THE YERKES OBSERVATORY OF THE UNIVERSITY OF CHICAGO.

BULLETIN NO. 12.

CARBON IN THE CHROMOSPHERE.

The green fluting of carbon, which terminates at $\lambda 5165.3$, was first found in the spectrum of the chromosphere at the Yerkes Observatory in September 1897. A large image of the Sun and excellent atmospheric conditions are required to render the bright lines of the fluting visible, as the layer of carbon (or hydrocarbon) vapor to which it is due is probably less than a second of arc in thickness, and lies in immediate contact with the photosphere. The forty-inch telescope, which gives a focal image of the Sun seven inches in diameter, was used for the observations, in conjunction with a large solar spectroscope containing a five-inch Rowland grating with 20,000 lines to the inch. The bright lines of the fluting were identified with the faint dark carbon lines in this part of the solar spectrum, by placing the slit on the image of the photosphere, where the dark lines were visible, and then quickly moving it to the chromosphere, where the dark lines were seen to be replaced by bright ones. At this time an unsuccessful search was made for the yellow and blue flutings of carbon.

In August 1899, after the solar spectroscope had been reconstructed and the 20,000-line grating replaced by a four-inch Rowland grating with 14,438 lines to the inch, the green fluting was better seen than before. The lines were carefully reidentified with those of carbon, and had a specially constructed micrometer been available at the time, it would have been possible to measure many of them. As the atmospheric conditions were very fine another search was made for the yellow fluting, which terminates at $\lambda 5635.4$. With perfect adjustment of the apparatus, and careful setting for tangency, the fluting was soon found. It can be observed, however, only with the largest instruments used under the best conditions. The blue fluting, which terminates at $\lambda 4737.2$, could not be seen.
Mr. W. S. Adams, Fellow in Astronomy, assisted in the work and confirmed the observations of the yellow fluting, which was also seen by Professor Frost, and has since been observed on other occasions by the writer. In this fluting less than a dozen lines could be separately distinguished. The green fluting contains so many bright lines that it is impossible to count them.

SOME NEW FORMS OF SPECTROHELIOGRAPHS.

Of the various forms of spectroheliographs described in my previous papers, thesimplest and best is undoubtedly that in which the instrument is moved as a whole at right angles to the axis of the telescope, the solar image and photographic plate remaining stationary. It is not always possible, however, to employ a spectroheliograph of this form. With the forty-inch telescope, for example, the motion of the very heavy spectroheliograph required could not be effected without jarring the instrument. For this reason it has been decided to cause the solar image to move across the first slit by means of the slow motion declination motor.\footnote{The plan of moving the solar image in declination was first suggested by Mr. W. H. Maw several years ago.} The first and second slits are fixed with reference to each other, and the photographic plate is moved across the second slit by means of a screw driven by the same motor, which is mounted on the tube of the forty-inch telescope. A wide range of exposures can be secured by means of a system of change gears. This spectroheliograph, which has an aperture of six and one fourth inches, is now nearly ready for trial.

Two other forms of spectroheliographs may occasionally prove useful. In both the first slit and the axis of the collimator are supposed to remain coincident with the optical axis of the telescope. In the first form a photographic doublet, of large field, is so placed that the solar image, at the principal focal plane of the telescope, and the first slit are in its conjugate foci. If the lens is then moved at right angles to its optical axis the image of the Sun will move across the first slit. The carriage which bears the photographic plate across the second slit is geared to the screw that moves the doublet in such a manner as to give a photograph of the Sun which is not distorted by the relative motion of plate and solar image.

The other form of spectroheliograph is similar, but the photographic doublet is replaced by a right angle prism, with hypothenuse.
parallel to the axis of the telescope, or a combination of three mirrors,\(^1\) arranged as shown in the figure.

When this device is used it is placed immediately in front of the first slit, which lies in the principal focal plane of the telescope. It is connected with the plate-carriage, and both are moved at right angles to the axis of the collimator.

Both of these instruments have obvious defects, such as liability to distortion of the photograph, due to the limited field of the doublet; diffuse light from lens and mirror surfaces; possible distortion of the prism or mirrors, due to heating; and the necessity of using large lenses and mirrors when a large solar image is to be photographed. If the details of the design are carefully worked out, however, these defects can be reduced to a minimum or perhaps altogether obviated. For example, the effects of heating and diffuse light can be greatly decreased by the use of moving screens, so arranged as to cover all parts of the solar image except the particular region which is being photographed at a given moment.

It will be seen that both instruments are better adapted for laboratory use, in conjunction with a heliostat, than for attachment to an equatorial. In the laboratory the considerable distance which must separate the doublet from the solar image and slit, in case a large image is desired, is not very objectionable. Either device affords a simple means of transforming a large fixed spectroscope, of almost any type, into a spectroheliograph.  

George E. Hale.

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\(^1\)Such combinations of mirrors, as well as right angle prisms, have long been used for the purpose of rotating the solar image in spectroscopic observations. It is obvious that rotation of the image (and photographic plate) may also be employed in spectroheliographic work, if it is intended to photograph only the limb of the Sun, and not the central part of the disk.