

## ANOTHER HELIOTROPE.

BY E. C. CASE.

A great many heliotropes have been devised for experiments in physiography to determine the height of the sun, but I have one that seems to me to present certain simple and advantageous features. It consists of two supports, *a* and *b*, (Fig. 1), fixed rigidly at a right angle. In the upper face of *b* is fastened a narrow strip of mirror so that its upper face is exactly perpendicular to the upright *a*. In making the apparatus, I plumbed the upright, and then cut a small hole in the base and filled it with

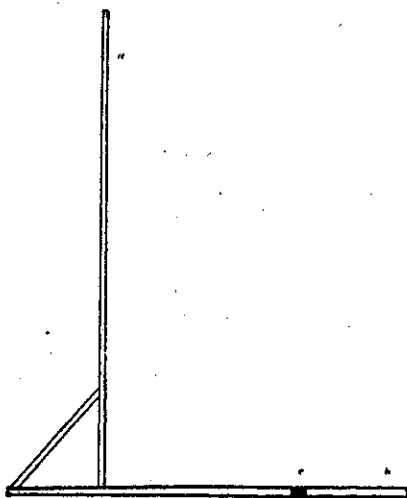


FIG. 1.

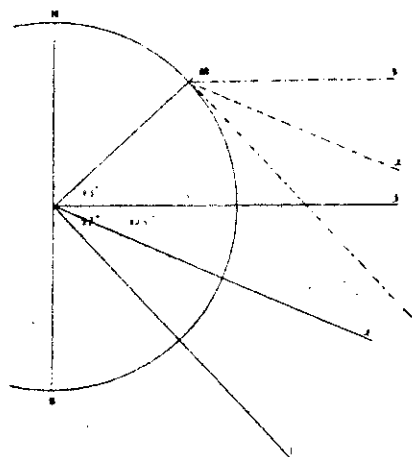


FIG. 2.

plaster of Paris, in which I laid the strip of mirror and leveled it with a small pocket level as the plaster set. A protractor was then set up with its middle point on the center of the strip of mirror, and a thread drawn to the upright, marking every degree from  $15^{\circ}$  to  $75^{\circ}$ . The greatest length of the strip of mirror is across the base, of course.

The method of use is simply to set the heliotrope in the sun

and read the middle point of the reflection cast on the scale. The real noon can, of course, be determined by noting the highest point of ascent, though this is not very exact. The azimuth of the sun can be determined, the noon line or true north once determined, by turning the apparatus toward the sun, one end of the base being fixed on the noon line, until the middle of the reflection lies upon a line ruled down the middle of the upright; then the angle of the apparatus to the true north line is determined, and we have the sun position in alt- and azimuth.

My method of explaining altitude experiments to the class is as illustrated in Figure 2. It may be old, but I haven't seen it anywhere. The sun's rays are parallel to themselves and fill a space certainly much greater than the earth. Then, if the sun is tangent at Milwaukee (Lat.  $43^{\circ}$  N.), they will be vertical over  $47^{\circ}$  S. latitude. This is shown by the whole line and dotted line 1. If the sun is vertical over the tropic of Capricorn,  $23\frac{1}{2}^{\circ}$  S., the ray, parallel to this vertical ray, which strikes Milwaukee will be  $23\frac{1}{2}^{\circ}$  from the tangent to Milwaukee, just as the vertical ray is  $23\frac{1}{2}^{\circ}$  from a point  $90^{\circ}$  from Milwaukee, and so the sun at Milwaukee will appear  $23\frac{1}{2}^{\circ}$  above the horizon. (Whole and dotted lines 2.) When the sun is vertical over the equator the parallel ray at Milwaukee will cause the sun to appear  $47^{\circ}$  above the horizon, for just as the equator is  $47^{\circ}$  from a line  $90^{\circ}$  from Milwaukee, so the ray striking Milwaukee will be  $47^{\circ}$  from a ray tangent to Milwaukee. So, for the summer solstice the sun will appear  $70\frac{1}{2}^{\circ}$  above the horizon.

Now, if a mirror were placed parallel to the horizon at Milwaukee, the law of reflection of light would cause the light from the sun to fall on a convenient scale and register the sun's height directly.

The advantage of this device is its exceeding simplicity and ease of setting up. The height of the sun can be read directly, and its change of position is very noticeable. My very hastily constructed model reads readily within a quarter of a degree of my transit.