The Newbie Corner

Plate Scale

By Brad Hutton

Hi. My name is Brad Hutton. Although I have been around the club for several years and on the Board I am still a NEWBIE to the hobby of astronomy. So, I decided to write a column for the "Observer" called "The Newbie Corner"- a column for newbie's by a newbie. We can learn together so let's get started. The first installment is on **plate scale.** Oh, by the way, if any of you old timers see anything wrong with what I publish, please let me know, since my training is "on the job," and I would not want to misinform anyone.

What is **plate scale**? The term, **plate scale,** I believe, comes from the olden days of astronomy - that time before CCD chips when film plates were used to image the night sky. If you know the scale of your **field of view** (FOV) then you can measure the distance between objects or stars in the image. The distance is usually expressed in arcminutes or arcseconds. **Plate scale** has been defined as "the ratio of angular distance between two stars to the linear distance between their images on a photographic plate". The scale of the image can be determined in several ways. One is if you can indentify two or three stars in the image. Then you can then look them up in a catalog. From the catalog, you can obtain the position in the sky and then calculate the scale of the image based on the stars you have selected. The second way is to use math to calculate the scale of your FOV. The FOV scale of any image is based on your optics system and actual image size. Let's work an example.

For this exercise the imaging telescope is an Astro Tech 102ED and the camera is a SBIG ST10. The specifications of the equipment are as follows…

Telescope
- Aperture 102mm
- Focal Length (FL) 709mm
- Focal Ratio (f) 6.95 (709/102=6.95)

SBIG ST10 Camera
- The imaging chip is 2184 pixels x 1472 pixels each pixel is 6.8 microns square.

Make sure when you work the equations that you are always working in the same unit of measure. The FOV of our example setup is expressed by the following formula.

$$FOV=3439 * (d_{ccd}/FL) \text{ arcmin}$$

Where d_{ccd} is the width or height of the CCD chip and FL is the focal length of the optic system. Since the FL of our system is in millimeters we must obtain the height and width of the CCD chip in millimeters (mm). We know each pixel is 6.8 x 6.8 micros. To convert this to millimeters we need to divide 6.8 microns by 1000 to get millimeters. 6.8/1000 equals .0068mm. Then each pixel is .0068mm x .0068mm thus the size of the CCD chip is 2184 pixels *.0068 by 1472 pixels *.0068 or 14.8512mm by 10.0096mm. We can now work the formula for the CCD chip height and width.

$$FOV_{width} = 3439 * (14.8512/709) = 72.1 \text{ arcmin}$$
$$FOV_{height} = 3439 * (10.0096/709) = 48.6 \text{ arcmin}$$

The FOV for this setup is 72.1 arcmin by 48.6 arcmin. If you divide these by 60 you will get the FOV in degrees 72.1/60 by 48.6/60 equals a FOV of 1.2 degrees by .81 degrees. While we are doing all of this math let us determine the size of the pixel in arcsec. We can do this with the following formula.

$$l_{pixel} = 206265 * (d_{pixel}/FL) \text{ arcsec}$$

Where d_{pixel} is the width or height of the pixel. The pixel scale (l_{pixel}) for our example setup based on a pixel of 6.8 microns or .0068mm is.

$$l_{pixel} = 206265 * (.0068/709) = 1.98 \text{ arcsec}$$

Since our pixels for this setup are square each pixel of our CCD chip with this optic system will represent 1.98 x 1.98 arcsec of the sky.

Now that we know the FOV or **plate scale** for our system, what can we do with it? We could do some **astrometry**. **Astrometry** is the study of the scientific measurement of the positions and motions of celestial bodies. Knowing the scale of the image allows you to measure the apparent angular distances of objects in the image. This is most easily done today with software programs.

Knowing the FOV before you image an object is helpful to determine if the object will fit the FOV or frame of the imaging chip. For example we want to image the full moon with our setup, will it fit in the FOV of the chip? We know that our FOV is 72.1 arcmins x 48.6 arcmins. The full moon is about _ a degree apparent size or 30 arcmins. So the moon would almost fill the frame in height and would only fill about half the frame in width. If we wanted to image the Andromeda Galaxy we would have a problem because its apparent size is 189.1 arcmins x 61.7 arcmins, this is much larger than the FOV of the chip.

Some common objects and their apparent sizes…

ITEM	DEGREES	ARCMIN	ARCSEC
1 hour of R.A	15	900	54000
Full moon	_	30	1800
Sun	_	30	1800
Jupiter	.009	.538	32.3
Saturn	.0053	.32	19.2
Andromeda Galaxy	3.15 x 1.03	189.1 x 61.7	11346 x 3702
Hercules Globular Cluster	.28	16.6	996
Great Orion Nebula	1.1	66	3960
Crab Nebula	.1 x .067	6 x 4	360 x 240

Use this information to find your way around the night sky. The next time you are out with a group and someone says look just north of Betelgeuse 2 degrees just think 4 full moons or 120 arcmins. Well that's it from the Newbie, keep your scope pointed up and clear skies.