The Normal Wave-lengths of the Calcium Lines H *and* K, *and the Relativity Shift of these Lines in the Prominences and Chromosphere.*
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The wave-lengths of the lines H and K in the arc in air referred to standard iron lines were determined by St. John in an exhaustive series of measures of arc, spark, and furnace spectra. Fairly consistent results were obtained, but the furnace spectra yielded values 0·002A smaller than the arc spectra.

St. John summarised his results as follows: "The wave-lengths of the H and K lines of calcium are 3968·476 and 3933·667, as determined from the secondary standards of Fabry and Buisson, with an uncertainty of not more than 0·001A" (*Astrophysical Journal*, 31, 156, 1910).

In my estimates of the shifts of these lines in the prominences, I have been led to suspect that the above values do not represent the wave-lengths in the combined iron and carbon arc, where the calcium lines are shown as narrow emission lines with a relatively weak iron spectrum. The beautiful definition of the arc lines of iron and calcium shown on the different series of solar spectra obtained with the 6-inch prisms of my spectroheliograph has enabled me to use the measures of these plates for the purpose of determining with accuracy the wave-lengths of H and K referred to the nearest strong iron lines.

The scale of these plates is approximately 1 mm. to the angstrom, and is derived from measures of some or all of the following *Fe* lines :—

3920·261	3930·300	3940·884
3956·682	3969·262	3977·746

These wave-lengths are from the secondary and tertiary standards of the iron arc in air, published in the *Transactions of the International Astronomical Union*, vol. i. These have been used throughout, although revised values have been published in vol. iii. (1928). The correction needed for this latest revision is − 0·001A, which will be applied in the final results.

Within the range of wave-lengths measured, the curve giving the relation of wave-length to measurement is practically a straight line, and the factors for converting measured intervals into wave-lengths can be readily derived from the graphs with the necessary accuracy. The wave-length of K has been derived from the interval 3930 − K, and of H from the interval H — 3969. In some cases where the line 3969 is too broad for accurate measures, the line 3967·424 has been substituted. These intervals correspond with about 3 mm., 0·8 mm., and 1 mm. respectively. Errors of scale will not enter appreciably into such small intervals, and such errors are always much smaller than the accidental error in setting the micrometer thread on a line.

In determining the wave-length of K in a photograph of the combined iron and calcium arc, there is a tendency to obtain low values, due to the presence of a faint iron line very close to K on the violet side. According to my measures, this has the wave-length 3933·605, and it gives trouble when K is relatively weak and the iron spectrum is strong enough to show the line at 3932. According to St. John, there is a weak iron line on the violet side of H also, but this line does not appear on any of my plates, even those of very high dispersion and with a strong iron spectrum. In order to make certain that the iron line, which I call K′, has no influence in my results, I have rejected all plates in which the iron spectrum is relatively strong ; and in addition I have obtained a series of arc spectra with the high-dispersion cinnamate spectrograph which have a scale of 2 mm. to the angstrom. These consist of the arc spectrum of iron alone, and carbon alone, the latter giving the calcium and aluminium lines with a weak *Fe* spectrum. In some of the iron spectra, which show the calcium lines very faintly, K and K′ are clearly resolved, and have been measured separately, these spectra obtained with the liquid prism containing ethyl cinnamate being also of excellent definition and high resolving power. The wave-lengths from this series of spectra confirm those obtained with lower dispersion. Finally, I have measured a series of high-dispersion plates of the iron and calcium arc photographed at Kodaikanal with a large Anderson grating in the third and fourth orders.

The variations from plate to plate, which may differ from the mean value by at the most 5 units in the third decimal, are larger than would be expected from the accuracy with which a line can be bisected; and it is curious that these variations are as large for the high-dispersion plates as for those having only one-half the scale. This seems to indicate real variations of wave-length in the lines themselves, and it is possible that the so-called " stable lines " are subject to very small changes near the poles of an arc. H and K are not subject to pole effect, and the reference lines of iron are all classed as stable. The iron spectra are from a Pfund arc carrying 6 amperes at 100 volts, but the length of arc varied considerably, and in many cases light from the region near the poles entered the slit. Some of the cinnamate spectra, however, represent the centre of a long arc, and these yield more consistent values than the spectra where precautions were not taken to exclude the regions near the poles. This applies more especially to H, which always gives larger variations than K.

The K line is measured from the narrow emission line at 3930, or from the equally narrow reversal of the broader emission line. This absorption line, representing the outer region of the arc, can scarcely be affected by the poles. The calcium lines are always measured as emission lines. Whatever these apparent variations may be due to, the only course is to treat them as accidental errors, or to repeat measures where a mistake is suspected. In nearly all cases of repetition the second measure agrees with the first, within 0·002A.

To save printing long lists of figures, I give only the mean results from the four series of plates, with their probable errors derived from the residuals of the individual values. These are as follows :—

Wave-length of K *referred to the Iron Line at* 3930·300.

25 prominence and arc spectra	3933·6643 ± ·0001
25 chromosphere and arc spectra . . .	·6639 ± ·0003
23 cinnamate arc spectra	·6638 ± ·0003
9 grating arc spectra.	·6639 ± ·0002

Wave-length of H *referred to the Iron Lines at* 3967·424 *and* 3969·262.

35 prominence and arc spectra	3968·4706 ± ·0003
35 chromosphere and arc spectra . . .	·4715 ± ·0003
20 cinnamate arc spectra	·4700 ± ·0004
9 grating arc spectra	·4717 ± ·0005

The agreement of the different values of K is extraordinarily close, and justifies the retention of the fourth decimal, but this of course only implies that the interval between the iron and calcium lines shows this degree of accuracy, the absolute position of the iron line being known only to the third place. The mean results to three places are as follows :—

K 3933·664 H 3968·471.

These values are smaller than those of St. John, by 0·003A in the case of K, and 0·005A in the case of H. It is not easy to account for these differences. Fabry and Buisson's wave-lengths of standard iron lines do not differ appreciably from the more recent values, but St. John's results appear to depend on very large measured intervals, which may have introduced errors of scale or of the micrometer screw.

According to my measures, the wave-lengths of K and H in the carbon-iron arc in air, corrected to the recently revised values of the iron lines, are as follows :—

K 3933·663 H 3968·470.

The Relativity Shift of H *and* K *in the Prominences and the Chromosphere.*—In *Monthly Notices*, **89**, 254, 1929, estimates are given of the shift towards red of the H and K lines in the prominences. The mean value of the whole series of 289 spectra, corrected for the pressure effect of the arc in air, is + 0·0154A, and the mean for a selected series of 180 spectra is + 0·0142A. As H and K yield sensibly the same shift, both lines are included in the means.

A previous estimate from 92 prominence spectra obtained in 1927 gave a mean value + 0·0109A. In the earlier series I used the *Fe* arc lines for determining the positions of the calcium lines in the prominences, and assumed that the normal wave-lengths of K and H were St. John's values 3933·667 and 3968·476 respectively. In the later series I measured the direct displacements between the solar and terrestrial calcium lines, using a carbon arc which gave strong but very narrow H and K lines, with a weak or absent *Fe* spectrum.

The difference of about 0·004A in the two series could be accounted for by supposing that the assumed values of H and K were too large by this amount, and the foregoing measures appear to show quite definitely that this is the case. The prominence measures are therefore brought into good agreement and indicate that the shift towards red is approximately + 0·015A.

I have now to add some measures of the shift of these lines in the chromosphere at the sun's limb. Here the lines are much wider and more difficult to measure than in the prominences. I have nevertheless been able to secure a series of plates which yields fairly reliable results. The spectra are taken in pairs at the east and west points on the sun, each pair giving the rotation shift and the general shift towards red. The mean values of the shift from 22 such pairs are again sensibly the same for K and H, K giving + 0·0133A, and H + 0·0135A. Taking the mean of these, and adding the pressure effect of the arc in air, the result is as follows :—

Observed mean shift of H and K . .	+ 0·0134 ± ·0004
Pressure effect	+ 0·0017
Chromosphere – arc in vacuum	+ 0·0151

This agrees well with the prominence result.

The Einstein relativity effect for the mean of H and K is + 0·0081 A at 30″ above the limb, and + 0·0083 A for the chromosphere. The excess over the Einstein effect is therefore about + 0·007 A for prominences and chromosphere, and any explanation of the cause of this discrepancy which might apply to the conditions in the chromosphere must be equally applicable in the region of the prominences altogether outside the sun's atmosphere.