THE SOLAR ROTATION AND SHIFT TOWARDS RED MEASURED IN PROMINENCE SPECTRA

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(Received 1945 September 26)

Summary

Measures of the shifts of the H and K lines in prominence spectra have been continued from April 1935 to March 1939. The results confirm previous measures in showing that the prominences give values of the angular speed of rotation in different zones of latitude greatly in excess of values derived from spectra of the reversing layer, or from the motions of sunspots. The mean value of the daily angular speed in this period was 16°·9, which exceeds the equatorial speed of the reversing layer by over 2 degrees.

The general shift of the H and K lines towards red in this series of measures only slightly exceeds the relativity shift of ·0081 A.

A comparison of the results with previous measures shows that the rotation values were about 2° per diem greater at times of maximum solar activity than near the minimum of 1933. The general shift has apparently decreased from +·015 to +·009 A. in the whole period 1926 to 1939, in which estimates have been made. The general mean of all the measures is +·012 A. or ·004 A. in excess of the relativity shift.

Continuing the series of measures of the H and K lines in prominence spectra, I have now to record the results obtained during the four years April 1935 to March 1939, covering the second period of maximum solar activity.

The auto-collimating spectrograph, consisting of solid glass prisms of 6-inch aperture, is the same as described in *Monthly Notices*.* The comparison spectrum is formed by a carbon arc containing traces of calcium, and giving the H and K lines of approximately the same width and intensity as the prominence lines. Only prominences showing narrow undistorted lines have been chosen for measurement, and since it very rarely happens that suitable prominences are situated at opposite ends of a solar diameter it is not possible to measure the double shift, east + west, as in the case of lines in the reversing layer. Each shift therefore of each individual prominence east or west is tabulated after correction for the Earth's motion. The tabulated shifts are then segregated in ten-degree zones of latitude, east and west separately. The half sum and the half difference of the total shift of each zone (W + E)/2 and (W − E)/2 give the mean rotation and mean shift respectively of each zone. The rotation shifts are then corrected for the retarding effect of the Earth's motion in its orbit, and for the inclination of the Sun's axis, and the shifts are corrected by adding ·0017 A., which is the mean pressure shift of H and K for one atmosphere. The results are set out in Table I.

The mean daily angle of rotation ξ in column 4 of Table I has been computed from the formula $\xi = \dfrac{SV \times 360^\circ}{2\pi R \cos\phi}$ (S = seconds in 24 hours, V = sidereal velocity in km./sec., R = Sun's radius, expressed in kilometres). In the computation the Sun's radius is

* *M.N.*, 95, 504, 1935.

TABLE I

Summary of Measures of Prominence Spectra, 1935-39

No. of Measures	Mean Latitude	V km./sec.	ξ Prominences	ξ Reversing Layer	Shift
	°		°	°	A.
29	10	2·545	17·7	14·4	+·0071
25	20	2·041	15·0	14·1	+·0086
63	30	1·826	14·6	13·7	+·0088
65	50	1·829	19·4	12·5	+·0091
Total 182			Mean 16·9		Mean +·0086

taken to be 960″ + 30″, the average height in each zone, excepting the 50° zone, in which the spectra were photographed at an average height of 40″. For comparison, column 5 in Table I gives the values of ξ from measures of lines in the reversing layer by Adams at Mt. Wilson in 1908, which agree very closely with the rotation values derived from sunspots. Later values, however, by St. John and others, give about half a degree less in each zone.

In all my estimates of rotation from prominence spectra there is no clear evidence of any decrease in ξ in the higher latitudes. I therefore give the mean value of all the zones, weighted according to the number of measures, at the foot of column 4 in Table I. The results confirm previous measures in showing that the angular speed in each zone of latitude always exceeds the speed of that zone in the reversing layer, and the mean of all the zones greatly exceeds the equatorial speed of the reversing layer, which according to Adams is 14°·5.

TABLE II

Period	No. of Measures	ξ	Mean Shift	Solar Activity
		°		
1926-28	381	18·1	·0153 A.	Maximum 1927-28
1929-34	401	15·5	·0104	Minimum 1933
1935-39	182	16·9	·0086	Maximum 1937-38

In Table II the mean values of rotation speed and line shifts are compared with previous values. From this it appears that at times of minimum solar activity the speed of rotation of prominences is least, and increases perhaps by two degrees at times of greatest activity.

The shift of the calcium lines H and K has apparently diminished from +·0153 A. in the first period to +·0086 A. in the last. This lowest value is close to the theoretical relativity shift, which at 30″ above the photosphere is +·0081 A. As it is impossible to say whether systematic errors due to the random motions of the prominences affect one series more than another, I can only give the general mean of the whole series of 964 spectra photographed in the years 1926 to 1939. This is +·0127 A., and this would be reduced to +·0119 A. if the less well-defined spectra in the earlier series were rejected. In round numbers, therefore, we may take the mean to be +·012 A., an excess over relativity or "limb effect" of ·004 A.

Highbroom, Ewhurst, Surrey:
1945 September 24.