pendent lose the special value which belongs to the earlier results. The observation of the 11th June was a very good one however, and comparison with the observation of the same spot made on the 7th May gives $10^h14^m.7$ for the length of a rotation (from 82 rotations); and with that made on the 13th May gives $10^h14^m.5$ (from 68 rotations).

(2) On the 13th May a white equatorial spot, similar in appearance to the preceding spot 2^a, was observed to transit at $10^h26^m.5$. On the 22nd May it transited at 9^h42^m; on the 28th May at 8^h57^m; and on the 31st May at 8^h37^m. These observations were all perfectly independent of each other, and they are all thoroughly accordant. Between the first and the last, there were 42 rotations of the length of $10^h14^m.5$. This spot is No. 3 of the ephemeris in the »Edinburgh Circular« No. 16. It was seen again on the 11th June, and estimated roughly on the centre at 11^h0^m; but this was not an independent observation.

(3) The observation of a white spot at 9^h38^m on June 2nd has already been alluded to. Comparison with the earlier results shows, that transits of it were observed at 9^h51^m on May 30th, and at 11^h50^m on May 12th. These are independent observations. Subsequently, with a knowledge of the calculated position of the spot, transits were recorded at 9^h13^m on June 5; 8^h43^m on June 11; and 8^h19^m on June 14. Between the observations of May 12 and June 2, there were 49 rotations of the length of $10^h14^m.4$. Between those of May 12 and May 30, 42 rotations of $10^h14^m.3$. Between those of May 30 and June 14, 35 rotations of $10^h14^m.5$. And between those of May 12 and June 14, 77 rotations of the length of $10^h14^m.4$.

(4) Not to unnecessarily swell the number of examples, I will refer only to one other case. The following independent observations, which clearly refer to the same spot, agree exactly with the rate of rotation derived from the preceding spots. May 11, 9^h27^m; June 9, 9^h50^m; June 12, 9^h36^m. Comparing the first and last observation, the period from 75 rotations is $10^h14^m.5$. The short interval between the results of June 9 and June 12 gives $10^h15^m.1$ (7 rotations).

In either of the above cases, the observations are sufficient of themselves to render pretty certain the identity of the spot and to indicate the rate of rotation. Taken collectively they furnish overwhelming proof. Up to the present time I have obtained observations of 10 or 11 distinct white spots, all situated in the equatorial zone of Saturn. In general appearance these objects bear considerable resemblance to the satellites of Jupiter when seen near the limb in course of transit before the disc of that planet, and just on the point of becoming lost in the brighter more central regions.

Owing to the increasing proximity of Saturn to the Sun, it is quite possible, that observations of these somewhat delicate features by other observers may not be forthcoming in the present apparition of the planet. But as the general result of my researches is to show that, so far as regards its physical aspect, Saturn must henceforth be considered a miniature of Jupiter, there is every reason to believe that these spots, or other spots of a similar nature, will be visible in future years, and hence that it will not be long before my observations receive complete independent confirmation.*) The material already accumulated is sufficient to enable the present period of rotation of matter in the equatorial region of Saturn to be computed with greater exactness than has hitherto been done.

*) From the description given by Prof. Hall, in his Memoir on »Saturn and its Ring«, of the position of the white spot discovered by him in 1876 (see Washington Observations, 1885, Appendix II, p. 6), it would appear, that that spot was similar to those recently discovered, but of an unusual degree of brilliancy. In this connection the following statement by Mr. W. F. Denning is also interesting. Referring to his observations of Saturn made in 1880, Mr. Denning remarks that »the equatorial zone is the brightest region of the disk, and gives indications of white patches in moments of best definition«. Monthly Not., Vol. 41, p. 82.

Percy Lodge, Burgess Hill, 1891 June 15. *A. Stanley Williams.*

Schreiben von Herrn A. Stanley Williams an den Herausgeber

betr. neuere Beobachtungen der Flecke auf dem Saturn.

Since the date of my previous communication, I have been continuing my observations of the spots in question whenever the weather has been sufficiently fine, and as it is not probable that they can be observed any longer during the present season, and you may be interested in the results, I beg to acquaint you with the following additional details.

Referring to the 4 spots mentioned in my previous communication:

(1) Transits of the dark spot 2 of Dr. Copeland's Circular have been obtained on two additional nights, and the white spot 2^a, just following it, on three nights.

	Dark Spot 2	White Spot 2^a
1891 June 17	$9^h\ 4^m$	9^h16^m Gr. M. T.
» 20	8 39	8 58
» 26	—	8 24

The dark spot was only seen with difficulty on both the 17th and 20th June. It required a fine night to be well seen, and after the 20th daylight prevented its being observed.

(2) Transits of this white spot = 3 of Dr. Copeland's Circular, have been observed on 4 subsequent nights. Altogether therefore this spot has been observed on 9 nights,

5 of the observations moreover being perfectly independent ones. The following is a complete list of all the observed times of transit.

1891 May	13	$10^h\,26^m.5$* Gr. M. T.
»	22	9 42*
»	28	8 57*
»	31	8 37*
June	11	11 0
»	20	10 5
»	26	9 33
»	29	9 11
July	2	8 40*

* The observations thus marked are the independent ones.

(3) Owing to the unfavourable hours when this spot was visible, I have been unable to secure any more satisfactory transits.

(4) This white spot was observed to transit at $9^h\,2^m$ on the 18th June. This observation was independent of the previous ones.

Several other white spots have been observed from 3 to 6 (and in one instance on 10) nights. Altogether about 80 transits of spots over the central meridian of the planet's disc have been obtained. I have endeavoured as far as possible to make these observations perfectly independently of each other. In the case of the spots included in the Edinburgh Circular (with the exception of the last observation of spot 3), it was impossible not to be aware of the computed times. Of the above mentioned 80 transits however, about 50 were independent. It was only by great efforts that so many have been obtained, since unless the seeing was pretty fair, the spots could not be seen at all.

The accidental errors of observation are somewhat greater than in the case of the corresponding but plainer and more easily observed spots on Jupiter, but the difference is not so great as might have been expected, and there is no difficulty in identifying the different spots. Owing to the greater difficulty in observing the transits of the more delicate spots of Saturn, recourse has been had to various methods by which observed times have been considerably increased in certainty and accuracy, beyond what would result from simple observations of the times at which spots arrived on the central meridian.

Hitherto I have not heard of any of these delicate spots having been observed elsewhere. Owing to the unfavourable position of the planet, and judging from the difficulty I experienced myself in my earlier observations in seeing them, I am not altogether surprised at this. I feel certain however, that similar markings will be visible in the autumn and winter, and I even have hopes of then successfully identifying several of the spots already observed. I find that continuous observation has greatly increased the facility with which these spots may be observed. In April they could not be discerned at all. In May, though certain, they were of extreme difficulty. Whilst in the latter half of June my eye had so increased in sensitiveness, that on a fine night the brighter spots were easy objects!

Percy Lodge, Burgess Hill, 1891 July 19. *A. Stanley Williams.*

Spectrum of β Lyrae.

By Prof. *Edward C. Pickering.*

The spectrum of the variable star β Lyrae is unlike that of any other star hitherto examined. With the aid of Mrs. M. Fleming and Miss A. C. Maury a careful study has been made of twenty-nine photographs of this object. These photographs form part of the Henry Draper Memorial. The images on four other plates were too indistinct to be used and were not included in the following discussion. The spectrum is traversed by broad dark bands due to hydrogen and also by other lines characteristic of many stars in the constellation of Orion and forming that division of the first type which is designated as B in the Draper Catalogue. But besides these several bright lines are visible which change their positions. The most conspicuous of them have the approximate wave-lengths 486, 443, 434, 410, 403 and 389. The first, third, fourth and sixth of these apparently coincide with the hydrogen lines *F*, *G*, *h* and *α*. The others are two of the most marked of the Orion lines. The bright lines sometimes have a slightly greater wave-length than the corresponding dark lines, so that the latter sometimes appear to have bright edges on the less refrangible side while at other times the reverse is the case.

It is obviously desirable to trace any connection which may exist between these changes and the variations in the brightness of the star, the principal minima of which occur at regular intervals of about $12^d\,22^h$. There are two maxima occurring at $3^d\,5^h$ and $9^d\,16^h$ after the principal minimum and an intermediate minimum following it $6^d\,11^h$. Of the eleven plates in which the bright lines had a diminished wave-length it was found that all had been taken during the second half of the period of variation, that is after the second minimum and more than $6^d\,11^h$ after the principal minimum. The fourteen plates taken during the first half of the period all showed an increase in wave-length of the bright lines, that is, the dark lines appear bright on the side towards the red. There are however three exceptions, plates at $6^d\,13^h$, $7^d\,12^h$ and at $11^d\,11^h$ show an increased instead of a diminished wave-length. A reexamination of these three plates showed that the deviation of the lines was not very marked and two other plates taken near the two minima showed a tendency of the lines to occupy an intermediate position and sometimes apparently to fall on the dark lines so as to nearly disappear.

Since the observations extend over more than four years or 130 periods of variation of the star, this latter