NOTE ON AN APPARENT INCREASE IN THE EQUATORIAL ROTATION VELOCITY OF THE SUN.

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Spectrographic measures of the solar rotation for several years past have given values for the sidereal velocity at the equator ranging from 1·90 km./sec. to 1·94 km./sec., and values of this order have been obtained by various observers since the year 1915. The earlier measures of Dunér, 1900–03, Halm, 1904–06, Adams, 1907–08, and others up to the year 1911, all agree in giving values exceeding 2 km./sec., in close agreement with the value deduced from sunspots. The systematic observations of St. John over a series of years from 1914 show a minimum velocity of 1·90 km./sec., which remains practically constant for the ten years 1919–28, but since then the more recent values in 1929 and 1930 show a tendency to increase, the latest giving 1·95 km./sec.*

In some recent measures of the shifts of the iron and calcium lines at the Sun's limb in the region of the spectrum near H and K, I have used a device in front of the slit of the spectrograph for rotating the Sun's image through any measured angle. This is in order to compare the shifts at definite points on the Sun's limb, such as the north pole, south pole, and equator. The measures of the equatorial plates yield also the shift due to the Sun's rotation, and the values obtained during this autumn are larger than any I have observed in previous years. Like the early measures between 1900 and 1911, the mean value exceeds 2 km./sec.

As the exposure times at the Sun's limb near K are rather long with the present low altitude of the Sun, I thought it would be desirable to get other values of the rotation in the region between λ 4000 and λ 4100, where the exposure could be reduced to one minute only, and these plates so far confirm the high values shown by the H and K plates.

In all the spectra, the east and west limbs are photographed side by side near the centre of the plate, with the arc lines of iron on either side. The exposures are made successively, first on the arc, then on the two limbs, the interval between the east and west exposures not exceeding about two minutes required for readjusting the Sun's image. Lastly, a second exposure is made on the iron arc. The arc exposures are superposed near the solar spectra, but by an occulting device one end of the long arc lines has the alternate exposures separated, so that any shift occurring between the first and last exposure would be revealed. The perfect alignment of the lines in the two exposures gives the assurance that no instrumental shift can have vitiated the measurements of rotation shift. A check of this kind is very necessary, as however stable the apparatus may appear to be, very small displacements do occasionally occur, which may perhaps be ascribed to earth

* C. E. St. John, Int. Research Council, 3rd Report, *Solar and Terrestrial Relationships*, p. 121, 1932.

tremors: a movement of rotation of the end prism of the train amounting to only 1/10th of a second of arc would seriously affect the results.

All the plates have a scale of slightly over 1 mm. to the angstrom, and the total shift, west plus east, amounts to between ·05 and ·06 mm. With 15 to 20 lines measured, the probable error of a single plate is about ½ to 1 per cent. of the rotation value.

A point of some uncertainty in spectrographic measures is the correction for the distance within the limb at which the measures are made. I have arranged in this series of plates that the correction to be added will not exceed 2 per cent. of the observed value.

I give in the following table all the rotation values obtained during this autumn, with the mean value and its probable error derived from the residuals in this series.

Solar Rotation

Values of $v+v'=V$

Date 1931	Km./sec.	
July 9	2·093	15 lines, λλ 3906–3977
Sept. 13	2·007	
Oct. 27	1·932	
Nov. 1	2·016	
„ 13	1·895	
„ 21	1·954	
„ 21	2·180	
„ 29	2·101	20 lines, λλ 4014–4095
„ 29	2·124	
Dec. 7	1·739	
„ 7	2·123	
Mean	2·015 ± ·026	

In my experience of rotation measures, large variations from plate to plate sometimes occur, as appears in this series. One of the two plates obtained on December 7 yields a very low value, while the other on the same date, with all the conditions of exposure, etc., similar, gives a value in close agreement with other recent plates. It is not easy to account for this anomaly. As the stability test, when measured, shows no trace of an instrumental shift, there would seem no reason for excluding either plate from the general mean. The relative measures of arc and Sun show that the east limb shift is normal, while the west limb is largely in defect. Omitting this plate the mean would become 2·042 ± ·020.

This value happens to agree closely with the older measures of 1900–11 and with the value deduced from sunspots.

If the high values continue through the next few years, and then decrease again, a variation having a period of some thirty years would be indicated. This seems too long to be correlated with the changing polarity of sunspots, as has been suggested by St. John.*

* C. E. St. John, Int. Research Council, 3rd Report, *Solar and Terrestrial Relationships*, p. 118, 1931.

These apparent variations in the rotation affect only the gases outside the photosphere, and they amount to a change of daily angular motion from 13°·5 to 14°·8. The photosphere itself is apparently not affected by movements in the reversing layer, but has always given a constant value of about 14°·4 from the motions of spots and faculæ. The movements of the reversing layer and chromosphere seem to be greatly affected by level. Adams found that certain lines representing high levels in the reversing layer gave larger rotation values than low-level lines,* and I have been able to confirm this and extend it to the calcium lines in the chromosphere and in the prominences. In these last the daily angular rotational speed amounts to 17°,† while the place of origin of the prominence rotates with the photosphere. If the level of absorption of the lines we measure in the reversing layer has risen recently, the increase in rotation would then follow from this remarkable law of increase with height.

In my recent measures I make no attempt to differentiate between low level and high level lines, for want of sufficient material, and my results refer to the average of iron lines of mean intensity 6 in the H and K region, and 7 in the region between λ 4000 and λ 4100.