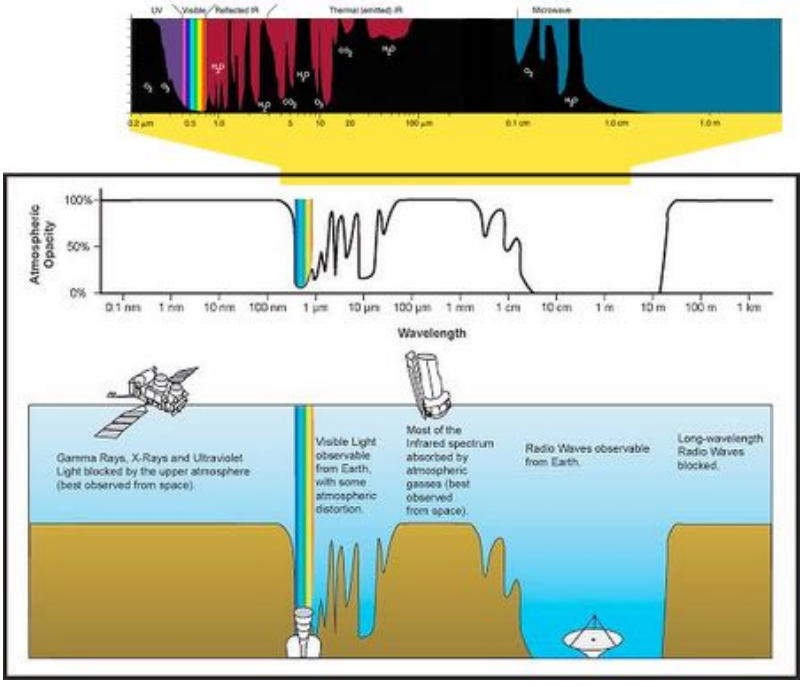
Reading: Chapter 6 + Special reading assignment posted on Astro 150 Canvas site
Homework: questions on special reading - answers due before recitation next Wednesday
Exam 1: Wednesday, Sept. 16 in recitation (i.e. live, via WebEx/Canvas)

Last time: **Spectroscopy and Spectral Lines**

- atoms and molecules produce / absorb specific colors
- 'line spectra' allow determination of elemental content of stars
- spectroscopy as the 'Rosetta Stone' of astronomy

Today: **The Telescope (and where to put it)**

- ultimate goal - every photon. The telescope as light bucket.
- size matters - bigger = more photons and better resolution
- different configurations for different purposes
- location, location, location



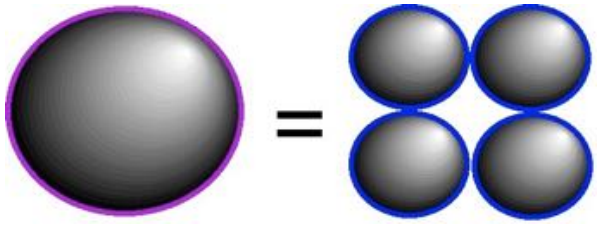
The Telescope:

The Primary Instrument in Astronomy

- **Purpose**
  - collect light
  - form image for examination with other instruments
- **Powers**
  1. light gathering power
  2. resolving power
  3. magnifying power

Light Gathering Power

- brightness = rate of energy received per unit area
- energy received = brightness x area of collector
  = B x πR^2



- **Bigger telescope**
  = brighter image
  = fainter objects detected

Resolving Power

- ability to distinguish fine details
- smallest angular size visible
- depends on aperture size *and* wavelength

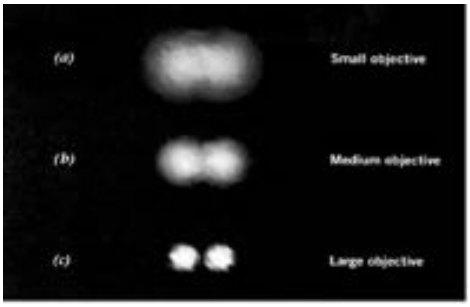
for visible light (λ=500 nm)

$$\theta_{\rm min} = \frac{12 \text{ arc seconds}}{\text{diameter [cm]}}$$

one degree: 1^{o} **= your thumb at arm's length**

one arc minute: $1'$ **= 1/60** ^{o} **= a face at 1 km**

one arc second: $1''$ **= 1/3600** ^{o} **= a face in Des Moines**

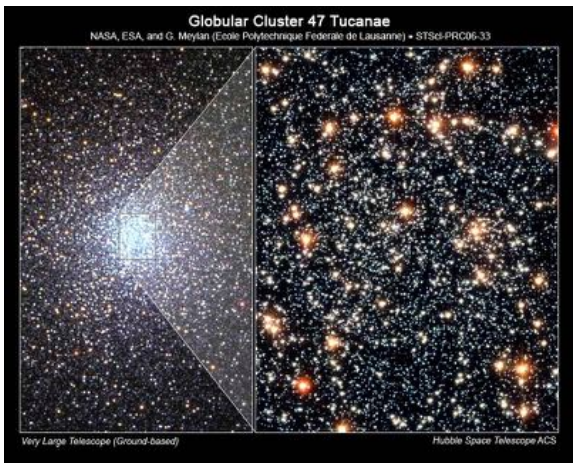


resolving power vs. magnification

resolved

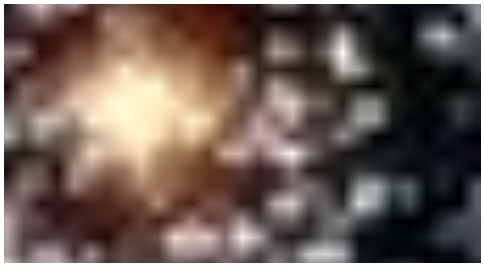
(over) magnified

resolving power vs. magnification



resolved

(over) magnified



Resolving Power: dependence on wavelength

$$\theta_{\text{min, arcsec}} = 2.3\times10^{5}\,\frac{\lambda}{\text{diameter}}$$

λ and diameter in same units

Examples:

Aperture	wavelength	$\theta_{minimum}$
0.5 cm	500 nm	0.4 arc min (eye at night)
20 cm	500 nm	0.6 arc sec (8 inch 'scope)
100 meters	21 cm	8 arc min (radio telescope)

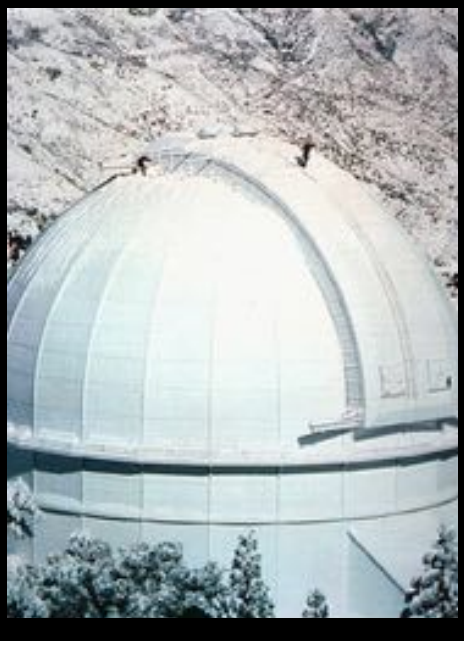
BUT: Earth's Atmosphere . . .

- degrades optical images
- rarely resolve better than 0.5" in optical without heroic efforts
- limits magnification to 20x for each cm aperture

Atmospheric Seeing (scintillation)

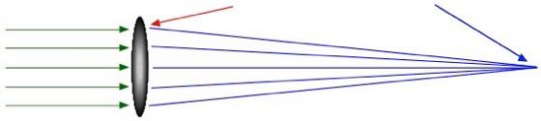
Mauna Kea, Hawaii

Mt. Wilson. CA



Types of (optical) telescopes

- **Refractors**: objective lens forms image



- lens supported at edge
- size limited to less than 1 meter (sagging)

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The Yerkes 40" Refractor

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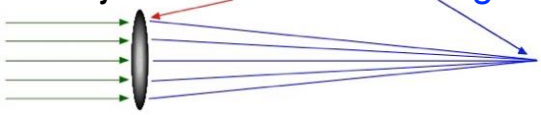
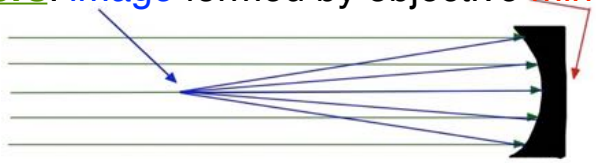


lens supported at edge

- size limited to less than 1 meter (sagging)

- **Reflectors**: image formed by objective mirror



- mirror supported from behind
- "unlimited" size, 10 meter Keck is biggest optical
- same design used in RADIO, X-ray, etc.

The GEMINI 8-meter Reflecting Telescope(s)

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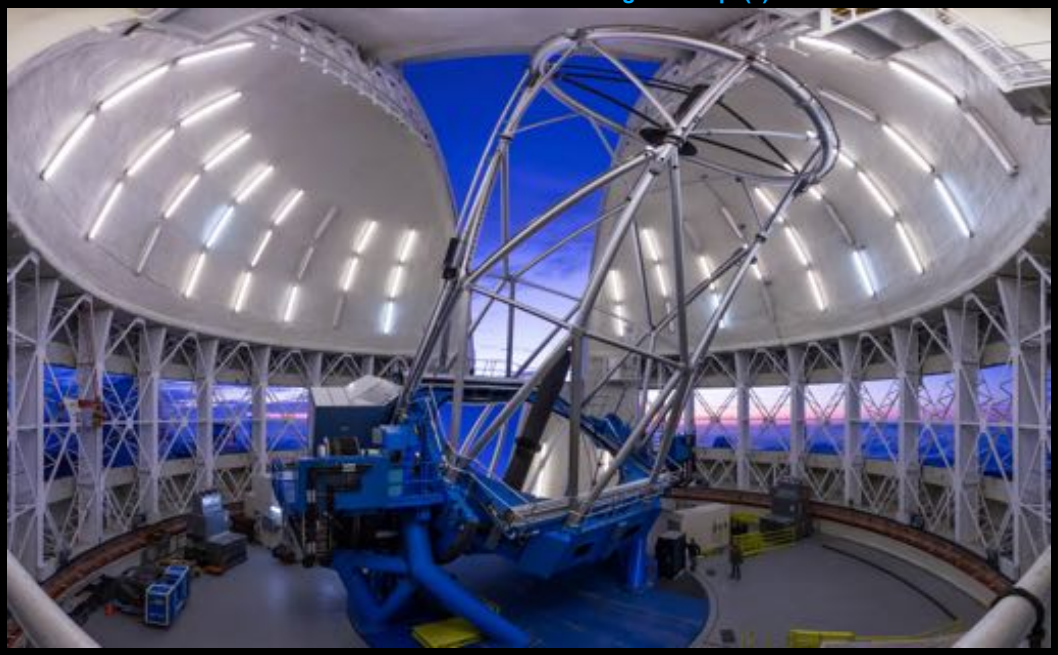

VERITAS (gamma ray / optical) Tucson, AZ

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Jodrell Bank Telescope (radio) - England

Jodrell Bank
Telescope (radio)
England


Arecibo Observatory (radio)
in Puerto Rico

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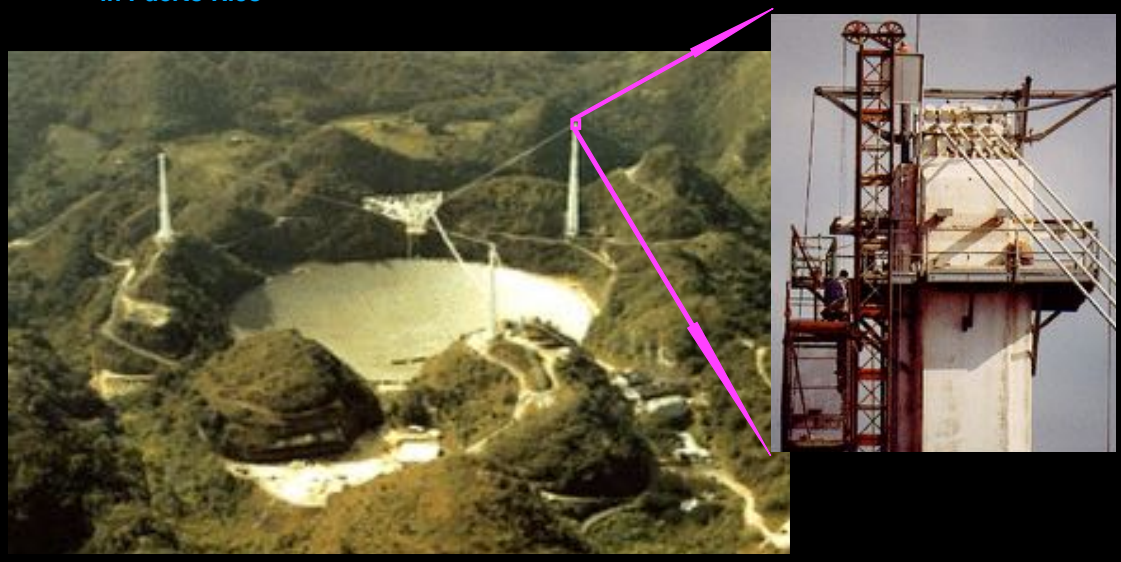
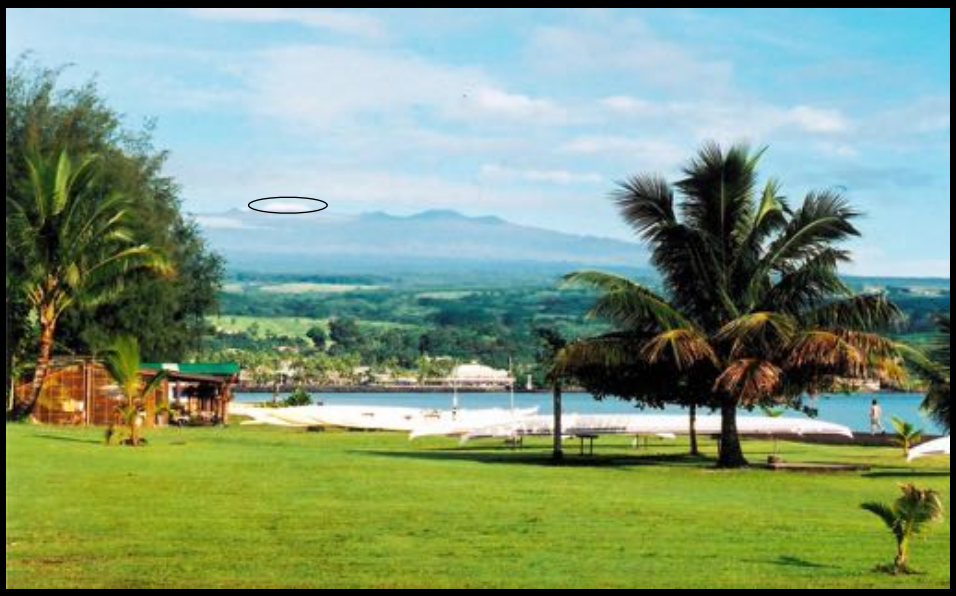
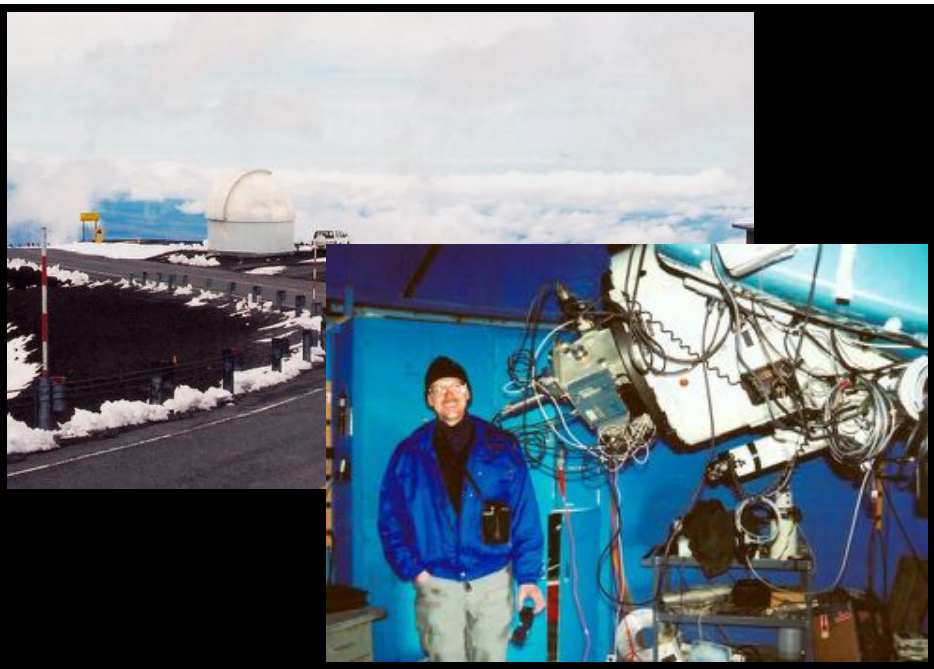
in Puerto Rico



Arecibo Observatory (radio)
in Puerto Rico

Mauna Kea Observatory, Hawaii





Pic du Midi, France