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Teaching Aids in Astronomy

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Abstract. Three teaching aids in astronomy are described. The first consists of a star locator with features of a transit, equatorial mount, and revolving star map for teaching celestial coordinates and identification of stars. The second is a set of black flash cards of common constellations, and the third is a rotating disc for practice in estimating standard time by the Big Dipper.

Star Locator

The celestial coordinate system is frequently difficult for the beginning student in astronomy, particularly right ascension and its relation to standard and sidereal time. In the interest of reducing this information to a more easily understood and usable form, this star locator was developed for the course in descriptive astronomy at Parsons College. It combines parts of the surveyor's transit, the equatorial telescope mounting, and a circular star map.

The altitude and azimuth coordinates are demonstrated by setting the instrument head in a level position. The difficulty of using this system on stars appears to the student when he attempts to follow a star, and he finds that slow changes in both altitude and azimuth become necessary. A simple tipping of the vertical axis to coincide with the earth's axis permits easy following, and thus shows the reason for the equatorial system.

The similarities of altitude, declination, azimuth and hour angle are emphasized by the instrument in a vertical and then a polar position. With the head clamped in the polar position and the sighting tube clamped at zero declination, swinging the tube completely around the axis defines the celestial equator and divides it into northern and southern hemispheres. The sighting tube is also used to demonstrate the celestial meridian, celestial north pole, zenith, and nadir.

Further explanation for tilting the head to an angle equal to the observer's latitude can be sketched on the chalkboard. With the tube at 90° declination, the head is rotated and the fact that Polaris remains near the center of the field of view shows that it is very close to the pole of the celestial sphere. The division of the instrument hour circle into hours and minutes instead of 360° logically follows because the earth rotates in 24 hours. This measurement is projected to the celestial equator.

Now setting the sighting tube at 0° declination and swinging from the eastern to the western horizon brings out the interesting fact that a star on the celestial equator spends 12 hours above the horizon and 12 below. Repeating this process but with an increased declination leads the student to discover that stars in the northern hemisphere are above the horizon longer than 12 hours, and that at a declination which is the complement of the observer's latitude, some stars never set. These we call circumpolar. This makes a good introduction to the pole star and the five principal circumpolar constellations. This we do out-of-doors with the class gathered around the locator, and at the same time the constellations are pointed out on the star map. Rotating the map through 24 hours also shows that Ursa Major, Ursa Minor, Cassiopeia, Draco, and Cepheus never go below the dotted line which indicates the northern horizon on the map's cover glass.

Closer study of the star map shows the celestial equator at the map's edge. The sky south of the equator to about –20° declination is on separate map segments. The celestial meridian is a white line on the cover glass. The sighting tube follows the meridian from southern to northern horizon when the hour circle is clamped at zero.

The hour line divisions indicate right ascension measurement. The 24 hour, or zero line, passes at about +60° declination close to the leading star Alpha in Cassiopeia. This is sometimes called "The First Point in Aries," and corresponds to zero longitude on a geographical map. At this time, Cassiopeia is pointed out in the sky to the class. The celestial sphere rotates counter clockwise when facing the north, thus defining the "leading" star in the constellation.

The star map can be turned so that it corresponds to the configuration of the sky at any moment of the night. When the sky and the map correspond, the date on the map's edge matches local standard time as shown on the frame edge. Thus, turning the map to the current date and time at the start of the class session correctly relates it to the sky overhead.

Constellations are easily located from the map after it is properly set, as the map is large and is in a normal reading position. This is much easier than trying to hold the ordinary small star map overhead.

Although the earth rotates in 24 hours and the stars in 23 hours and 56 minutes, this small difference is neglected and the finding of sidereal time does not enter into the student's use of the locator.

The following is an example of the locator's use:

1. Let the date be April 17 and the time 9:00 p.m.
2. The instrument is set up and leveled with the plumb bob, and with the declination at 90° and hour circle at zero, Polaris is

centered in the tube. This orients the instrument enough for instruction purposes.

3. The star map is turned to proper date and time.
4. Suppose the star Regulus is selected and its right ascension and declination is taken from any catalog.
5. The tube is set at +12 declination. The right ascension of 10 hours 6 minutes is found on the map, and with a ruler along this line, the hour angle between the ruler and the meridian on the cover glass is estimated to nearest five minutes. If the star is east of the meridian the tube is pointed eastward to the proper hour angle which, in this case, is about 45 minutes. Now Regulus will appear through the tube.

This process is easily reversed. Suppose an unknown visible star is selected. With the tube sighted on this star, say +19, and hour angle 3^h30^m Eastward are read. The star is then quickly located on the map and can also be further identified in the American Ephemeris or other catalog by number, letter, name, and constellation. The instrument as it stands is quite rough, but it is accurate enough for the more prominent stars. During the use of the locator, the student must remember to rotate the star map occasionally to keep it in step with the sky as the hour grows later.

In the above use, the student learns the celestial system without the reduction of standard time to sidereal time and the corrections to obtain Right Ascension. The device and method are straightforward, it eliminates tedious arithmetic which seems complicated and mysterious to many, and experience with students indicates it is both easily understood and enjoyed in use.

Constellation Flash Cards

The second teaching aid consists of large black flash cards showing common constellations in white. Each card carries only one or two constellations, with white painted lines connecting the principal stars. The elimination of background stars helps a student to memorize the outline so that he knows what to look for and recognizes the constellation when he sees it. Since the cards can be oriented in any position, the appearance in the sky at any hour can be duplicated. A few minutes' practice with the flash cards at several class sessions develops rapid recognition out-of-doors. This common elementary device has been found to give excellent practice in the classroom and in the observatory.

Star Clock

It is desirable to have the student learn a simple and easily remembered way to tell time by the stars with reasonable accuracy.

The following method gives the student a feeling of familiarity with the northern sky, and he acquires a satisfying skill.

This aid is a simple disc showing the Big Dipper and is used to teach the method first in the classroom. In the Parsons College observatory there is mounted on the wall a similar disc six and a half feet in diameter with the constellation in fluorescent paint.

The following method of estimating local standard time is applicable wherever the Big Dipper is visible, and was developed about 1925 by Dr. C. C. Wylie, former professor of Astronomy at the State University of Iowa, and Mr. William Merrymon of the Westinghouse Research Laboratories, Bloomfield, New Jersey. I first learned the method from Dr. Wylie in 1945, but have not seen it used by any other teacher. In brief, it uses the "pointers", Dubbe and Merak of the Big Dipper, as the hour hand of a giant clock whose center is the North Star. It is done mentally as follows:

1. Estimate the time to the nearest quarter-hour by the hour hand of the sky clock.
2. Add the months since January 1 to the nearest quarter month.
3. Double this sum.
4. Subtract this result from 40¼ or 16¼.

This gives the local standard time plus or minus fifteen minutes. With practice in estimating the hour hand's position and using the nearest one-eighth month, the margin of error can be narrowed to plus or minus five minutes.

This simple movable black disc with the Big Dipper and arrow for the hour hand visualizes the process for the class and gives an opportunity to memorize and practice the method.

Literature Cited

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