Buying a Telescope

Originally by Carl Wenning (ISU Planetarium), adapted by Dave Leake

In class, I told you about my friends Jack and Diane. Many people are faced with the same dilemma – what do I look for when buying a telescope? The point in class was to stay away from a high-power (magnification) telescope. But let's face it . . . .if you're faced with two telescopes, side-by-side, same size but one goes to 80x and the other goes to 500x, how many will take the 500x telescope? Probably quite a few! High magnification makes an object appear larger but it also takes the feeble light from a distant object in space and spreads it out, thus making the object appear dimmer. It is possible to use so much magnification that you won't find the nebula or galaxy at all! High magnification also brings with it a narrow field of view, like you're looking through a long cardboard tube used for wrapping paper. I've seen kids using 500x not be able to find a full Moon! So how do you account for losses in light from magnification? You collect more light! Collecting light makes an image brighter. This is done by using a lens or mirror to bring more light to your eye. More light means a brighter image and then you can get away from magnifying it more. A larger "light collector," of course, means a larger chunk missing from your wallet, too.

Here is the example, I did in class . . . . . recall Jack & Diane live next door to each other. Diane purchases a modest instrument that has an aperture (diameter of the lens or mirror) of 2 inches and magnifies only 7 times. The magnification makes the object you're looking at 7 times higher and 7 times wider, so you're really spreading out the image by a factor of 7 x 7 or 49 times. The object would appear 49 times dimmer. However, we're collecting a lot of light. When fully dialated, your eye is about ¼ inch in diameter. A 2 inch aperture is 8 times larger than your eye (8 x ¼ = 2 inches) but your eye and the lens are circles. We must consider the area of a circle (πr2) so, if we leave off π and just take 8 x 8, we're collecting 64 times more light than our eye alone. This is good! Let's do a ratio now. We're collecting 64 times more light than our eye (making our object 64 times brighter) but we're spreading out the light by a factor of 49. 64/49 = 1.3 . . . or we can say the object we're looking at through the telescope will appear 30% brighter.

Now let us consider Jack's choice. Jack goes to a local department store where, on sale, there is a telescope with a 3 inch lens and it magnifies 500x. There are also photos on the box taken by the Hubble Space Telescope. We do the same calculations. A 3 inch lens is 12 times larger (diameter-wise) than our ¼ inch eye (1/4 x 12 = 3). But we have to consider areas so we're collecting 12 x 12 or 144 times more light than our eye can do alone. But Jack is impatient and wants to use the telescope immediately at 500x. The target will have its light spread out by a factor of 500 x 500 (remember, we deal with areas) or 250,000 times! So we're collecting 144 times more light but we're spreading it out by a factor of 250,000!! Lets do the same ratio: 144/250,000 = 0.000576. The image will appear 1736 times dimmer!!!

What is sad is that Jack's telescope is typical of many on the market these days, especially in department stores. The most important thing a telescope can do is collect light! Sure, they do magnify objects but ONLY after the light is collected. You can have two much magnification. A suggested maximum high magnification is 60 power per inch of aperture. So, for a 3 inch telescope (3 inch lens), you can go to

180x and no more. Jack's telescope used at low magnification would be fine but you're paying for the high magnification eyepieces.

Diane's "telescope" is actually a pair of 7 x 50 binoculars.   "7" is the magnification and the "50" is the diameter of the lenses (aperture) in millimeters. 50mm = 2 inches. When beginners want a telescope, binoculars are often suggested as a first step, but few see the advantage of buying binoculars (which are two telescopes mounted side-by-side).

Binoculars also have a wide field-of-view. A typical binocular FOV is 6-8 degrees where a high power telescope may yield a ¼ degree FOV. Again, the area of the sky observed increases with the square of the radius, so a 7^{o} field will show you about 784 times more area of the sky than the telescope.   You can see more!   Binoculars area also usually less expensive, light-weight, easier to maintain, and you can take them to a football game.

Which would you buy?