These observations therefore support the view which is held by Mr. Campbell (and I think by most other spectroscopists), that a high resolving power is not advantageous for detecting bands composed of numerous closely packed fine lines. The same conclusion may be arrived at by comparing any group of fine lines in the solar spectrum as seen with a powerful instrument, or on a map like Rowlands', with the same group in a small spectroscope.

The chief difficulty in photographing the lower spectrum of a planet arises from the peculiar curve of sensitiveness of an orthochromatic plate. The curve falls very abruptly near D, and only a very short range of spectrum in this region can be given the proper density. Full exposure, which tends to equalize the density, is a partial remedy, but the difficulty is always a serious one.

JAMES E. KEELER.

MR. JEWELL'S RESEARCHES ON THE SOLAR ROTATION.

We are informed by Mr. Lewis E. Jewell of Johns Hopkins University that his recent work in measuring a large number of lines in photographs of the solar spectrum has brought out a new and remarkable peculiarity in the law of the solar rotation. It is found that there is a difference of several days in the rotation periods of the outer and inner portions of the Sun's atmosphere, the period increasing as the photosphere is approached. The measures also show the equatorial acceleration to be much the greatest for the outer portions of the atmosphere. At the lower levels the acceleration is small, there being little difference in the periods for different latitudes. It is further found that the carbon (cyanogen) lines and the shaded portions of H and K take their rise very low down in the solar atmosphere. Mr. Jewell is at present engaged upon the reductions of the measures. His detailed account of the investigation will appear in a later number of this JOURNAL.

HARVARD COLLEGE OBSERVATORY, CIRCULAR NO. 7.

TEN NEW VARIABLE STARS.

THE following list of new variable stars includes, as described below, three whose variability was discovered or suspected elsewhere and has been confirmed at this observatory. The successive columns

give the name of the constellation, the designation in the *Durchmusterung* catalogues, the approximate right ascension and declination for 1900, the number of plates examined, the magnitude when brightest and when faintest as derived from the photographic charts, and the authority for the variation, the letters H. C. O. indicating that the variation was found at this observatory.

Constell.	Design.	R. A. 1900	Dec. 1900	No. Pl.	Mag. Br.	Mag. Ft.	Authority
Horologium..	.....	$2^h\ 22^m.4$	$-60°\ 0'$	21	9.7	<12.7	H. C. O.
Canis Minor..	$+5°$ 1797	7 43 .4	$+5$ 40	42	10.3	11.3	H. C. O.
Pyxis	-24 7693	9 0 .7	-24 41	13	8.9	11.1	Thome
Hydra	-22 7652	9 46 .4	-22 32	32	8.2	10.1	H. C. O.
Centaurus ...	.....	11 16 .1	-61 20	70	9.2	<12.9	H. C. O.
Libra	-19 4047	15 6 .5	-19 25	70	9.2	<12.9	H. C. O.
Scorpius	-35 11829	17 35 .7	-35 12	31	10.7	11.6	H. C. O.
Cor. Austr....	-37 12782	18 34 .3	-37 56	67	8.9	<11.8	H. C. O.
Sagittarius ...	-33 14076	19 10 .0	-33 42	89	6.1	<11.3	Markwick
Sculptor	-30 19448	23 3 .7	-30 41	47	8.0	8.9	H. C. O.

The first star, R. A. $2^h\ 21^m\ 39^s$, Dec. $-60°\ 8'.0$ (1875), has a period somewhat greater than 300 days.

The second star, $+5°$ 1797, was faint on two plates taken in 1886, and on the photographs taken since then shows variations which though small appear to be real.

The third star, $-24°$ 7693, was suspected of variability by Thome (*Annals Cordoba Observatory*, **16**, p. xxxviii). As he distinguished this star by an exclamation mark, photographs of it, and of six others similarly marked, were examined here by Miss E. F. Leland and the variability of this star was established.

The fourth star, $-22°$ 7652, was found by Miss L. D. Wells from a comparison of two chart plates in her search for stars having large parallaxes, proper motions, or variations in light. This star has been suspected of variability by Espin and Thome. Their names, however, are not included in the above table since almost all red stars have been suspected of variability, and attempts to confirm suspected variables have failed in a large number of cases. It would obviously be unfair when an astronomer publishes a long list of suspected variables to regard him as the discoverer of any which on later evidence may prove to be variable. It is extremely improbable that the light of the Sun, or of any star, is absolutely constant, although the change is in the great majority of cases beyond our present means of measure-

ment. If the distinction between real and suspected variability is not maintained, the person first stating that all stars are variable might claim the discovery of all variables subsequently found. It will be seen that this star stands on a wholly different basis from the preceding star, since in that case the variability suspected by Thome was the reason for the further examination of this object. This star is -22° 2739 in the *Bonn Southern Durchmusterung*. Its spectrum was found to be of the fourth type by Dunér.

The fifth star, R. A. $11^h\,15^m\,1^s$, Dec. $-61^\circ\,11'.4$ (1875), has maxima represented by the formula J. D. 2,411,100 + 162 E. The next maximum will accordingly occur on October 21, 1896.

The sixth star, -19° 4047, ι Libræ, appears in four of the catalogues of stars measured with the meridian photometer. In Vol. XIV. measures on seven nights gave the magnitude 4.87. In Vol. XXIV., Table I., three nights gave the magnitude 4.36. In Vol. XXIV., Table IV., three nights gave the magnitude 5.02, and in Vol. XLIV., unpublished, three nights gave the magnitude 4.37. The discordance is so great as compared with that of other stars contained in these catalogues that variability of the star seemed to the writer the only reasonable explanation. Accordingly, visual observations were at once undertaken with the meridian photometer, and also by Argelander's method. By the latter method, Mr. Wendell soon confirmed its variability, finding it two grades fainter than θ Libræ on May 19, and two grades brighter than the same star on June 1, 1896.

The eighth star, -37° 12782, has an approximate period of 136 days.

The ninth star, -33° 14076, is a very remarkable object. It was one of a list of forty-two stars suspected of variability sent here for examination by Colonel E. E. Markwick of Gibraltar. A report was sent to him that an examination of several photographs failed to show any sign of variability. A few days later an object having a peculiar spectrum was discovered by Mrs. Fleming. All the plates of the region were examined and its variability established. It was about to be published in *Circular* No. 6 when it was found to be identical with the star of Colonel Markwick. It was accordingly reported to him for announcement, but he has kindly authorized its publication here. The photographs show that on eight nights in the summer of 1889, on six nights in 1890, on six nights in 1891, on five nights in 1892, on twelve nights during April, May, June, and July of 1893 the variation of

light of this star was comparatively small and irregular. Colonel Markwick's first two observations on July 14 and 19, 1893 showed it of the seventh magnitude and a little brighter than the adjacent star —33° 14068. In August he found it fainter than this star, and by September 12 it was invisible and below the ninth magnitude. A photograph taken here on September 11, showed that it must then have been fainter than the magnitude 9.6, and on October 23, fainter than 11.3. Photographs taken on April 30, May 30, July 8, August 7, August 10, September 12, September 15, November 12, and November 13, 1894, gave the magnitudes 10.9, 10.3, 9.4, 8.6, 8.3, 7.5, 7.6, 6.4 and 6.4 respectively, thus showing a nearly regular increase in its normal brightness which it retained with irregular variations on twenty-seven nights in 1895. Observations by Colonel Markwick, beginning on August 20, 1894, lead to a similar result. The spectrum of this star is peculiar, and contains bright lines which show evidence of change.

The variation of the tenth star, —30° 19448, is small and irregular.

The spectra of the first, fifth, eighth, and probably the tenth stars are of the third type, having also the hydrogen lines bright. The second and seventh have spectra of the fourth type. These six variables were found by Mrs. Fleming in her regular examination of the Draper Memorial photographs.

MISCELLANEOUS NOTES.

A large number of observations has been made with the meridian photometer to determine the forms of light curve of stars of the Algol type. S Antliæ has hitherto been regarded as belonging to this class and is of interest from the shortness of its period, $7^h\ 46^m.8$, and since it was said to retain its full brightness for less than half of the time. It is difficult to reconcile the last condition with the theory that the variation is due to a dark eclipsing body. One hundred and seventy-seven measures, each containing sixteen photometric settings on S Antliæ, were made with the meridian photometer and give eight normal points. A smooth curve with only two points of inflection can be drawn through these normal points, the greatest deviation being 0.02 magnitudes. From this it appears that S Antliæ is not a star of the Algol type, that its light is continually changing, and that it belongs to the class of variables of short period like δ Cephei and η

Aquilæ. An interesting feature of this curve is that the time of increase occupies 0.62 of the entire time of variation, the increase of light being slower than the diminution.

U Pegasi appears to be second in this respect; since, according to the *Astronomical Journal*, **16**, 108, its time of increase is 0.55 of the entire time, and that of other short period variables varies from 0.20 to 0.33. On the other hand, the time of increase is about 0.17 for No. 18 of the variables discovered in the cluster Messier 5 (see *A. N.*, **140**, 285).

The star β Lyræ is commonly regarded as a variable of short period of the same class as the above. Observations of its spectrum, however, show that two or more bodies, revolving round each other, are present. The light curve found by Argelander may be closely represented by assuming that the primary minimum is caused by the eclipse of the brighter body by the fainter, and the secondary minimum by a similar eclipse of the fainter body by the brighter. This star should, therefore, be taken from the class of ordinary short period variables and included among the stars of the Algol type.

Mr. Backhouse calls attention to his announcement in the *Observatory*, **17**, 402 of the variability of $+0^{\circ}939$, announced in the ASTROPHYSICAL JOURNAL, **2**, 198, and to his observations which indicate a period of not more than a year. Variability also suspected by Espin.

The variable star, R Microscopii, is identical with $-29^{\circ}17235$.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY, CIRCULAR No. 9.

STARS HAVING PECULIAR SPECTRA.

A LIST of stars having peculiar spectra is given in the annexed table. They were all discovered by Mrs. Fleming in her regular examination of the Draper Memorial photographs. The number of stars of the third type is so large, now amounting to several thousands, that it has not been thought worth while to announce them, but to reserve them for a full list of stars having peculiar spectra to be published in a volume of the *Annals*. In the following table, the designation of the star in the *Durchmusterung* catalogues is given in the first column when it occurs in that work. The approximate right