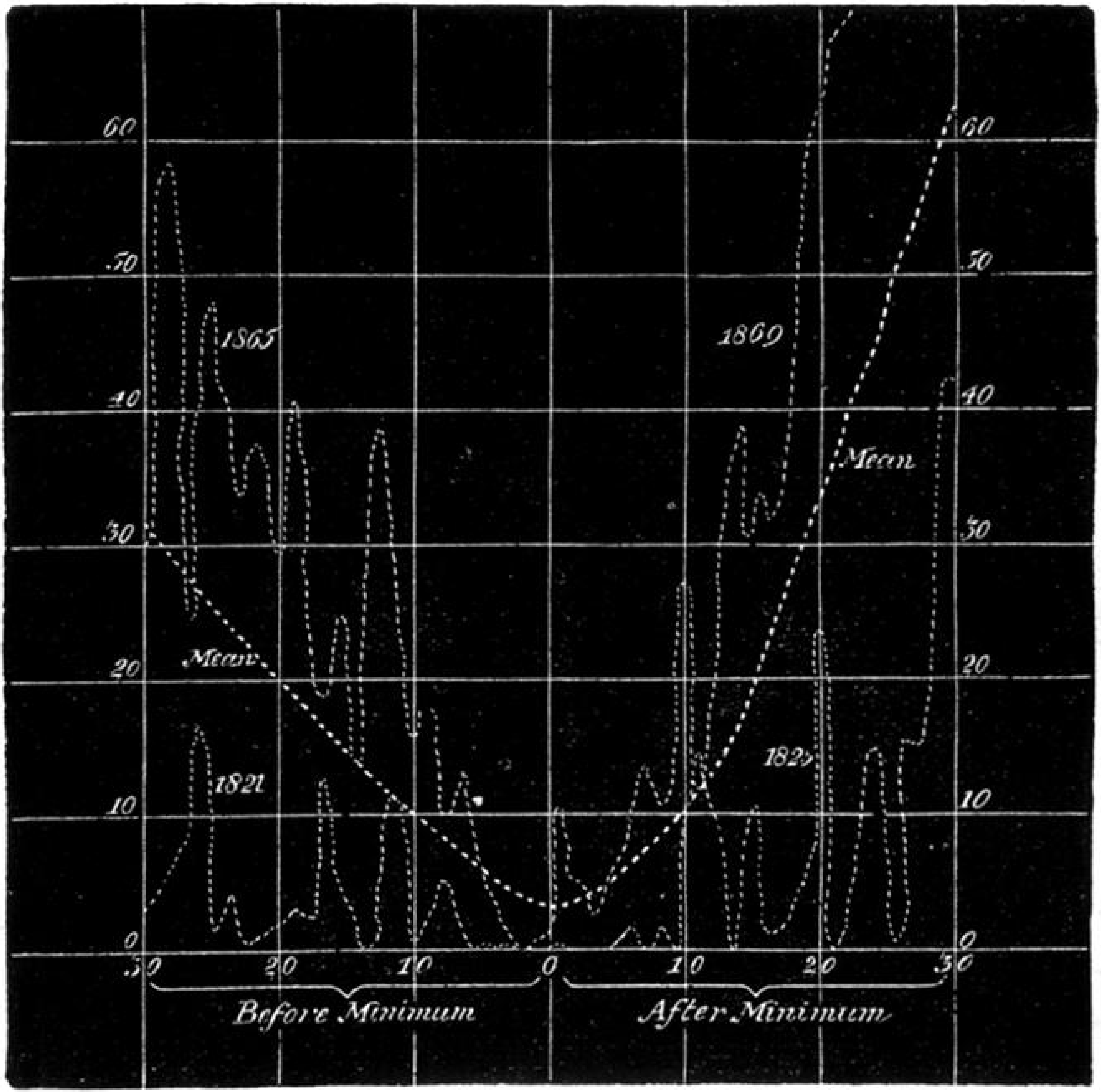
This law, together with the fact which we have previously established, that a longer period shows generally a depressed curve, while a shorter is characterized by great peaks, points strongly to the conclusion that *the energy of the ultimate causes of sun-spot production, whether these causes be intrasolar or extrasolar, is for every period constant.*

IV. "Note on the Telescopic Appearance of Encke's Comet." By William Huggins, D.C.L., LL.D., F.R.S. Received December 16, 1871.

The first three figures which accompany this note represent the comet on evenings on which its appearance was described in a note on the spectrum of the comet which I had the honour to present to the Royal Society*. A continuance of bad weather prevented me from making later observations of the comet, with the exception of one evening, December 5, when figure 4 was obtained under unfavourable circumstances.

Fig. 1. November 7, 7.30 P.M.—From Oct. 17, when the comet consisted of a nearly round nebulosity without condensation in any part, to Nov. 7 no observations could be obtained. At the latter date, the remarkable fan-form which distinguishes this appearance of the comet was already distinctly presented. The faint light by which the comet was surrounded terminated on the side from the sun, that from which the tail is usually projected, in a straight boundary at right angles to the longer axis of the comet. At the opposite side, that towards the sun, the faint nebulosity expanded and became fainter until it could be no longer traced. The

* *Suprà*, p. 45.



60
50
40
30
20
10
0
1865
1869
Mean
Mean
1821
1829
30
20
10
0
10
20
30
Before Minimum
After Minimum