SPECTROSCOPIC NOTES ON OBSERVATIONS—CHIEFLY SOLAR—1879-80.

By Prof. C. A. Young, of Princeton, N. J.

(*a*) The magnesium lines of the *b* group and the sodium lines have been seen several times (first on June 5, 1880) *doubly*-reversed in the chromosphere spectrum—*i. e.* a bright line appeared as usual in the centre of the broad dark shade, and then this bright line widened and a thin dark line appeared in its centre. The phenomenon seems to be the exact correlative of the double-reversal of the bright sodium lines observable in the flame of a Bunsen burner under certain circumstances.

(*b*) I have recently been able to repeat the observations on the H lines first made at Sherman in 1872. In the spectrum of the chromosphere I find both H_1, and H_2, (or K, as some call H_2) to be *always* reversed; and what is more, H_1 is *double*, the principal line, which is in the centre of the dark shade, being accompanied by another of about half the strength, one division of Angstrom's scale lower—*i. e.* less refrangible. Since last March I have always been able to observe the two H's whenever I could see h, and H_1 *invariably* double.

In the neighborhood of sun spots however, though both H and K are usually reversed on the solar disc, H_1 is *not* double; its attendant line therefore belongs strictly to the spectrum of the chromosphere, and seems to be identical with No. 271 of my catalogue of chromosphere lines, though its wave length is about 3969 instead of 3970.

The observations were made with grating of 17,280 lines to inch; collimator and telescope 12-inch focus.

(*c*) A high dispersion spectoscope has been constructed by combining the above-mentioned grating, having nearly four square inches of ruled surface, with collimator and telescope of 3 inches aperture and 42 inches focus, the magnifying power employed varying from 50 to 200. The apparatus is strapped to the tube of the equatorial, and thus kept directed to the sun, an image of which is formed on the slit by an anachromatic lens of 3 inches aperture.

The performance of the grating is admirable when perfectly flat—a force of ¼ oz. applied at one corner is however sufficient to distort the plate (of speculum metal) ⅜ inch thick by about 3½ inches square, to an extent which seriously impairs the definition; it is sensitive to such distortions to a degree entirely unexpected. This instrument doubles an enormous number of the Fraunhofer lines. Out of 47 lines between C and G marked by Thalen as common to the spectra of two or more bodies, 38 are double or triple, 3 are doubtful (from difficulty of identification), and 6 only are single so far as the instrument can show,

(*d*) Distortion of solar prominences by a diffraction spectroscope. Generally, in such an instrument, the forms seen through the opened slit are either disproportionately extended or compressed along the line of dispersion. If the angle between the normal to the grating and the view-telescope is *less* than that between the normal and the collimator, there will be compression or flattening, and *vice versa*. The mathematical investigation is very simple—

Let n be the order of the spectrum observed.

Let λ be the order of the wave length of the ray.

Let S be the distance between adjacent lines of grating.

Let τ be the angle between normal to grating and telescope.

Let κ be the angle between normal to grating and collimator, and finally $a=\tau+\kappa=$angle between telescope and collimator, which is supposed constant. Then from the fundamental conditions of spectrum formation $n\lambda=S\,(\text{Sin. }\tau-\text{Sin. }\kappa)$ or $\text{Sin. }\tau=\frac{n\lambda}{S}+\text{Sin. }\kappa$, whence $d\tau=\frac{\text{Cos. }\kappa}{\text{Cos. }\tau}\,d\kappa$, or $(\text{Cos. }a+\text{Sin. }a\text{ Tan. }\tau)\,d\kappa$, whence, in general, $d\tau$ will not equal $d\kappa$.

Special cases—

1. If $\kappa=\tau$, there is no distortion—but also no dispersion; it is the case of simple reflection.
2. If $\kappa=0$, grating being kept normal to the collimator, then $\xi=\text{Sec. }a\,d\kappa$.
3. If $\tau=0$, grating being kept normal to the telescope and moving with it, then $d\tau=\text{Cos. }a\,d\kappa$.
4. If $a=90°$ $d\tau=\text{Tan. }\tau\,d\kappa$.
5. If $a=0$, $d\tau=d\kappa$ and there is no distortion. This is possible only by using the same tube both for collimator and view-telescope, the grating being slightly inclined. The principal difficulty with this form of instrument lies in the reflections from the surface of the object glass, which, it is hoped, may be avoided by a special construction of the lens. An instrument on this plan is in process of construction by the Clarks, for the Physical Laboratory at Princeton, and nearly completed.

ON THE THERMO-ELECTRIC ELECTRO-MOTIVE POWER OF FE. AND PT. IN VACUO.

By Prof. C. A. Young, of Princeton, N. J.

Eisner, a few months agö, published a paper asserting that the thermo-electric power of Antimony and Bismuth is destroyed by removing them from all contact with oxygen, and inserting them in an atmosphere of pure nitrogen. From this he argues that the thermo-electric force in general is due to the contact of the gases which bathe the metals. The following experiment was tried to test the theory.

By the kindness of Mr. Edison and Mr. Upton a vacuum tube was prepared in Mr. Edison's laboratory, containing an iron wire, about 2 inches long, firmly joined to two platinum terminals which passed through the walls of the tube; the tube was exhausted until a 2-inch induction coil spark would not pass $\frac{1}{8}$ of an inch in the gauge-tube, indicating a residual atmosphere of about one-millionth. The wire was heated too in candescence during the exhaustion, in order to drive off any possible occluded gases. The platinum wires outside the tube were joined to iron wires, the joinings being covered by glass tubes slipped over them, and a sensitive reflecting galvanometer was included in the circuit. By laying the tube and connected joinings in the sunshine, and alternately shading one or several of the joinings, it was found that the electro motive power of the joinings within the tube was precisely the same as that of those without, and the development of current just as rapid. There was no trace of any modification due to the exhaustion.

ON THE ABSOLUTE INVISIBILITY OF ATOMS AND MOLECULES.

By Prof. A. E. Dolbear.

Maxwell gives the diameter of an atom of hydrogen to be such that two millions of them in a row would measure a millimeter, but under ordinary physical conditions most atoms are combined with other atoms to form molecules, and such combinations are of all degrees of complexity; thus a molecule of water contains three atoms, a molecule of alum about one hundred, while a molecule of albumen, according to Mulder, contains nine hundred atoms, and there is no reason to suppose albumen to be the most complex of all molecular compouuds. When atoms are thus combined it is fair to assume that they are arranged in the three dimensions of space, and that the diameter of the molecule will be approximately as the cube root of the number of atoms it contains, so that a molecule of alum will be equal to

$$(\sqrt[3]{100} = 4.64)\ \frac{4.64}{2000000} = \frac{1}{431000}\text{ mm.}$$

and a molecule containing a thousand atoms will have a diameter of $\frac{10}{2000000}=\frac{1}{200000}$ mm. Now a good microscope, will enable a skilled observer to identify an object so small as the $\frac{1}{4000}$ mm. Beale in his works on the microscope pictures some fungi as minute as that, and Nobert's test bands and the markings upon the *Amphiplura pelucida*, which are of about the same degree of fineness, are easily resolved by good lenses. If thus the efficiency of the microscope could be increased fifty times $(\frac{200000}{400}=50)$ it