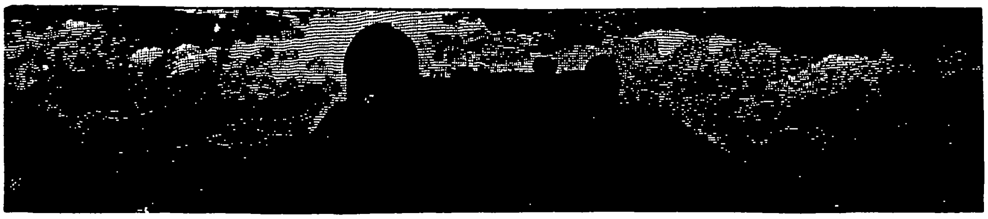
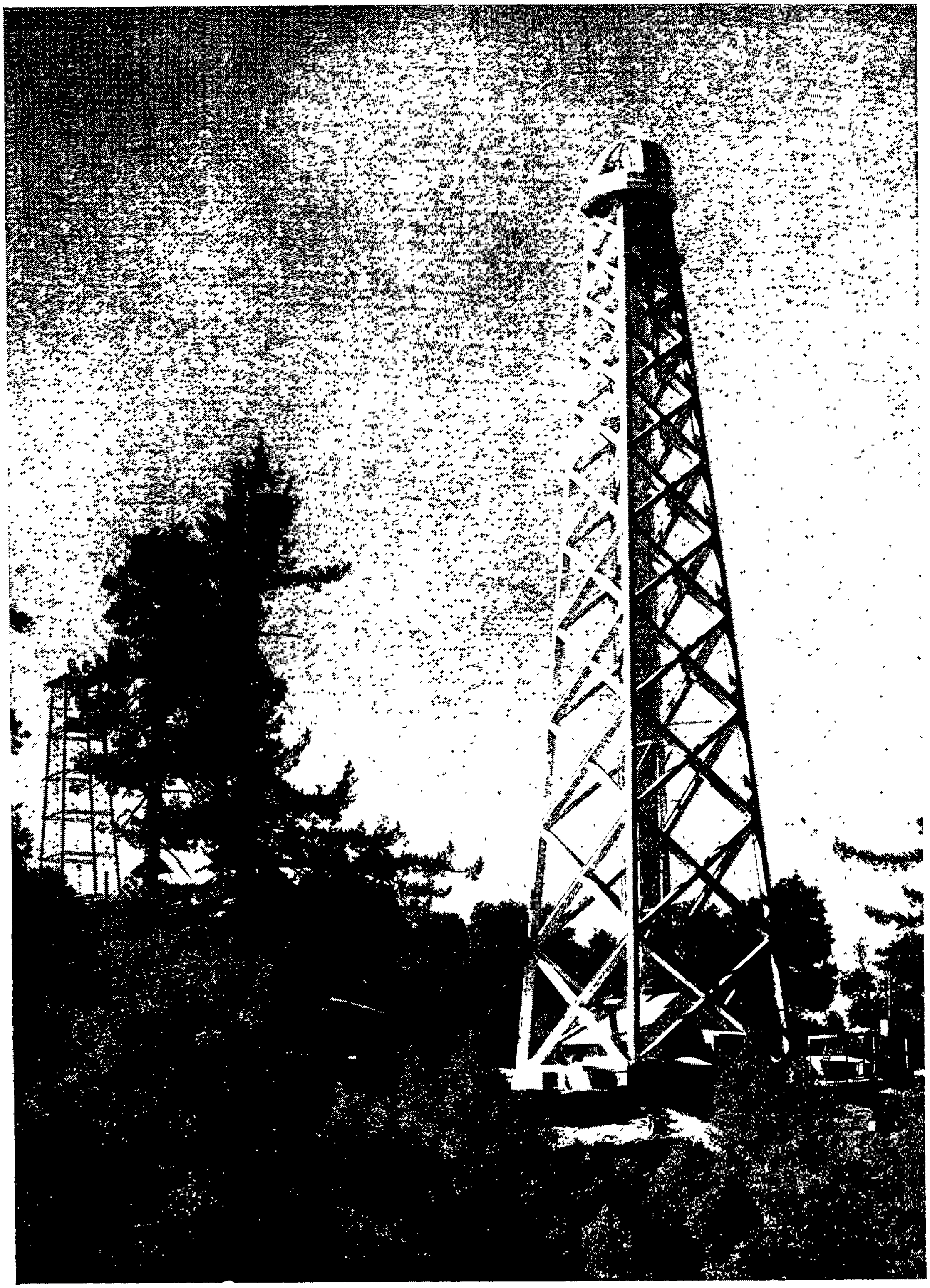


NOTES FROM PACIFIC COAST OBSERVATORIES.

THE 150-FOOT TOWER TELESCOPE OF THE MOUNT WILSON SOLAR OBSERVATORY.

The year has marked the completion of this instrument, after long delays occasioned by the difficulty in obtaining a suitable object-glass of 150 feet focal length. As mentioned in the last annual report of the Solar Observatory, the 12-inch triple objective at first supplied by the makers was defective and had to be replaced by a visual objective of the ordinary two-lens type. This gave poor definition, and new glass disks were obtained for a third attempt, which proved to be very successful. The third objective was delivered by BRASHEAR in May, and was immediately mounted in the telescope, where it has been in regular use for a variety of investigations.

The 75-foot combined spectrograph and spectroheliograph was completed in December, and the 12-inch objective, of 60 feet focal length, which belongs to the old tower telescope, was then transferred to the new tower, in order that observational work might begin before the completion of the 150-foot focus objective. The preliminary tests were most satisfactory in all respects save one—the focal length varied at different hours of the day and the solar image gave evidences of astigmatism near noon. Experience with the 60-foot tower having shown that the rise in temperature of the mirrors from night to day would probably produce such effects, water-jackets surrounding their edges were provided, but during the winter these were not needed. In July the higher temperature and the use of the 150-foot focus objective rendered the changes far more conspicuous. The slight astigmatism previously found gradually grew more marked, and finally it became evident that the image was not merely astigmatic, but multiple. This was



THE 150-FOOT TOWER TELESCOPE OF THE CARNEGIE SOLAR OBSERVATORY.
From a photograph by Mr. F. ELLERMAN.

accompanied by increased focal change, amounting in some cases to five feet (1.5^m) in a few hours.

In the hope of preventing such changes, a steady circulation of water, kept at a nearly constant temperature, was maintained in the water-jackets covering the edges and backs of the mirrors. As soon as equilibrium was established, the astigmatism completely disappeared, and the change of focal length was reduced to a small fraction of its former amount. Long exposures with the spectroheliograph may now be given without interference from this cause.

On account of the great height of the new tower (176 feet to top of dome) doubts have been expressed by various writers as to its stability. The work of the last year proves these fears to be groundless. So delicate an operation as the photography of the "flash" spectrum has been carried out when the wind was blowing twenty miles an hour, and there has never yet been an occasion when it was necessary to stop work because of trembling of the image.

In another respect the tower has also met our hopes—the definition of the solar image is much better than that of the Snow telescope after the early morning hours. There is no convection up the vertical tube, and the protection of the beam from the warm air rising from the heated earth is doubtless the cause of the improvement.

The 75-foot spectrograph has also proved to be very satisfactory. With the Michelson grating the definition of the solar spectrum is excellent in the first three orders; in the third spectrum, where the distance between D lines is over an inch, both D_1 and D_2 are clearly double. A large number of excellent photographs of spectra have been taken with the focal length of 75 feet (22.88^m), but at present the spectrograph is used with a focal length of 30 feet (9.15^m), since the exposure times are of course much shorter in this case. The ease with which the base of the instrument can be shifted from the bottom of the well to the 30-foot level is a valuable feature of the design.

Another advantage of the instrument is the possibility of changing the dispersion through a very wide range without disturbing the adjustments. For example, the following series of photographs of a sun-spot group may be taken in rapid succession:—

1. Structure of the group, using the instrument as a spectroheliograph, with the camera slit set on the continuous spectrum.

2. Calcium (H_2 or K_2) flocculi, integrating the phenomena of different levels.

3. Hydrogen ($H\alpha$) flocculi, showing the vortex structure.

A table at the base of the instrument is then rotated, bringing a 60° prism or a grating into position.

4. High-level hydrogen flocculi, using center of $H\alpha$.

5. High-level (H_3 or K_3) calcium flocculi.

If $H\alpha$ indicates radial motion, a double mirror is rotated into position beneath the prism, replacing the single mirror used before. This gives two images of the spectrum from the same slit.

6. Ascending and descending hydrogen flocculi (two camera slits, one set on violet edge of $H\alpha$, the other on red edge).

Additional spectroheliograph images, with higher dispersion or with other lines, may be taken if desired. The instrument is then used (with a grating) as a spectrograph, for the following additional records:—

7. Magnetic survey of the spot group, showing polarity and strength of the field in different regions and at different levels. Single exposure with multiple slit and polarizing apparatus.

8. Radial motion of spot vapors, using multiple slit without polarizing apparatus.

9. Spectrum of the umbra with high dispersion for identification of spot lines, determinations of pressure, strength of magnetic field at different levels, etc.

In such a program, the order in which the photographs are taken and the size of the solar image employed will naturally depend upon the special requirements of each class of work. The ease with which the diameter of the image can be changed, by swinging into place objectives of 30, 60 and 150 feet focal length, and the equal facility of changing the dispersion by a device similar to the multiple nose-piece of a microscope, renders possible a great variety of work in a limited time.

The combined spectrograph and spectroheliograph is also designed for the photography of the spectrum of the chromosphere ("flash spectrum"), the comparative study of the spectra of center and limb, the measurement of the solar rotation, the determination of the pressure at different levels in the solar atmosphere, and for various other purposes.

The auxiliary apparatus includes a reflecting slit, especially adapted for the photography of the spectra of pores and other minute regions; a device for securing uniform density of the spectra of umbra, penumbra and photosphere in a single exposure; a special guiding device, to maintain any part of the Sun's image on the slit with great accuracy throughout an exposure; a parallel motion apparatus, to facilitate accurate orientation of the instrument; polarizing apparatus, with simple and compound quarter and half-wave plates for various wavelengths; and an electric arc for comparison spectra.

GEORGE E. HALE.

A SUN-SPOT HYPOTHESIS.

The following tentative working hypothesis of sun-spots is proposed merely as a guide to further research. As the result of an eruption, or some other cause tending to produce rapid convection, a gaseous column moves upward from within the Sun toward the surface of the photosphere. Vortex motion is initiated by the difference in rotational velocity of adjoining zones or by irregularities of structure and is maintained by convection. The circulation in the vortex is vertically upward and then outward along the photosphere, as in a terrestrial tornado. Expansion produces cooling at the center of the vortex, and a comparatively dark cloud (the umbra) results. As in HARKER's electric furnace experiments,[1] a rapid flow of negative ions sets in towards the cooler gases at the center from the hotter gases without. The ions, whirled in the vortex, produce a magnetic field.

The descending gases (especially hydrogen) in the higher atmosphere of the Sun are drawn in toward the pole of the magnet along the lines of force, as in BIRKELAND and STÖRMER's theory of the aurora. This accounts for the configuration of the hydrogen ($H\alpha$) flocculi, as shown by the spectroheliograph.

[1] See *Nature*, July 18, 1912.