The Astronomical League

A Federation of Astronomical Societies

Astro Note F2 – Astrophotography 2:

Projection Systems

Image Size:

The linear size, S, of an object at the focal plane of a system will depend on the object's angular size, θ, and the focal length of the system, F, according to:

$$S = \frac{\theta * F}{q}$$

where q = 57.3 if θ is in degrees,

= 3438 if θ is in minutes of arc,

= 206264 if θ is in seconds of arc

The units of S will be the same as the units of F.

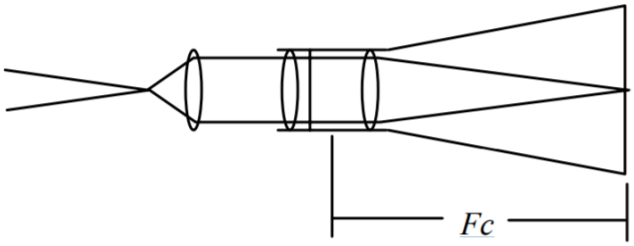
For small diameter objects such as planets or lunar features, long effective focal lengths are required to produce a reasonable image size.

Angular Size of Some Solar System Objects:

Sun	32.6’ (perihelion)	31.5’ (aphelion)
Moon	32.7’ (perigee)	28.5’(apogee)
Mercury	5” – 13”	
Venus	10” – 64”	
Mars	4” – 25”	
Jupiter	31” – 48”	
Saturn	15” – 21” (ball)	34” – 45” (rings)
Uranus	3” – 4”	
Neptune	2.5”	

The normal focal length of a telescope, Fo, can be increased by projection. Three common projection methods are used.

Afocal Projection:



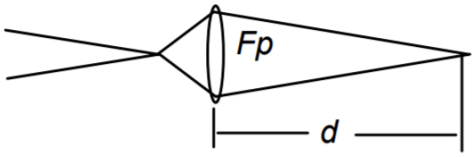
In the Afocal projection system, the telescope and eyepiece are focused on an object and the camera, with its lens in place and focused at infinity, is placed behind the eyepiece. Given the camera lens focal length, Fc, and telescope/eyepiece magnification, M, the system focal length is:

$$F = M * Fc$$

For best image formation, it is necessary that the eyepiece exit pupil have the same location as the camera entrance pupil. This is often impossible due to the mechanical design of the eyepiece and the camera.

Use of a cell phone mounted to take a picture through a telescope's eyepiece is Afocal Projection.

Positive or Eyepiece Projection:

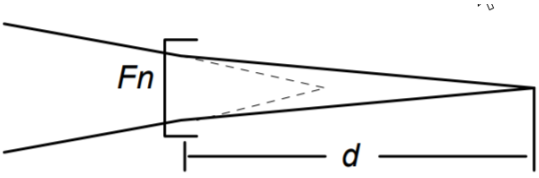


If a positive lens or eyepiece of focal length Fp is used to project the image a distance d, then magnification and resulting system focal length are found by:

$$M = \frac{d}{Fp} - 1 \qquad \text{magnification}$$

$$F = M * Fo$$

Negative or Barlow Projection:



Fn d If a negative lens such as a barlow lens of (negative) focal length Fn is used to project the image a distance d, then the magnification and resulting system focal length are found by:

$$M = \frac{d}{Fn} + 1 \qquad \text{magnification}$$

$$F = M * Fo$$