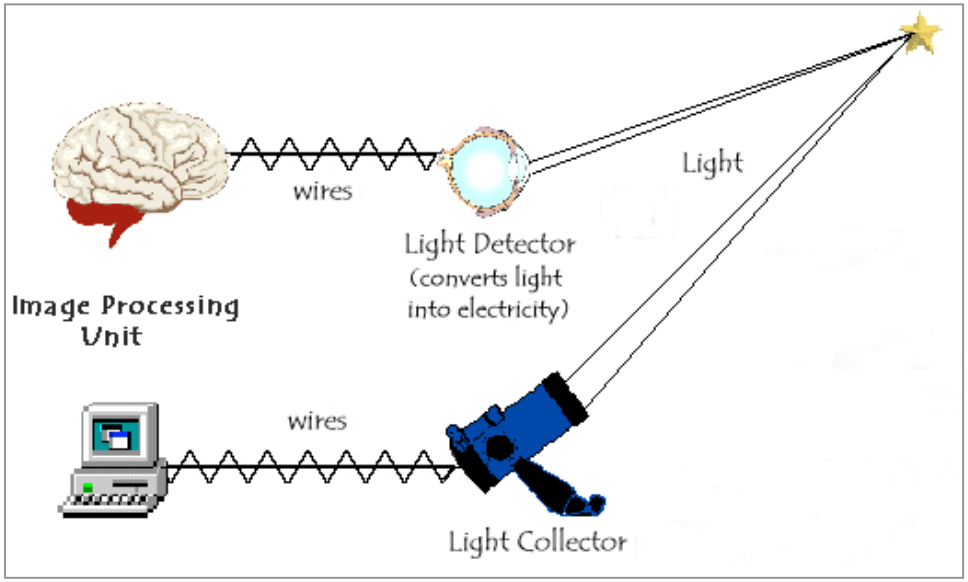
Telescopes

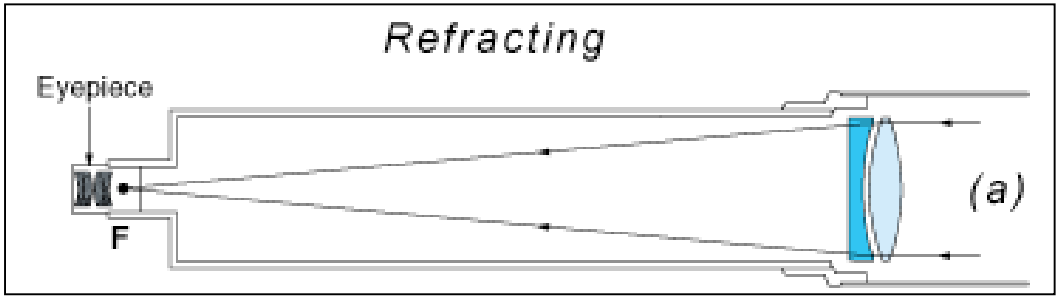


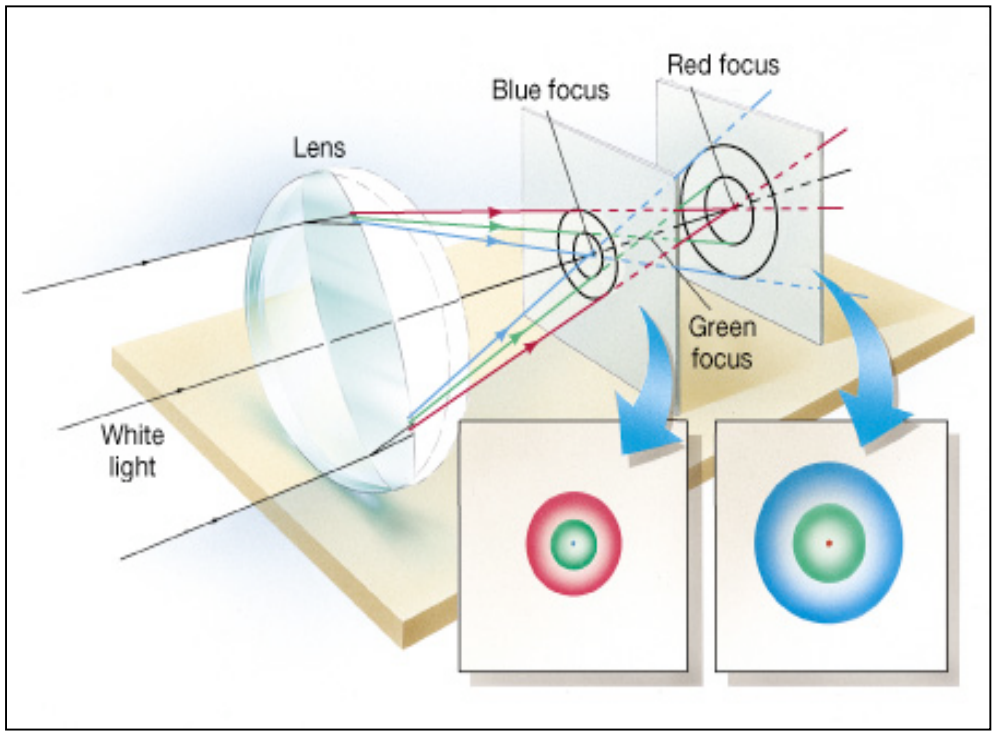
Telescopes only have a few jobs:

1) Point to a particular point on the sky
2) Collect lots of light and focus it onto a detector
3) Follow the apparent motion of the object

Refractor

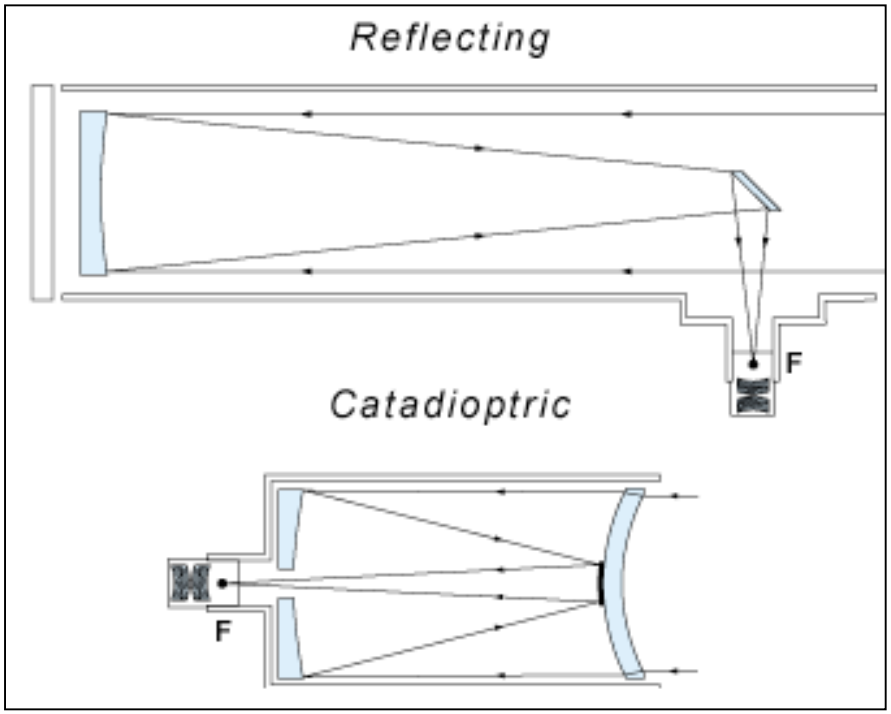
- Up to the early part of the 20th century the largest telescopes were `refractor' telescopes -- they used a lens and refraction to focus the gathered light





- Among the problems of using lenses, the most serious is chromatic aberration.
- Light of different wavelengths (colors) gets focused at different distances from the lens.

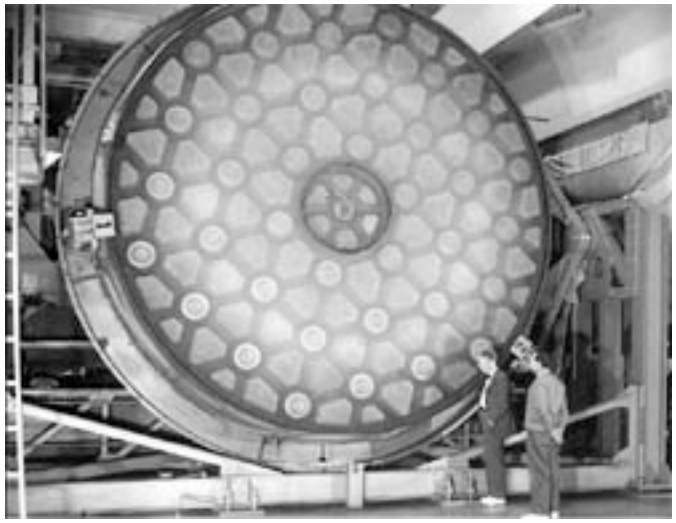
Reflecting Telescopes



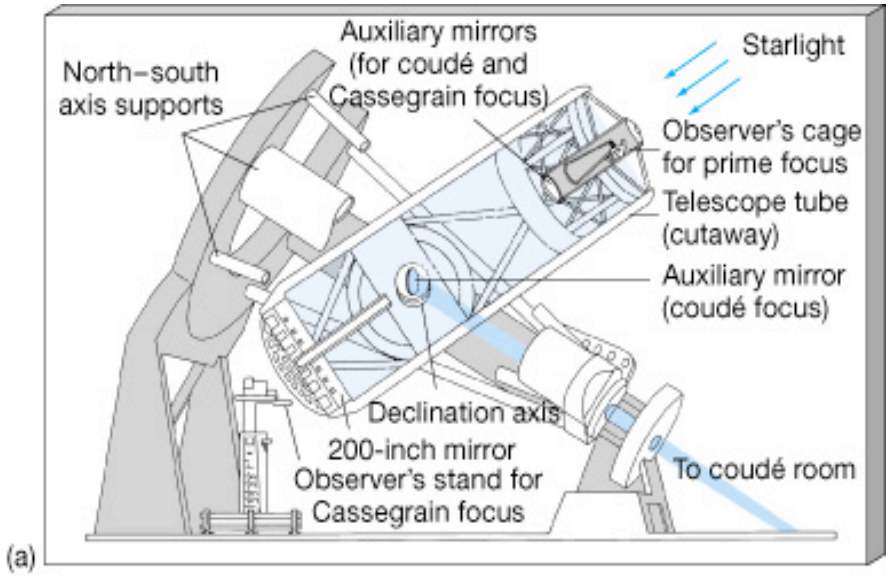
- Most large telescopes for the last 80 years use mirrors. Most common are a two-mirror designs.
- Instead of the secondary mirror, sometimes an instrument is installed at the `prime' focus.

Telescopes

- The size of a telescope is characterized by the diameter of its primary mirror.
- 1918 - 100” (2.5m) Mt Wilson Telescope
- 1958 - 200” (5m) Mt Palomar Telescope
- 1968 - Soviet 6m (doesn’t work very well)

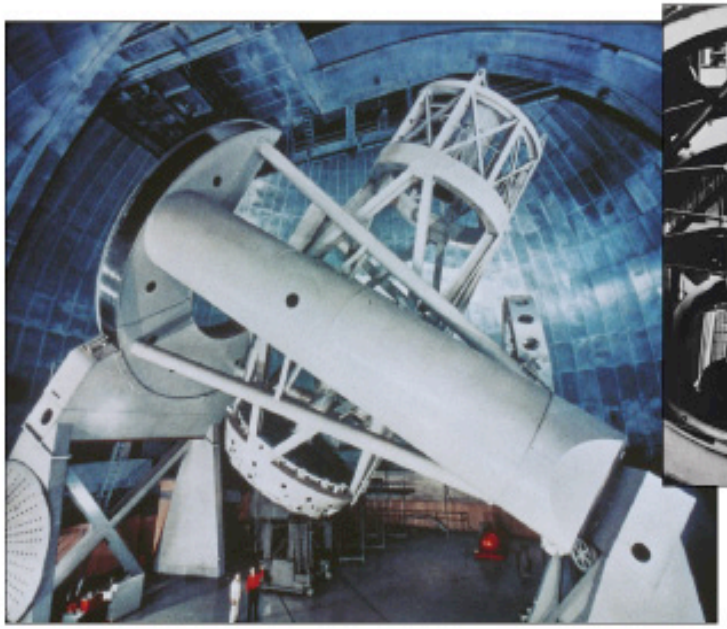


Palomar 200” (5m) mirror


Auxiliary mirrors
(for coudé and
Cassegrain focus)
Starlight
North–south
axis supports
Observer's cage
for prime focus
Telescope tube
(cutaway)
Auxiliary mirror
(coudé focus)
Declination axis
200-inch mirror
Observer's stand for
Cassegrain focus
To coudé room

(a)

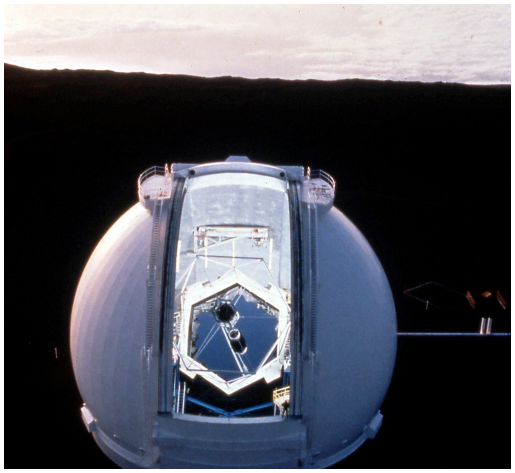
(b)

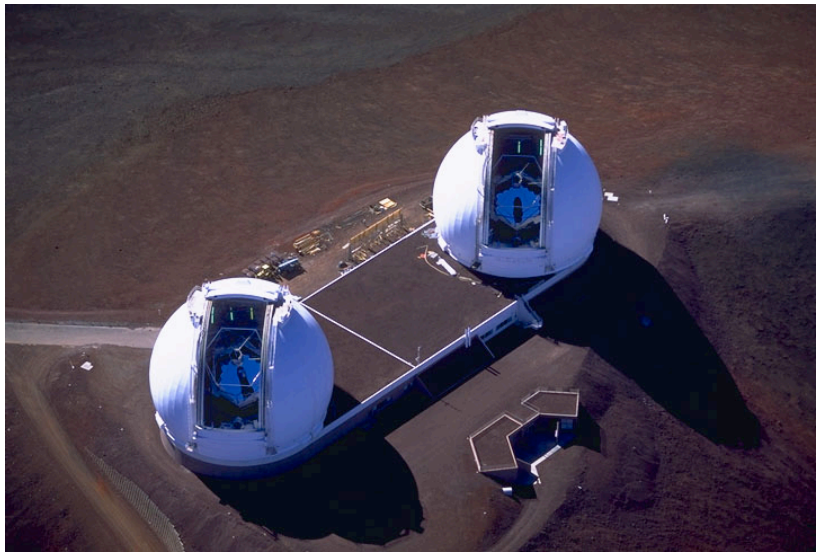


(c)

Keck Telescopes

- In 1993, the first real breakthrough in telescope size occurred with the Keck I 10m segmented-mirror telescope. UCSC professor Jerry Nelson was the person who had the idea and made it happen.





Telescopes

- The US operates optical national facilities in Chile, near Tucson, on Mauna Kea (Hawaii) and near Sunspot, NM.

Kitt Peak National Observatory
near Tucson

KPNO 4m + Steward 90”

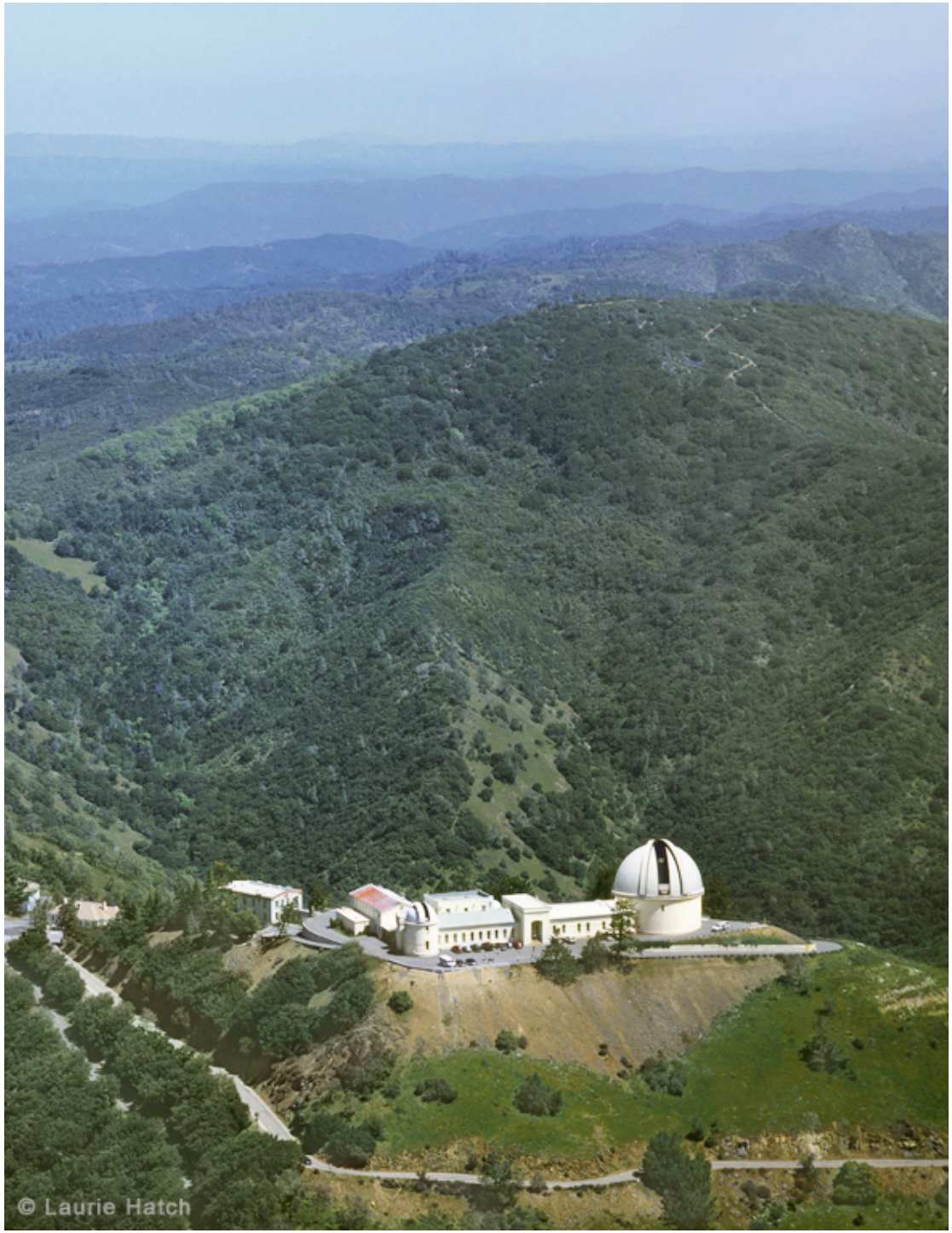
Cerro Tololo Interamerican Observatory, Chile

European Southern Obs

European Southern Observatory

ESO Very Large Telescope Array

Lick Observatory
on Mt Hamilton
near San Jose

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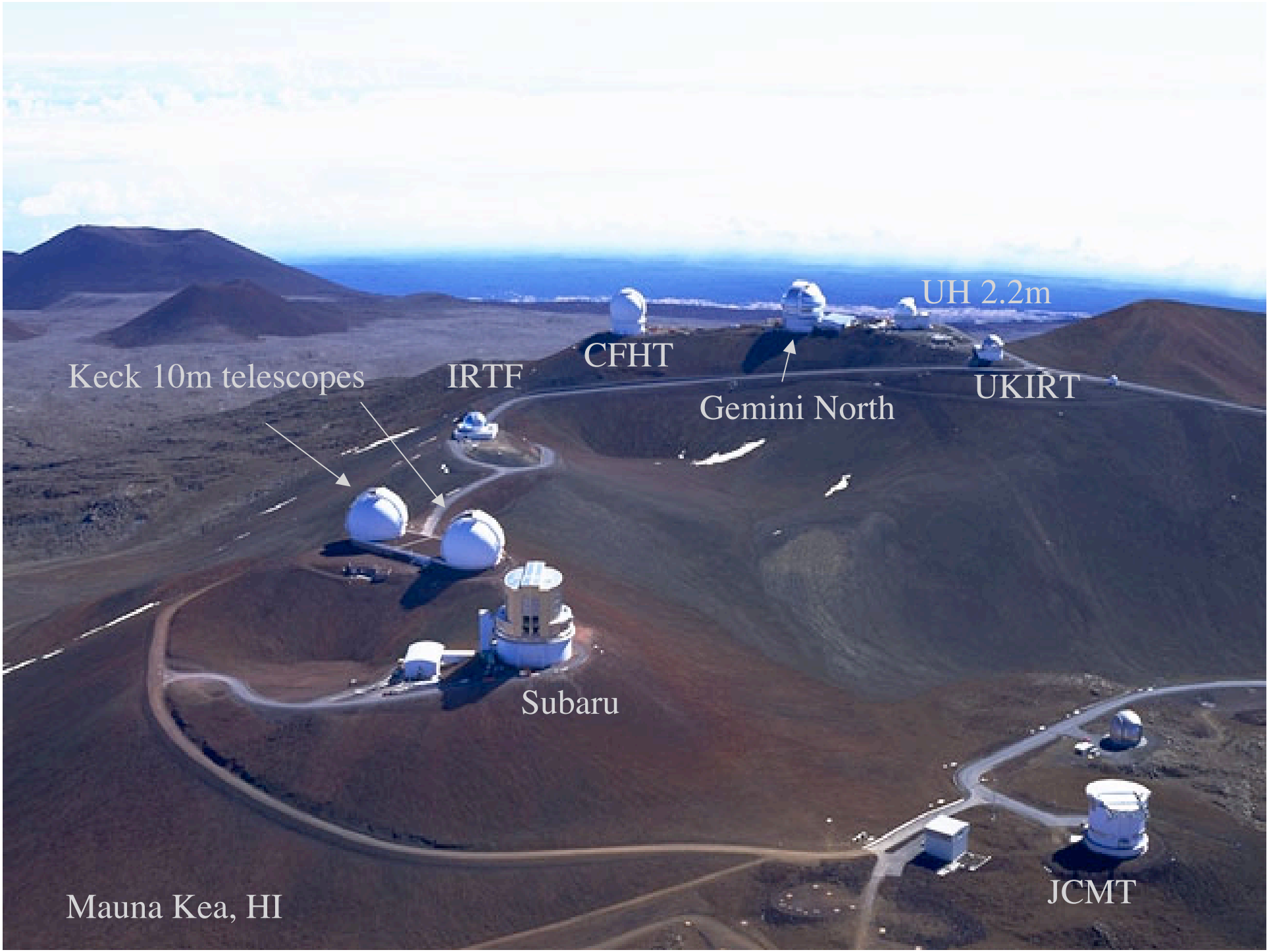
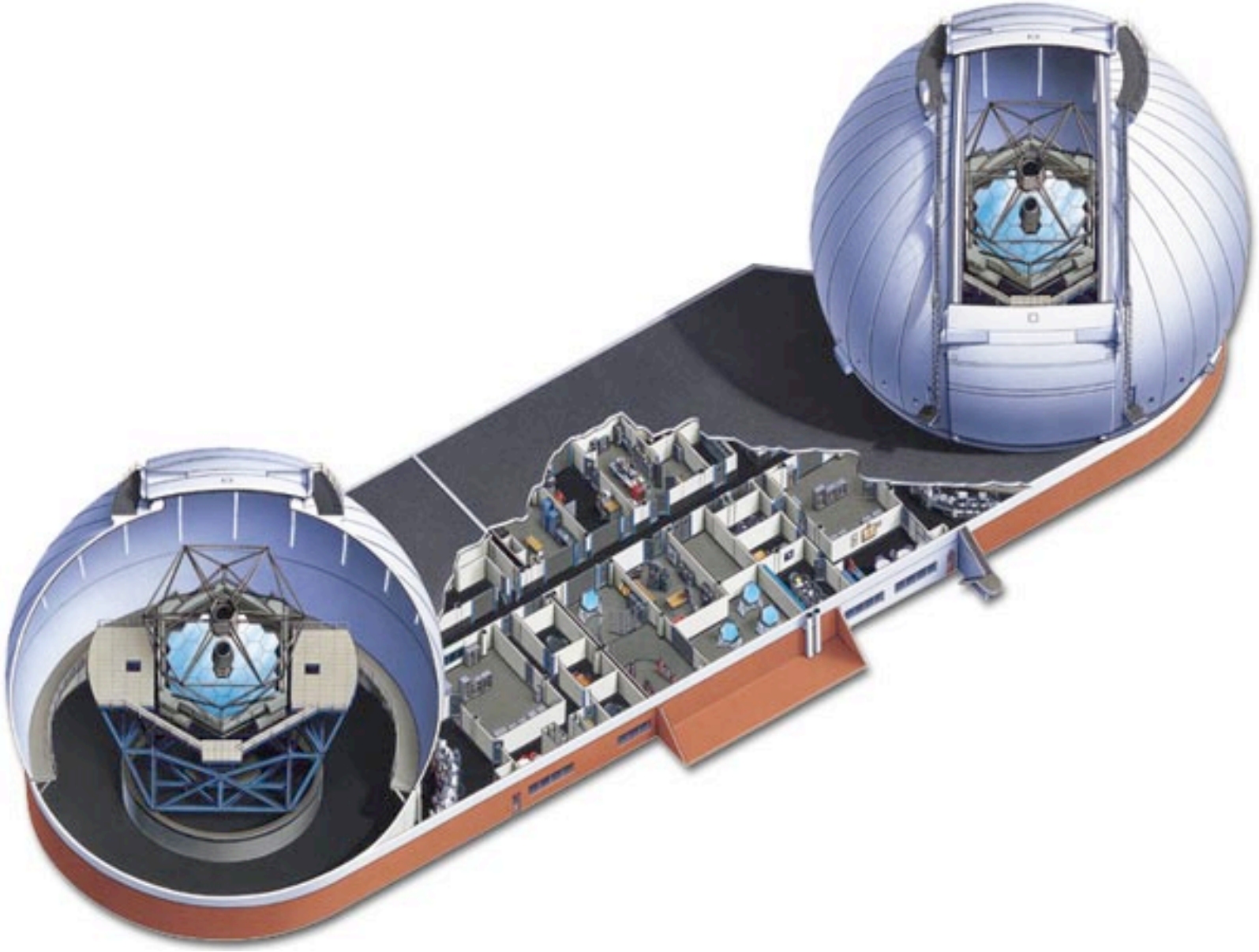

UH 2.2m
CFHT
Keck 10m telescopes
IRTF
Gemini North
UKIRT
Subaru
JCMT
Mauna Kea, HI

Keck Telescopes

- Completed in 1993 and 1996, the twin Keck 10m telescopes on top of Mauna Kea, HI were a huge jump in light collecting area. The facility is run by the University of California and Cal Tech.

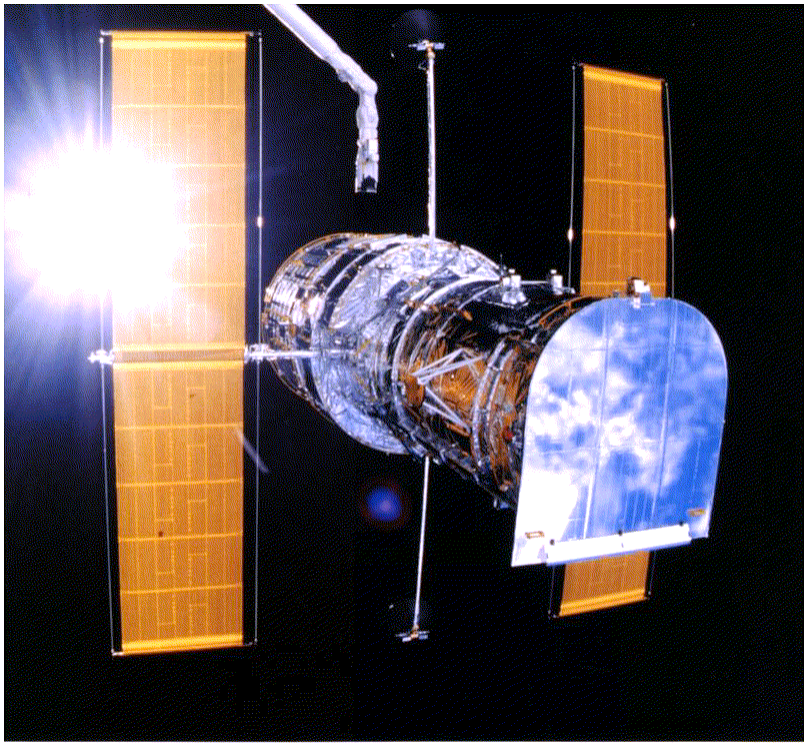
Keck Observatory

- The telescopes weight 300 tons each and are 8 stories tall
- The big increase in mirror size was made possible by a new technology- segmented mirrors. The Kecks have 36 segments each.

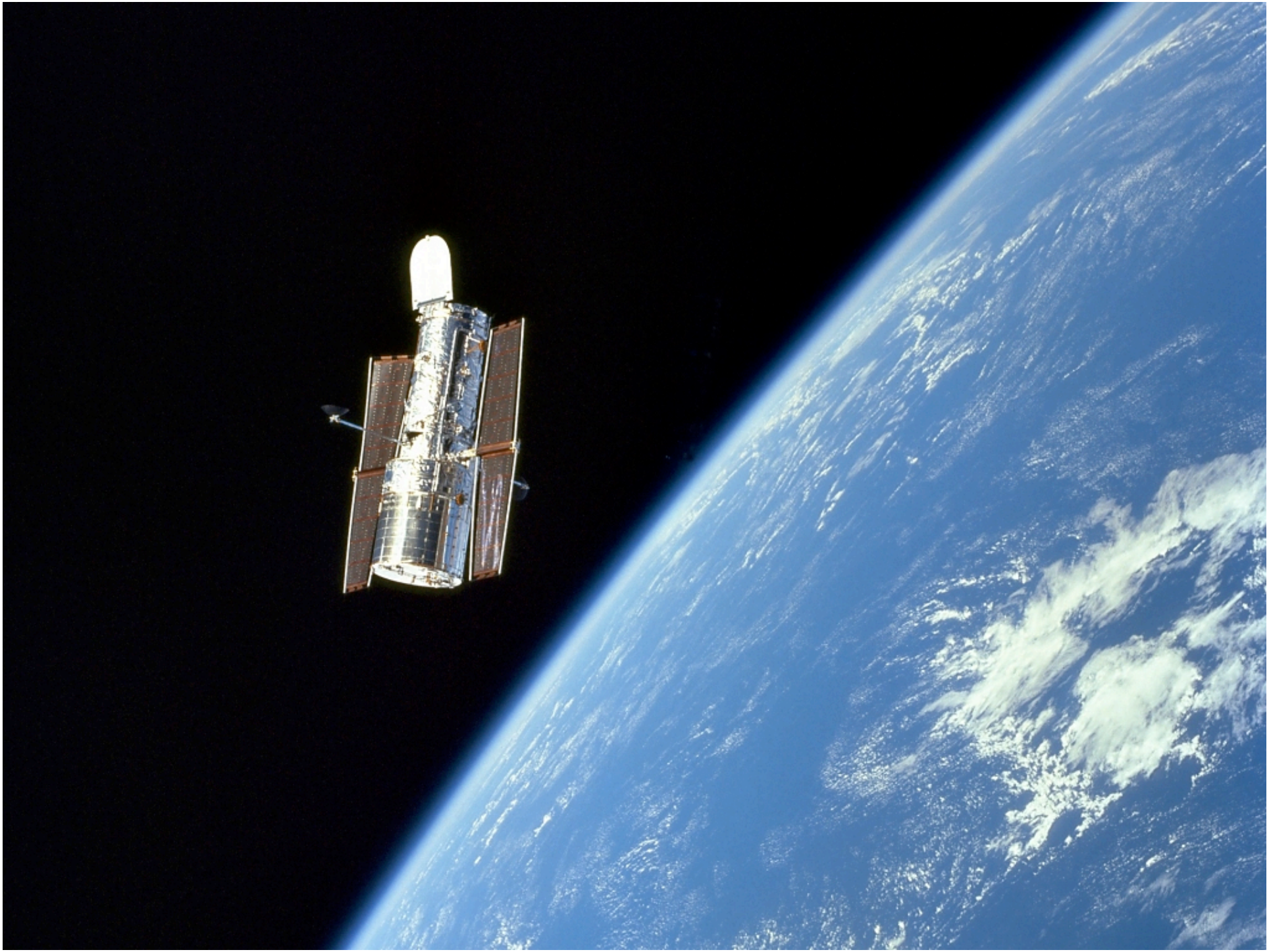


The Keck are connected by a light tunnel and can be used as an optical interferometer with the resolution of an 85m telescope.

Space Telescopes



- No distortion from the atmosphere
- No absorption or emission background from the atmosphere. Xray telescopes, far infrared telescopes, gamma-ray telescopes have to be in orbit.



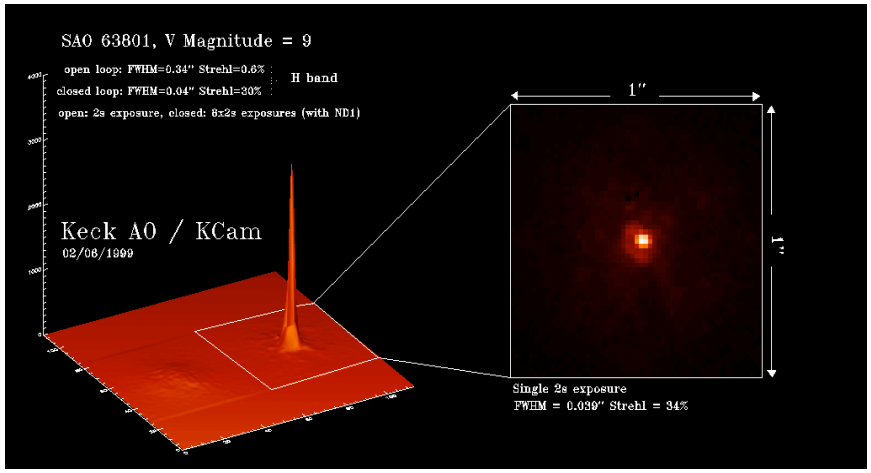
Radio Telescopes

- As we will talk about later, there are many different types of signals from the Universe.
- Radio telescopes are sensitive to long wavelength electro-magnetic radiation

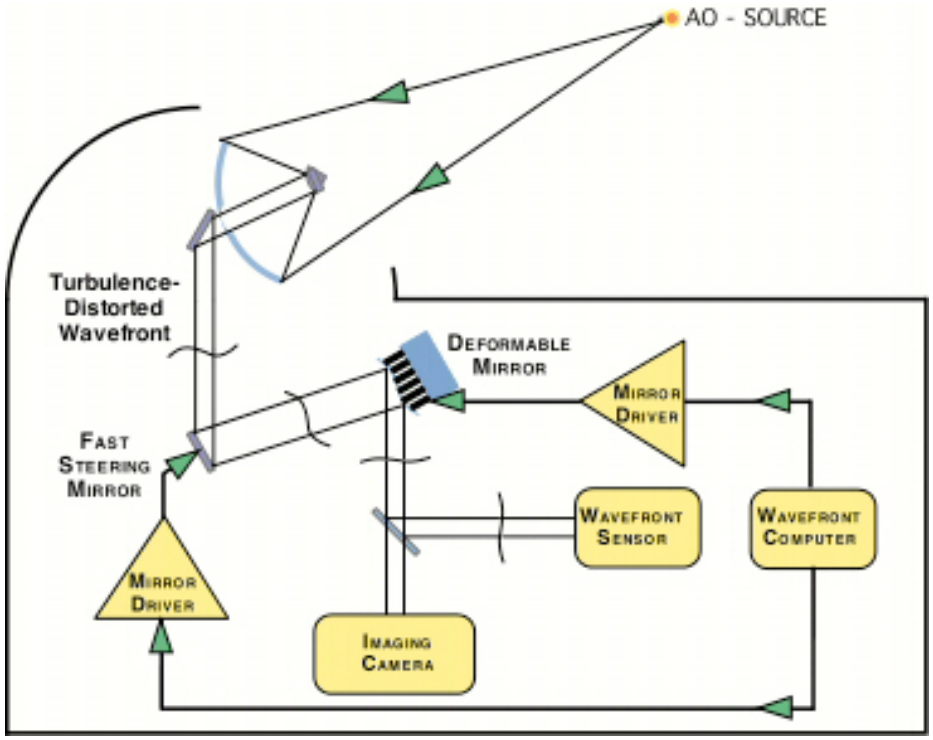
Light pollution

- Increasingly, ground-based sites are plagued by increases in the optical sky background.

The Future: Adaptive Optics



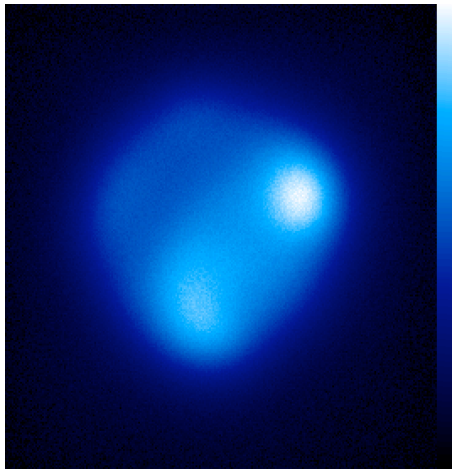
- High-spatial-resolution imaging is about to return to ground-based telescopes.
- `Adaptive optics' (AO) uses a deformable mirror and sophisticated sensing and allows for correction of the atmospheric distortions.
- Lick & Keck Observatories are leading the way here.



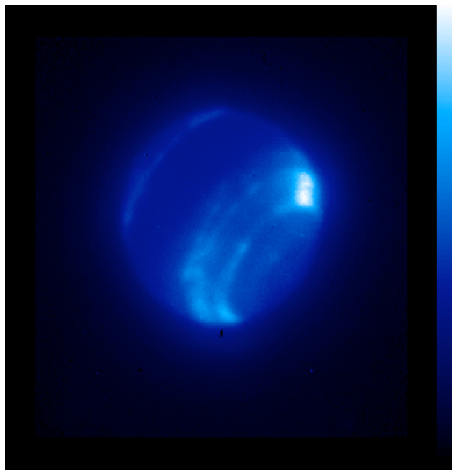
- AO is tricky, difficult stuff. It is amazing that it works.
- One problem is that you need a bright star to do the corrections

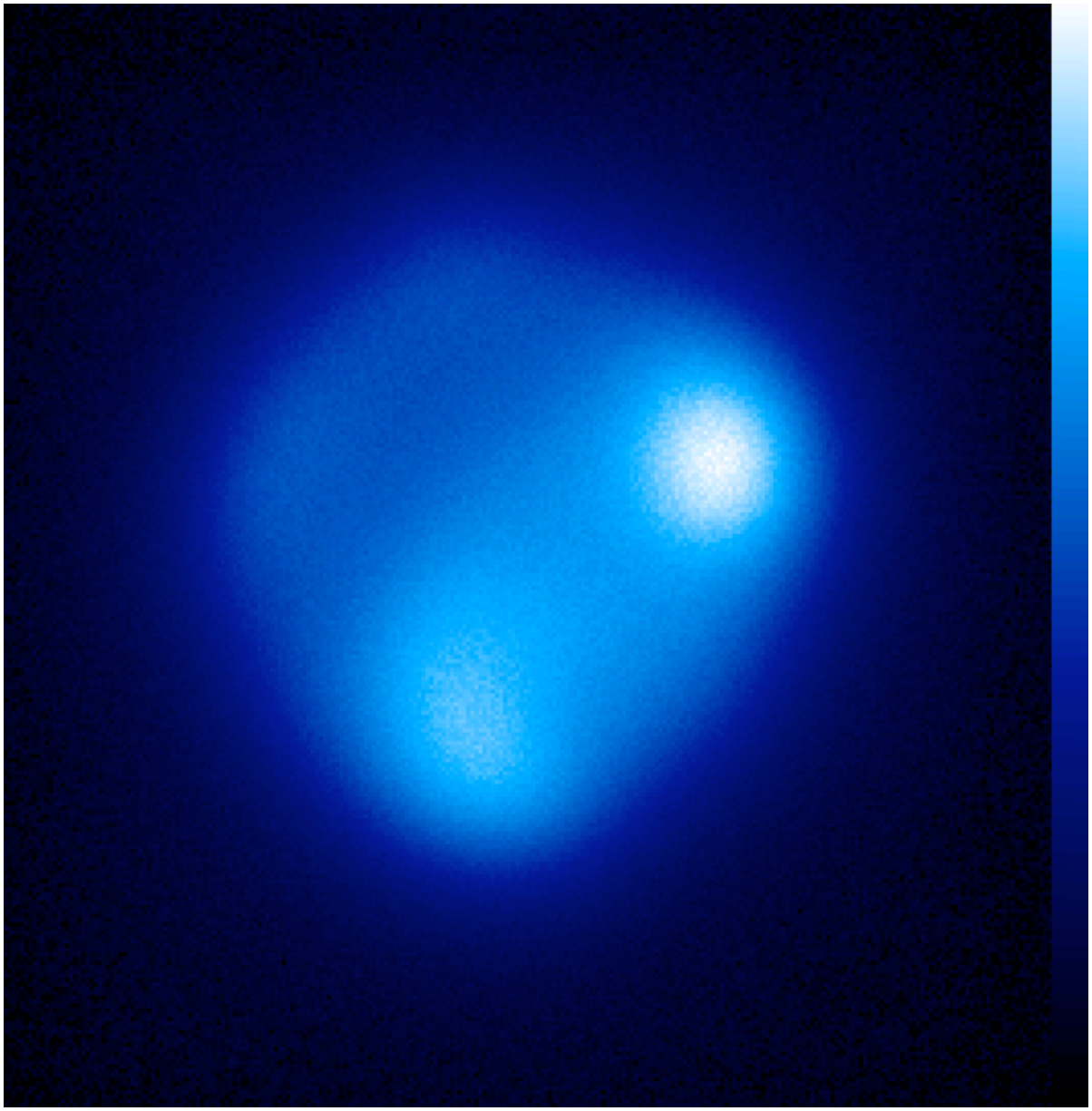
AO works

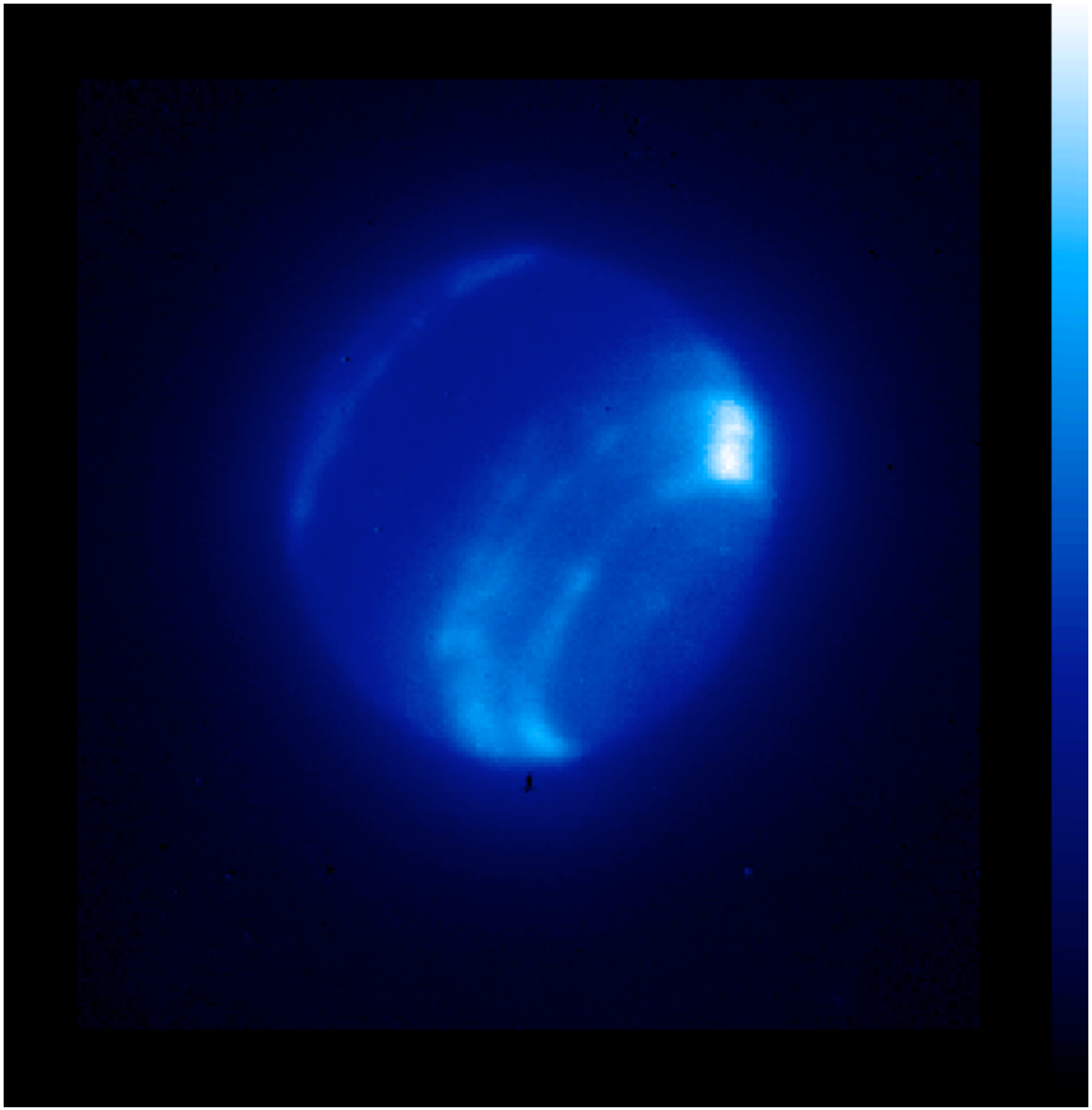
- AO loop off

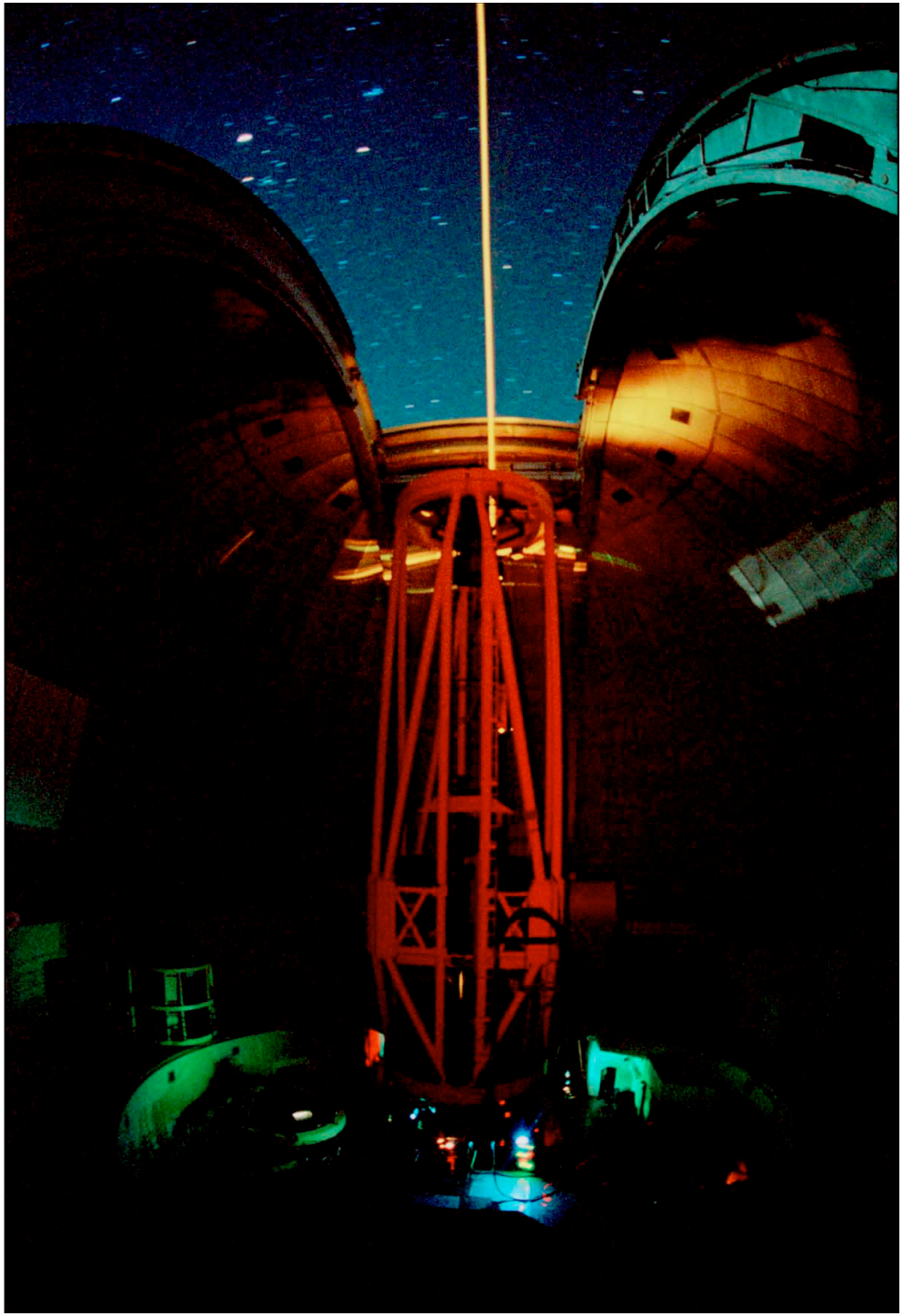


- AO loop on…









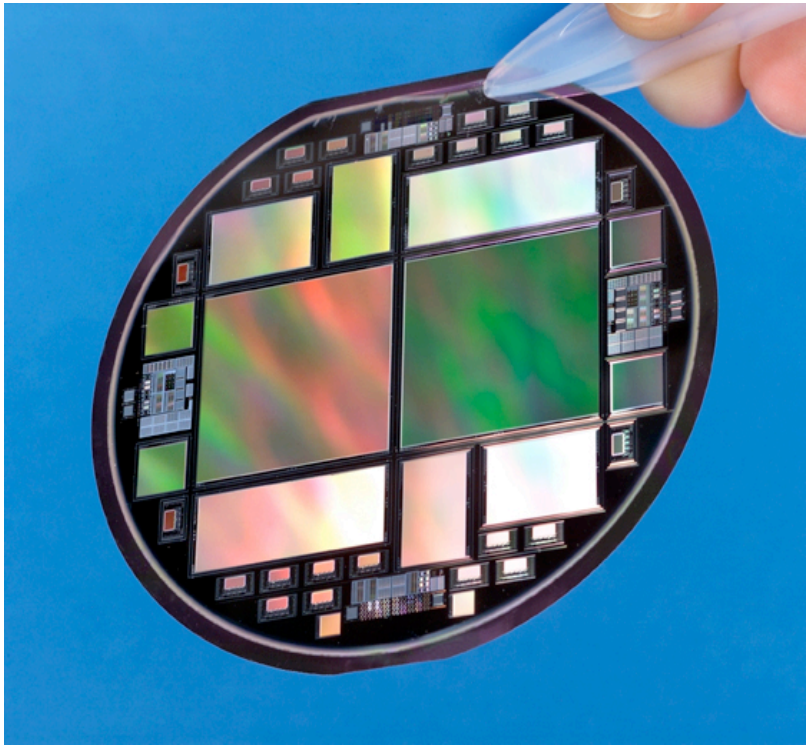
Lick 3m laser


© Laurie Hatch

Keck Laser

Detectors have come a long way

- In the late 1980's a new kind of detector replaced photographic plates.
- `Charge-coupled' detectors are a factor of more than 100 better in efficiency.



The Future II - ELTs