TELESCOPES

Question

What do astronomers gain by using telescopes? What do big telescopes that cost tens of millions of $'s have that smaller telescopes dont?

(there are at least 4 'gains' here)

TELESCOPES

- light gathering power
  - collecting area
  - ability to integrate
- resolution (magnification, field of view)
- travel opportunities

Refracting / reflecting Telescopes

wide field vs narrow field

f

Focal length of the telescope determines the plate scale:

$$\frac{d\theta}{dy} = \frac{1}{f}$$

angular separation on sky θ (radians)

linear separation in focal plane y

Figure 5.6 Largest Refracting Telescope Photograph of the Yerkes Observatory's 40-inch-diameter refractor. *(Yerkes Observatory)*

Focal length & magnification

Image size depends on focal length.

Q. Which produced the larger image, the lens with small or large focal length?

Long focal length ⇒ larger images
more magnification

Short focal length ⇒ smaller images
less magnification
larger field of view

Q. What sort of observations would we use a long focal-length telescope for?
short focal length?

The Yerkes Observatory 40" refractor is the largest refracting telescope (lenses) in the world.

It has high magnification, & is used for very accurate measures of position of stars — astrometry.

Q. The Yerkes refractor is small compared to modern telescopes

Why did astronomers stop making refracting telescopes (which use lenses) and start using reflecting optics instead (curved mirrors)

?

Reflecting telescopes are easier to make large because of mirror construction & support.

Q What is a disadvantage of the reflecting telescope design?

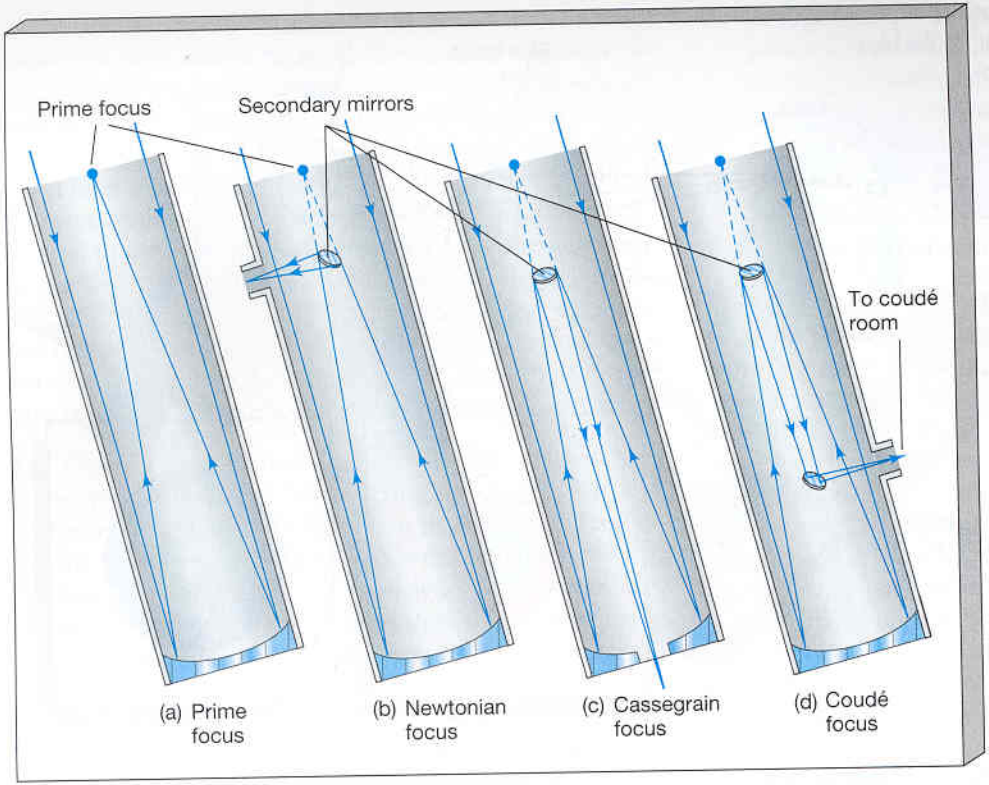
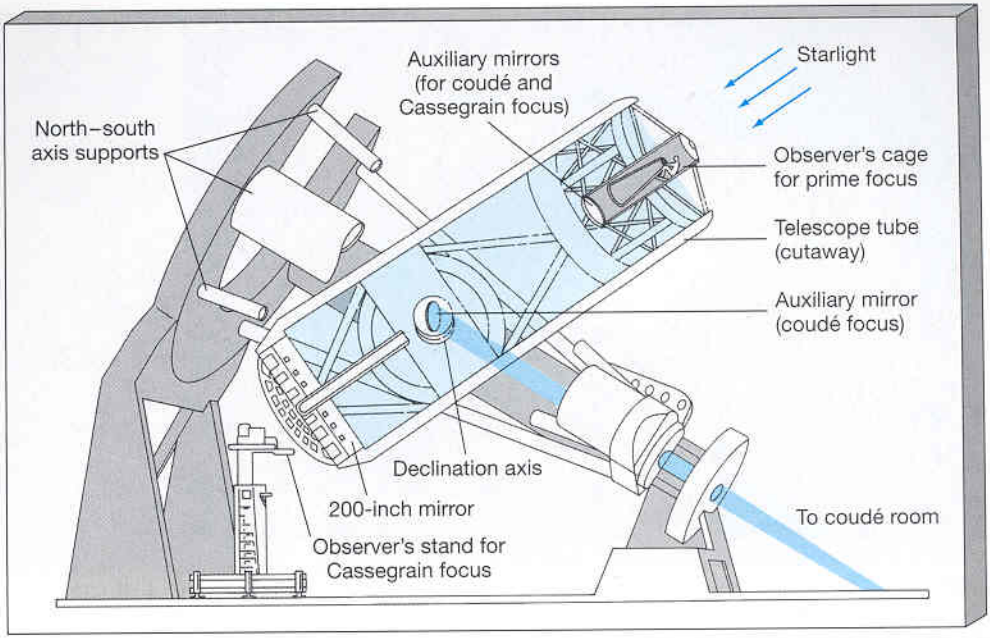
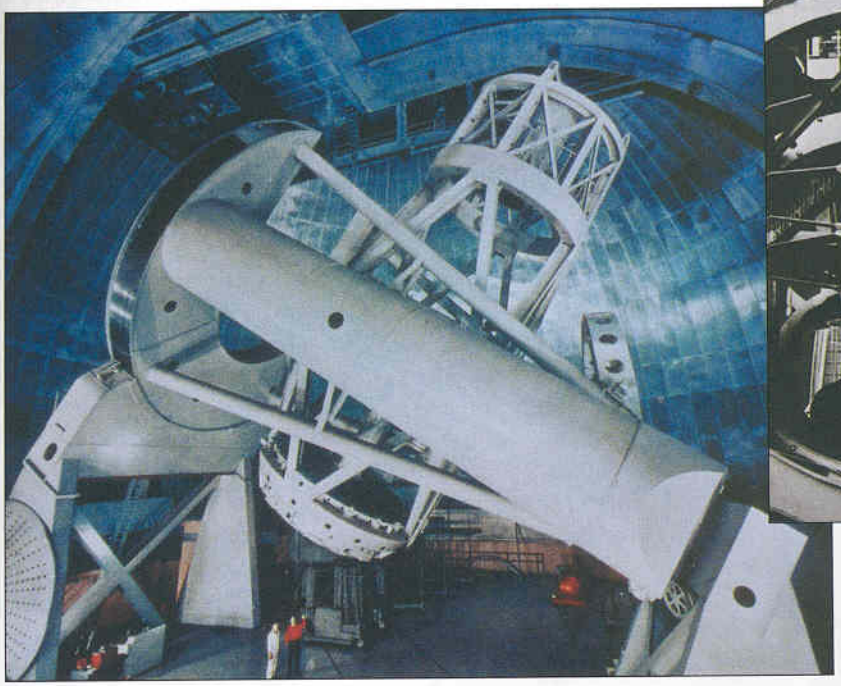


Figure 5.7 Reflecting Telescopes Four reflecting telescope designs: (a) prime focus, (b) Newtonian focus, (c) Cassegrain focus, and (d) coudé focus. Each uses a primary mirror at the bottom of the telescope to capture radiation, which is then directed along different paths for analysis. Note that the secondary mirrors shown in (c) and (d) are actually slightly diverging, so that they move the focus outside the telescope.

Figure 5.8 Palomar Telescope (a) Artist's illustration of the 200-inch-diameter Hale optical telescope on Mount Palomar in California. (b) A photograph of the telescope. (c) Astronomer Edwin Hubble in the observer's cage at the Hale prime focus. *(California Institute of Technology)*



(a)



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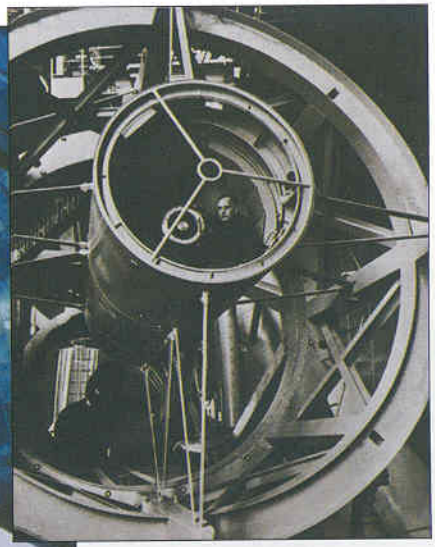
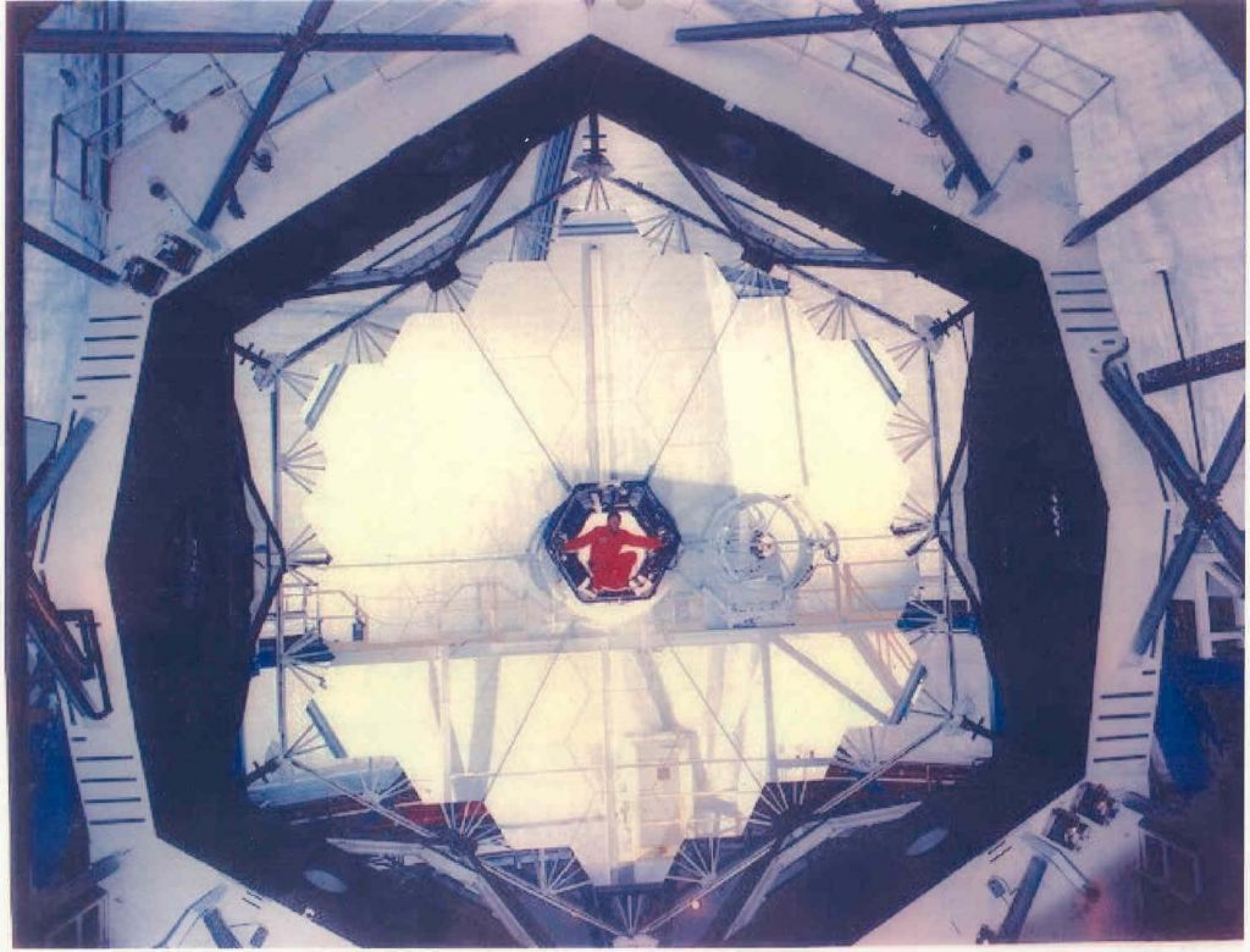


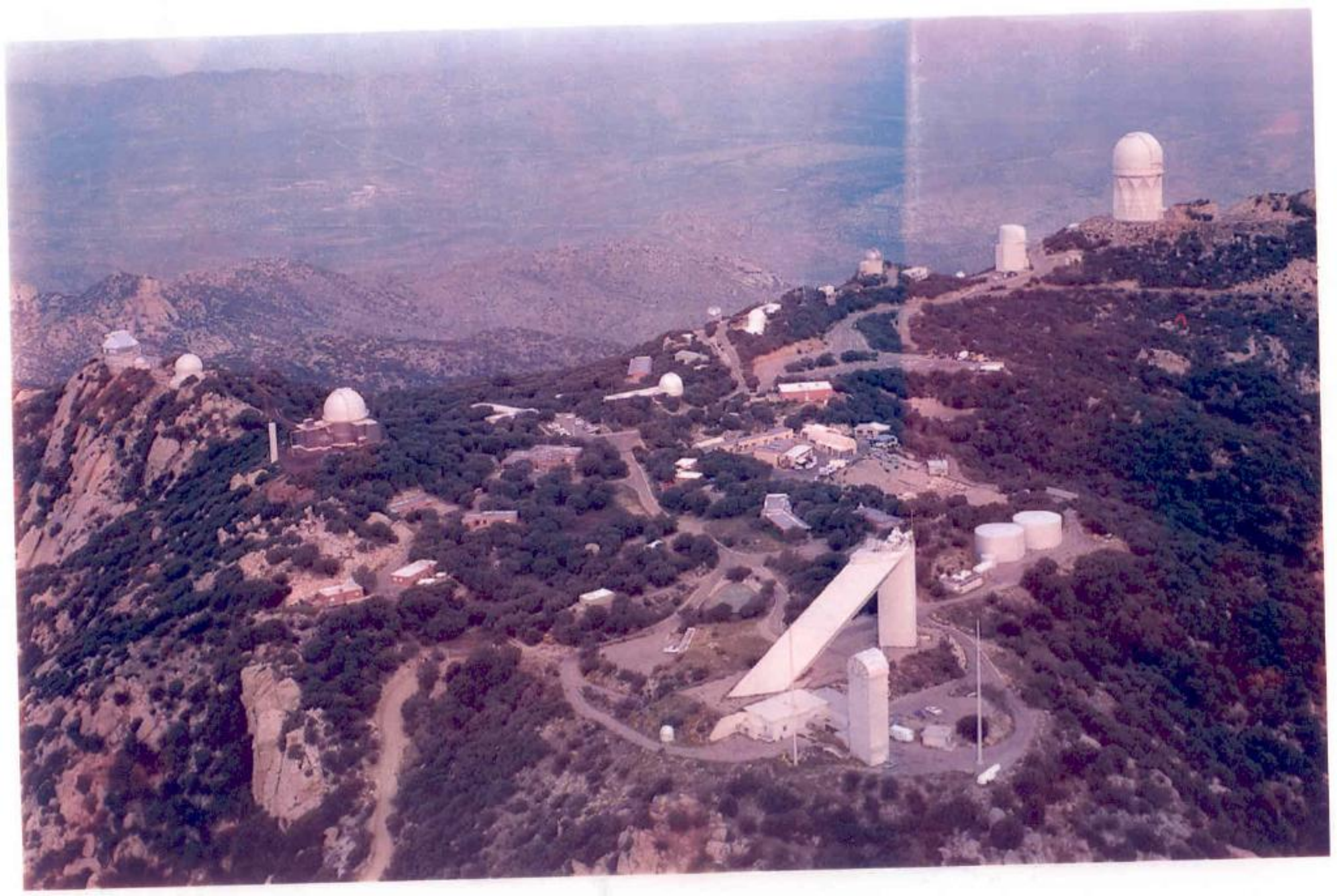
(c)



DAO 1.8 m

Q. Apart from increased field of view, what other practical advantages might a short focal length telescope have?

A. Size of dome: the cost of the dome is an important part of the overall construction cost.



The shorter the focal length, the larger the field of view

Biggest field possible with conventional design is about 1 degree
(4 full moons)

To survey the whole sky we would need to take more than 40,000 1 sq degree images

To get an even bigger field, use a combination refractor-reflector design
— Schmidt Telescope