produced by the very slow descent of matter from above. The spectrum of these higher portions of the chromo­sphere, whether produced from below or above, is more complicated than the ordinary one. The following table (C) gives the principal lines which have been recorded up to 1887 :—

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1869. | Hydrogen D3 | All lines. |  |  |  |
|  | 1474 (5315∙9) | Unknown. |  |  |  |
|  | *b*1 *b*2 *b*4 | Magnesium, | 3 out of 7 (Thalén). | | |
|  | *b*3 | Nickel, | 1 | ,, | 34 |
|  | D1 D | Sodium, | 2 | ,, | 8 |
|  | 4933∙4 | Barium, | 2 | ,, | 26 |
|  | 4899∙3 |  |  |  |
|  | 4923∙1  50l7·6 | Iron, | 2 | ,, | 460 (Ångstrom). |
|  | 5275  5233 6  5179∙9  4921∙3  5014·8 bright | Unknown. |  |  |  |
| After 1869. | /4471  4924∙5  B—C  B—*α* | Unknown. |  |  |  |
|  | 5019 | Titanium, | 1 out of 201 (Thalén). | | |
|  | H  K | Calcium, | 2 | ,, | 74 |

The first new line in this table is called in spectroscopic language 1474, because when this work was begun the only maps available were those made by Professor Kirch­hoff, and this particular line fell at 1474 on his scale. Since then these artificial scales have been discarded in favour of the natural one, which is given by the wave­lengths of light of different colours. In this the reference number of the same line is 5315·9, which represents the wave-length in ten-millionths of a millimètre of that particular quality of light. After this we observe three lines of magnesium, only 3 out of 7 ; next a line of nickel, one only, however, out of 34 ; then two lines of sodium, although we might naturally expect to get all the 8 lines ; then two lines of barium out of 26 ; and so on. Almost all the other lines have origins which are absolutely un­known : that is to say, we never get them in our terrestrial laboratories, and never, therefore, are able to match the bright lines in the chromosphere of the sun with any chemical substance. In 1871 the sun was more active, and this activity resulted in the addition of new lines, all, however, absolutely unknown to us, except one, which represents a line in the spectrum of titanium; but in that case we get one line out of 201 in exactly the same way as we get two only of iron out of 460. It is most important to note that practically none of the lines shown in table C are among those w’hich are widened in spots.

The prominences are of two kinds—those which are relatively quiet and give almost exclusively the lines of hydrogen and those in which the motions are as a rule very violent. The spectrum of the latter class generally includes a large number of metallic lines ; hence they are generally called metallic prominences. The first stage of metallic prominence is usually the appearance of three lines of the following wave-lengths—4943, 5031, 5315·9. As the prominence increases in magnitude and violence other lines are added, until at times the spectrum seems full of lines. The rate of uprush of these prominences sometimes reaches 250 miles per second, or nearly a million miles an hour,—figures w’hich convey an idea of the enormous energies involved. The lines seen in these pro­minences, although many are present in the spectra of the metallic elements, appear with greatly changed intensities : the lines seen brightest in the prominences are frequently dim lines in the terrestrial spectrum. Again it may be remarked that these are not the lines which are most widened in spots. In the case of the spectrum of any one

substance the number of lines seen usually in the promi­nences is very small.

The general conclusions which have been derived from a discussion of the prominence observations made by Profs. Tacchini and Riccò, in connexion w’ith the sun-spot observa­tions already mentioned, are as follows.

(1) The chromospheric and prominence spectrum of any one substance, except in the case of hydrogen, is unlike the ordinary spectrum of the substance. For instance, we get two lines of iron out of 460.

(2) There are inversions of lines in the same elements in the prominences, as there are inversions in the spots : in certain pro­minences we see certain lines of a substance without others ; in certain other prominences we see the other lines without the first.

(3) Very few lines are strongly affected at once, as a rule, and a very small proportion altogether,—smaller than in the case of spots.

(4) The prominences are less subject to sudden changes than spots, so far as lines of the same element are concerned.

(5) There is a change in the lines affected according to the sun’s spot period.

(6) The lines of a substance seen in the prominences are those which in our laboratories become considerably brightened when we change the arc spectrum for the spark spectrum.

(7) None of the iron lines ordinarily visible in prominences are seen at the temperature of the oxy-hydrogen flame. Some of the oxy-hydrogen flame lines are seen in the spots, but none have ever been seen in the prominences.

(8) A relatively large number of the lines ordinarily seen are of unknown origin.

(9) Many of the lines seen are not ordinarily seen amongst the Fraunhofer lines. Some are bright lines.

(10) As in the spots the H and K lines of calcium in the ultra­violet are always bright in the spot spectrum, the other lines of calcium and the other substances being darkened and widened, so it would appear that the lines H and K of calcium are always bright in the prominences in which the other lines are generally unaffected.

(11) Many of the lines are common to two or more elements with the dispersion which has been employed.

The spectrum of the inner corona indicates that it is chiefly composed of hydrogen. All the hydrogen lines are seen in it, and up to a certain height the H and K lines of calcium, proving the presence either of calcium or of something that exists in calcium which we cannot get at in our temperature.

In the outer corona most of the hydrogen lines dis­appear ; but one, the green line F, remains for a consider­able height side by side w’ith the 1474 line, indicating, as far as we can see where everything is so doubtful, that the constituents of the outer corona consist most probably of hydrogen in a cool form and the unknown stuff which gives the 1474 line. We also know that the outer corona contains particles w’hich reflect the ordinary sunlight to us, because in 1871 Dr Janssen, and in 1878 Professor Barker and others, saw the dark Fraunhofer lines in the spectrum of the corona. We must imagine, therefore, that some part of that spectrum depends for its existence on solid particles which not only give a spectrum like that of the lime-light but have the faculty of reflecting to us the light of the underlying photosphere. It was also put beyond all question in the eclipse of 1882 in Egypt that this corona has another spectrum of its own. There are bright bands in the spectrum, showing that with these additions it is not a truly continuous spectrum like that of the lime-light, and that its origin is therefore in all probability very complex.

*Association and Distribution of Phenomena.*

Observations of prominences, spots, and other pheno­mena which require continuous investigation have been carefully made from day to day for several years, and one conclusion arrived at is that when and where the (disturbed) spots are at the maximum the faculæ and metallic prominences are also at the maximum. When the maximum changes from north to south latitude in the spots it also changes from north to south in the metallic