attempt has been made to separate the possibly new gases from the known ones which come over with them; hence, the lines are in some cases very dim, and the application of high dispersion is impossible. The wave-lengths therefore, especially in the visible spectrum, are approximations only; but the view that we are really dealing with gases operative in the solar atmosphere, like the helium which produces $D_3$, is strengthened by the fact that of the sixty lines so far recorded as new in the various minerals examined, about half occur near the wave-lengths assigned to chromospheric lines in Young's table. I am aware that most of the chromospheric lines have been recently referred to as due to iron,* but I believe this result does not depend upon direct comparisons, and it is entirely opposed to the conclusions to be drawn from the work of the Italian observers, as well as from my own.

## II. "On the new Gas obtained from Uraninite. Third Note." By J. Norman Lockyer, C.B., F.R.S. Received May 9, 1895.

In my preliminary note communicated to the Royal Society on the 25th ult., I gave the wave-lengths of the lines which had been observed both at reduced and at atmospheric pressure in the gas (or gases) produced by the method to which I then referred of heating the uraninite mineral (bröggerite) *in vacuo*.

As a short title in future, I shall term this the distillation method.

Since then the various photographs obtained have been reduced, and the wave-lengths of the lines in the structure spectrum of hydrogen observed beyond the region mapped by Hasselberg. I have further observed the spectra of other minerals besides uraninite for the purpose of determining whether any of them gave lines indicating the presence of the gas in uraninite or of other gases.

I now give a table of the lines so far measured in the spectra of eighteen minerals between λλ 3889 and 4580 (Rowland), the region in which, with the plates employed, the photographic action is most intense.

On this table I may remark that of the lines given in my paper of April 25, the final discussion has shown that the following lines are hydrogen structure-lines in the region beyond that mapped by Hasselberg, λλ 4479, 4196, 4156, and 4152·5. The line 4368 is also omitted from this list as it has not been finally determined whether it coincides with a line of oxygen.

In the table, besides the wave-lengths on Ångström's and Rowland's scale, I give lines which have been observed in the sun's

* Scheiner's 'Astronomical Spectroscopy,' Frost's translation, p. 184.

Table.

Lines photographed in the Spectra of Gases obtained from various Minerals experimented upon up to May 6.

| Wave-length. | | Chromospheric lines. (Ångström's scale.) | Eclipse lines (1893). (Rowland's scale.) | Orion star lines. (Rowland's scale.) | Remarks. |
|---|---|---|---|---|---|
| Rowland. | Ångström. | | | | |
| 3889·0 | 3888·5 | 3888·73 H | 3889·1 (9) | (Probable.)* | U |
| 3947·0 | 3946·5 | 3945·2 H | 3946·0 (2) | — | U |
| 3982·0 | 3981·5 | — | 3982·0 (2) | — | |
| 4026·5 | 4025·9 | — | 4026·5 (6) | 4026·5 (6) | U |
| 4142·0 | 4141·3 | — | — | — | |
| 4145·0 | 4144·3 | — | 4144·0 (3) | 4144·0 (5) | |
| 4177·0 | 4176·3 | 4178·8 | 4177·8 (2) | 4178·0 (4) | |
| 4182·0 | 4181·3 | — | — | — | |
| 4338·0 | 4337·3 | 4338·0 | * | 4338·0 (2) | |
| 4347·0 | 4346·3 | — | — | 4346·0 (2) | |
| 4390·0 | 4389·3 | 4388·5 | 4390·0 (1) | 4389·0 (5) | |
| 4398·0 | 4397·3 | 4398·5 | 4398·7 (2) | — | |
| 4453·0 | 4452·3 | — | 4454·0 (1) | — | |
| 4471·0 | 4470·3 | 4471·2 | 4471·8 (10) | 4471·8 (6) | U |
| 4515·0 | 4514·3 | 4514·0 | 4514·5 (2) | — | |
| 4522·0 | 4521·3 | 4522·0 | 4522·9 (2) | — | |
| 4580·0 | 4579·3 | — | — | — | |

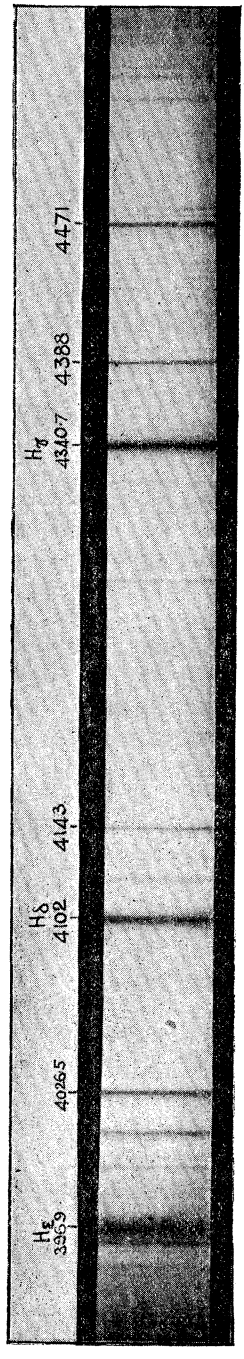
U = lines noted frequently in the spectra of bröggerite.
H = lines photographed by Hale.

chromosphere and chronicled by Young; those photographed during the eclipse of 1893 with a 6-in. prismatic camera by Mr. Fowler, and those photographed with the same instrument at Kensington in some stars of Group III of my classification in the constellation of Orion.

This table carries the matter of the relation of the new gases to solar and stellar phenomena much further than I ventured to suggest in my second note. We appear to be in presence of the *vera causa*, not of two or three, but of many of the lines which so far have been classed as "unknown" by students both of solar and stellar chemistry, and, if this be confirmed, we are evidently in the presence of a new order of gases of the highest importance to celestial chemistry, though perhaps they may be of small practical value to chemists, because their compounds and associated elements are for the most part hidden deep in the earth's interior.

The facts that all the old terrestrial gases, with the exception of hydrogen, are spectroscopically invisible in the sun and stars—though they doubtless exist there—and that these new gases, scarcely yet

* The broad hydrogen line Hγ extends over these positions.

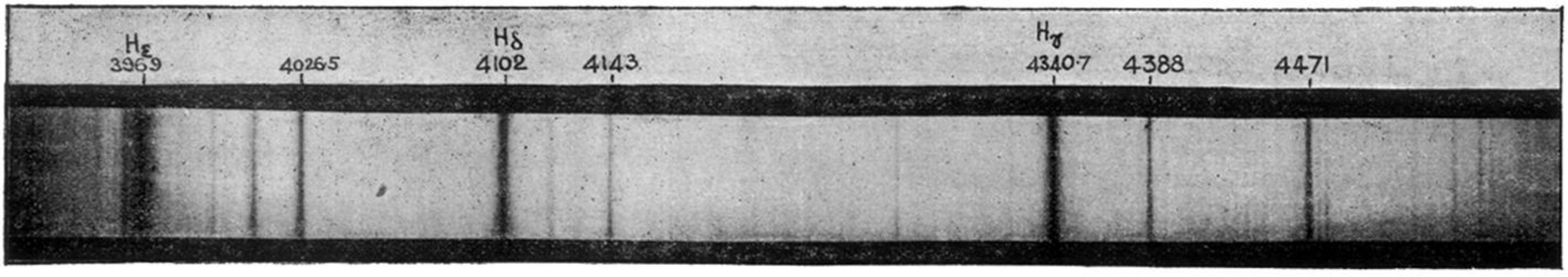



The spectrum of Bellatrix, showing the lines at 4026·5, 4143, 4388, and 4471, which have been photographed in the spectra of gases obtained from minerals, reversed in the spectrum of that star.

glimpsed, have already in all probability supplied us with many points of contact between our own planet and the hottest part of our central luminary that we can get at, and stars like Bellatrix, are full of hope for the future, not only in relation to the possibility of more closely correlating celestial and terrestrial phenomena, but in indicating that terrestrial chemistry, founded on low density surface products in which non-solar gases largely enter, is capable of almost infinite expansion when the actions and reactions of the new order of gases, almost, it may be said, of paramount importance in certain stages of stellar evolution, shall have been completely studied. With regard to the differences indicated between the results of the chromospheric and eclipse observations in the above table, it may be useful to remark that Professor Young's "frequencies," invaluable though they are, must necessarily be of less importance from the present point of view than the eclipse observations obtained, it may almost be said, at the same instant of time. There may be, and doubtless are, two perfectly distinct causes for the appearance of the so-called chromospheric lines. First, the tranquil condition of the lower strata of the sun's atmosphere, which gives us the pure spectrum produced at a constant—and the highest that we know of in the sun—temperature. Secondly, the disturbed condition which fills the spectrum with lines of a so-called prominence. Formerly it was universally imagined that the prominences were shot up from below, and, in that case, the lines added would indicate a temperature *higher* than the normal. But I have sent many papers in to the Society indicating the many arguments against this view,* and to me at the present time this view is almost unthinkable. If these disturbance lines are produced from above, they may represent the effect of many stages of *lower* temperature. Hence a list of chromospheric lines loses most of its value, unless the conditions of each observation are stated, and the phenomena appearing at the same place at the same instant of time are recorded.

Now this same place and same time condition is perfectly met by eclipse photographs, and hence I attach a great value to them; but the comparison between such eclipse observations and the spectra of certain stars indicates that the latter afford the best criteria of all.

* They are set out at length in the 'Chemistry of the Sun,' which I published in 1887.




The spectrum of Bellatrix, showing the lines at 4026·5, 4143, 4388, and 4471, which have been photographed in the spectra of gases obtained from minerals, reversed in the spectrum of that star.