<u>Eyepiece Magnification and Field of View</u>

By Bill Warren

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Magnification. Determining what magnifications your eyepieces are applying to celestial objects is easy: just divide the eyepiece focal length – it's expressed in millimeters (as in *26mm* or *9.7mm*), usually printed on the side of the eyepiece – into the focal length of your telescope, which is also expressed in millimeters. The number you come up with is that eyepiece's magnification.

For example, if you have an 8" telescope with a focal length of 1200mm and your eyepieces are 25mm and 10mm, their magnifying powers are 48x and 120x, respectively. A 2x Barlow lens attached to your eyepiece will double their magnifications to 96x and 240x, but will not necessarily improve the clarity of the resulting images. A magnification of, say, 48x means that the object is seen 48 times larger than it would appear to the naked eye.

Incidentally, for those of you who wear eyeglasses while viewing, a Barlow lens offers better eye relief (i.e., a wider viewing aperture) than a higher power aperture of the same magnification. Thus, a 25mm eyepiece with a Barlow affixed should provide nearly the same magnification as a 12mm eyepiece, and with better eye relief. Of course, there's the problem of taking the time to fit the Barlow into place after finding an object at low power; still, you could remedy that problem by buying another low power eyepiece and using one of them for low power viewing and the other with the Barlow attached for medium power observing. That may seem a drastic measure to some – but if it makes viewing with eyeglasses easier, isn't it worth the effort?

Magnification Limits. While you could -- theoretically, at least -- apply *any* magnification to any telescope, there are practical limits to what you should expect to see clearly at high power. Beyond those limits, images tend to lose contrast by spreading and dimming the light that afforded clearer images at lower magnifications.

The useful magnification limits (known as the Dawes limits) are roughly 50x for a 60mm (2-1/2") telescope, 100x for a 4-1/2" 'scope, 150x for a 6" 'scope, 140x-160x for an 8" 'scope, 175x-200x for a 10" 'scope, 210x-240x for a 12" 'scope, and 245x-280x for a 14" 'scope.

Those figures aren't etched in stone – but to get good views with higher than those stated magnifications generally requires exceptionally steady seeing and high quality optics. Even then, though, you aren't likely to find magnifications of upward of 350x-400x useful; there's just too much atmosphere to contend with. (On the positive side, that same atmosphere makes breathing possible, so we shouldn't complain too bitterly.)

Field of View. Your field of view includes everything that can be seen in your telescope or binoculars without moving them around. The greater the magnifying power of a given eyepiece, the smaller its field of view (fov) will be – but objects within that fov will be correspondingly larger. That's why images leave the field of view so quickly at high power.

To measure an eyepiece's field of view, select a star that is somewhere near the celestial equator – say, Aldebaran, the right eye of Taurus, the Bull – and place it at the E edge of your fov. Then time how long in seconds it takes for that star to drift through the center of the field to the opposite edge. That time divided by four gives the diameter of the field in arc-minutes. (60' [arc-minutes]=1^{o}, 30'=$1/2^{o}$, 15'=$1/4^{o}$, etc.) If your field of view is $1/2^{o}$, or 30', the Moon will fit neatly inside it.

Knowing your field of view can be helpful in finding objects by star-hopping. If, for example, you're told that a given object is, say, $3/4^{o}$ E of a given star and your field of view is only $1/2^{o}$, you already know that you won't find your object in that star's field with that eyepiece. To find it, you could either switch to a lower magnification (and thus expand your fov), or else place the guide star in the W side of your field, guide your 'scope one field of view to the E, and look for the object in the middle of *that* field of view.

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