Radium and the Chromosphere.

REFERRING to the Astronomer Royal's communication in *Astronomische Nachrichten*, No. 4589, and in the *Observatory*, No. 451, I would point out that the identification of radium lines with chromospheric lines in eclipse spectra appears much less probable when the results of eclipse observers other than those quoted by him are included in the comparison.

In the following table I repeat the wave-lengths given by Dr. Dyson, omitting intensities to save space, and adding three other determinations of chromospheric wave-lengths:—

	Spark-spectrum of Radium.	Spectrum of Chromosphere.				
	Runge & Precht.	Dyson.	Lockyer.	Evershed.	Lord.	Mitchell.
1	3649·75	3649·66	...	3649·50	...	...
2	3814·58	3814·67	3814·7	3814·73	...	...
3	4340·83	Hγ	Hγ	Hγ	...	...
4	4436·49	...	4436·6	4435·3	4435·13	4435·4 4436·5
5	4682·36	4682·20	4682·5	...	4682·24	4682·6
6	4826·12	...	4826·0	...	4823·95	4824·0

It will be observed that in line no. 1 there is a fair agreement between Dr. Dyson's wave-length and my own (both are mean values from three plates), and they indicate an appreciably smaller wave-length than that of the radium line. There is no difficulty in identifying the chromosphere line with the solar dark lines

$$3649{\cdot}\overset{\cdot 438}{\underset{\cdot 654}{476}}$$

attributed by Rowland to Fe, La, and Co.

In line no. 2, the strongest of the radium series, there is a very good agreement between the three eclipse measures, and they all show a distinctly greater wave-length than that of the radium line. This line in my eclipse spectra is well defined, and the error in my determination of wave-length (also the mean of three plates) is almost certainly less than $\pm 0{\cdot}05$ Å. I have identified it with the Fraunhofer line 3814·698, intensity 8, which consists of two lines, 3814·671 and 3814·738, according to Rowland, the first being

attributed by him to Fe-C, and the second to C and another element. This other element, according to Hasselberg, is Ti. Dr. Dyson appears to consider this line as due to Ti only. but if so the dark line intensity would be too great. Dr. Royds has measured, on some iron arc spectra obtained here, a line of medium intensity at 3814·68, and there can be no doubt that the solar line is a close double of which the more refrangible component is due to Fe and the less refrangible component to Ti.

In my discussion of the 1900 eclipse results I showed that "every strong dark line in the solar spectrum exceeding Rowland's intensity 7 is found in these (chromosphere) spectra as a bright line" (Phil. Trans. A 201, 476). It is improbable, therefore, that the line referred to above of intensity 8 would be an exception, and not appear as a bright line in the chromosphere. The bright-line intensity in my eclipse plates is by no means exceptionally great considering the origin to be Fe and Ti, especially as the Ti line is slightly enhanced in the spark, and would therefore be strong in the chromosphere. If radium were present the bright line would certainly be widened on the more refrangible side, and the measures would show an appreciably smaller wave-length than that of the dark line. I assume, of course, that the radium lines have been measured with the necessary precision, and are based on Rowland's system, which is doubtless the case.

The remaining lines, nos. 4, 5, and 6, fall near to chromosphere lines, but the eclipse results are far from being in such satisfactory accordance in this less refrangible region of the spectrum. The mean of the eclipse determinations of the line at 4682 agrees well with the radium line no. 5, but there is a group of solar dark lines at this position with origins including Ti, Fe, and Co, so that small weight can be given to this apparent coincidence.

In the radium spectrum there is a strong line at 5813·9 which occurs in a blank region of the solar spectrum, and it would therefore be a crucial test of the presence of radium to determine whether this line occurs in the chromosphere spectrum or not. I am convinced, however, that with the eclipse material already available the question can be definitely settled both as regards radium and the emanation.

In 1905 Mitchell secured some grating spectra of the "flash," which, in the region between "*b*" and $H\gamma$, are, I believe, by far the finest which have ever been obtained; the images are so thickly crowded with fine lines all along the spectrum that one might suppose that it would be easy to match any series of lines whatever with the chromospheric lines. I have in my possession some positives on glass of these plates, kindly sent me by Dr. Mitchell, and as no wave-length determinations have, so far as I know, been published, I have myself made a set of measures of all the lines which fall near to either radium or emanation lines.

The results of these measures, which will be published in detail elsewhere, show clearly that the chromosphere lines can in nearly

every case be matched by a dark solar line, or group of lines, within the limits of accuracy of the measures, and that in general the wave-lengths differ appreciably from those of the radium or emanation lines. The very few lines of these elements which fall within allowable limits of the chromosphere lines may well be ascribed to chance coincidences.

Dr. Royds points out to me that radium and its emanation, when in equilibrium, as they presumably would be in the chromosphere, can only exist in enormously disproportionate quantities, the amount of emanation being only 1/200,000th that of the parent radium. Consequently, if the emanation spectrum were visible in the chromosphere, one would expect to find an intensely brilliant radium spectrum.

I conclude that neither radium nor the emanation can be detected in the chromosphere by their spectra. J. EVERSHED.

Kodaikanal, 1912, Sept. 2.