Examination of Lines in the Solar Spectrum which are given in the Maps as common to Two or more Substances.—For this purpose a spectroscope of high dispersion has been constructed by combining the grating mentioned above, which has about 4 square inches of ruled surface, with a collimator and observing telescope each of 3 inches aperture and about 42 inches focal length, using magnifying powers ranging from 50 to 200. The apparatus is arranged upon a wooden frame-work, and when in use is strapped to the tube of the 12-feet equatorial of our observatory, so that it is kept by the driving-clock directed to the sun. An image of the sun is formed on the slit by an achromatic object-glass of 3 inches aperture, in order to increase the light and to avoid the widening of the lines due to the sun's rotation. A large prism of about 20° angle was sometimes placed in front of this object-glass (between it and the sun) to separate the colours before reaching the slit; and in examining the darker portions of the spectrum a concave cylindrical lens was sometimes used next the eye, like a shade glass, to reduce the apparent width of the spectrum and thus increase its brightness.

The grating is an admirable one, on the whole the best I have ever seen. But I have been greatly surprised at its excessive sensitiveness to distortion by pressure or inequalities of temperature. Although the plate is fully $\frac{3}{8}$ of an inch thick, and only $3\frac{1}{2}$ inches square, an abnormal pressure of less than a single ounce at one corner will materially modify its behaviour, and a quarter of a pound destroys the definition entirely. In fact the plate is not naturally exactly flat, and to get its best performance it is necessary to crowd a little wedge gently under one corner. When it is in good humour and condition, however, the performance is admirable; one could wish for nothing better, unless for a little more light in the violet portions of the spectrum.

With this instrument I have examined the 70 lines given on Ångström's map as common to two or more substances. Of the 70 lines, 56 are distinctly double or triple; 7 appear to be single; and as to the remaining 7, I am uncertain; in most cases, because I was unable to identify the lines satisfactorily on account of their falling upon spaces thickly covered with groups of fine lines, none of which are specially prominent.

As a general rule the double lines are pretty close, the distance being less than that of the components of the 1474 line. Generally also the components are unequal in width or darkness, or both, though in perhaps a quarter of the cases they are alike in appearance. The doubtful lines are the following, designated by their wave length on Angström's map: 5489·2, 5425·0, 5396·1, 5265·8, 4271·5, 4253·9 and 4226·8. I strongly suspect 5396·1 and 5265·8 (which present no difficulty in identification) of being double, but could never fairly split either of them, and therefore leave them among the doubtfuls.

Those which show no signs of doubling, so far as could be seen, were: 6121·2, 6064·5, 5019·4, 4585·3, 4578·3, 4249·8, and 4237·5.

In respect to the lines 5019·4, 4585·3 and 4237·5 it is quite possible there may be some mistake as to the coincidence, since in his *tables* Thalén gives neither of them as due to iron. An accidental strengthening of the dotted line, which, on the map, leads up from the symbol of the element concerned, through the iron spectrum, would account for the matter, by making the line appear on the map as belonging to iron also.

As the facts stand, therefore, it is obvious that arguments which have been based upon the coincidence of lines in the spectra of different elements lose much of their force; it appears likely that the coincidences are in all cases only near approximations. At the same time this is certainly not yet demonstrated. The complete investigation of the matter requires that the bright line spectra of the metals in question should be confronted with each other and with the solar spectrum under enormous dispersive power, in order that we may be able to determine which of the components of each double line belongs to one, and which to the other element. If in this research it should be found that *both* of the components of a double line were represented in the spectra of two different metals, and the suspicion of impurity were excluded, we should then indeed have a most powerful argument in favour of some identity of material or architecture in the molecules of the two substances involved.

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. The reason is this: if the slit be illuminated by monochromatic light, the image of the slit, formed on each side of the simple reflected image in the focus of the view-telescope (which is supposed to have the same focal length as the collimator), will have the same width as the slit itself only in one special case, not usually realised with a reflecting grating.

If the angle, between the normal to the grating and the view-telescope, is *less* than that between the normal and the collimator, the slit-image will be *narrower* than the slit, and a prominence seen through it will be *compressed* in the plane of dispersion. If the relation of the angles be reversed, then of course the distortion will also be reversed, and we shall have extension instead of compression.

The mathematical theory is very simple. Suppose the collimator and telescope to be fixed at a constant angle, as in the now usual arrangement.

Let angle between telescope and collimator $= \alpha$.
Angle between telescope and normal to grating $= \tau$.
Then angle between collimator and normal $= \kappa = \alpha - \tau$.
Also, let space between adjacent lines of grating $= s$.
And the order of spectrum observed $= n$.

Then, by principles of spectrum formation, we have

$$\lambda = \frac{s}{n}\left\{\sin\tau - \sin\kappa\right\},$$

λ being the wave-length of the ray which is in the centre of the field of view:

whence $$\sin\tau = \frac{n\lambda}{s} + \sin\kappa.$$

Differentiating, we have at once

$$d\tau = \frac{\cos\kappa}{\cos\tau}d\kappa, \text{ or } \frac{\cos(\alpha-\tau)}{\cos\tau}d\kappa;$$

which reduces to, $d\tau = (\cos\alpha + \sin\alpha\tan\tau)\,d\kappa$. Distortion can only disappear in cases when this coefficient of $d\kappa$ reduces to unity. Special cases—

1. If $\tau = \kappa$ there is no distortion—but also no dispersion: it is the case of simple reflection.
2. If $\kappa = 0$, the grating being kept normal to the collimator, then $d\tau = \sec\alpha\, d\kappa$.
3. If $\tau = 0$, the grating being kept normal to the telescope (which in this case must be movable), then $d\tau = \cos\alpha\, d\kappa$.
4. If $\alpha = 90°$, $d\tau = \tan\tau\, d\kappa$.
5. If $\alpha = 0$, $d\tau = d\kappa$, and there is no distortion.

This is possible only by using the same tube and object-glass both for collimator and view-telescope, the grating being slightly inclined at right angles to the plane of dispersion. The principal difficulty in this form of instrument lies in the diffuse light reflected by the surfaces of the object-glass. It is hoped that this may be nearly obviated by a special construction of the lens which will throw the reflected light outside of the eyepiece. An instrument on this plan is being made for Prof. Brackett by the Clarks, for use in the physical laboratory at Princeton, and is now nearly completed.

Princeton, September 27, 1880 C. A. YOUNG

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

DR. J. E. HARRIS (D.Sc. Lond.) has been appointed to the vacant Professorship of Natural Philosophy at Trinity College, London.

FROM the new Calendar of the University College of Wales we learn that the present number of students is fifty-seven. We see there are classes for most of the branches of science, only unfortunately they are all taught by one professor, which, to say the least, must be rather hard on him. We hope the college will soon be able to have separate teachers, at any rate for the physical and biological sciences.

THE new University Library at Halle has just been opened. It is built entirely on the French system, and special precautions have been taken with regard to fire. It now numbers some 200,000 volumes, but there is room for half a million. The cost of the building amounts to 400,000 marks (20,000*l*.).

SCIENTIFIC SERIALS

THE *American Naturalist* for December, 1880, contains:—D. Cope, on the extinct cats of America.—F. V. Hayden, Twin