“Calibrating” your eyepieces

Having owned my telescope for 5 years, I finally decided it was time to make some more ‘serious’ use of it. In the past I had been unsure of the area of sky covered by each of my eyepieces, which made it difficult to match my observations to star charts. It seemed that the more I ‘zoomed in’ on computerised star charts, the more faint stars were revealed in patterns which could match what I had seen at the eyepiece. I finally decided to put this problem to rest and work out the “field of view” of my eyepieces.

By using the “drift method” it was easy to estimate each eyepiece’ field of view. In this method you position a star at the eastern edge of the eyepiece and time how long it takes to cross through the centre to the western edge. You then use that time measurement to determine the field of view (in arc-minutes) via the following equation :

Field of view = 15 t cos(dec)

where t is the drift time in minutes and ‘dec’ is the declination of the star observed.

For stars on (or near) the celestial equator, cos(dec) equates to 1 (or very nearly so). Hence the equation simplifies to :

Field of view = 15 t.

You may be wondering where the factor of 15 comes from ? There are 60 minutes of arc per degree, and 360 degrees in a circle. Hence, in one sidereal day the Celestial Sphere rotates through 21,600 arc-minutes. A sidereal day is 23 hours, 56 minutes and 4 seconds long; which equates to 86,164 seconds. So the angular speed that it rotates at is given by :

Angular speed of rotation of celestial sphere = 21,600 arc-minutes / 86,164 seconds,

which evaluates to 0.2507 arc-minutes per second, or 15.04 arc-minutes per minute. Rounding off, we can take this as 15 arc-minutes of motion, per minute of drift of the star being observed.

For stars away from the celestial equator, the cos(dec) term arises from the geometry of the celestial sphere. Consider figure 1. The star at position A1 lies on the celestial equator (declination = 0). As it moves from A1 to A2 it traces an arc of length $R\sigma$ (R, of course, is assumed to be very large).

The star at position B lies a significant distance away from the celestial equator, at a declination angle of θ. If we project B’s position onto the celestial equator we find it lies a “distance” of $R \cos(\theta)$ from the Earth (which is at the origin, O). Star B moves at the same angular speed as the star at A1 (15 arc-minutes per minute of drift). However, the length of its path as projected onto the celestial equator is the shorter $r\sigma$ (this is a simple line of sight effect). Since r is simply $R \cos(\theta)$, it follows that the path length for B is R cos(θ)σ. As a consequence, you would have to observe star B for a longer period than A, for it to cover the same apparent arc through your eyepiece. The cos(dec) factor scales down the observed drift time to what you would see from a star on the celestial equator.

I have used this method to 'calibrate' my 3 eyepieces (both alone, and when used in conjunction with a 2x Barlow lens). I am now fairly certain of the area of sky that each covers, and this is helping me to identify the stars I see through the eyepiece. I use a free planetarium computer program called "HNSky" by Han Kleijn (available from the Internet, but it is a monster of a download) which provides access to a number of catalogs including SAO and Tycho. It allows you to define up to five 'pointing circles' which encircle user-defined areas of sky. I've now set all 5 of these to match my eyepieces and identification of fields of view has become much easier.

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