Lecture 09 – 12 February 2009

- **SCIENCE TOPICS**:
  The Doppler Effect
  Telescopes
- **READING**
  Ch 2, Sec 2.7
  Ch 3, Sec 3.1 and 3.2
- **PRACTICE**
  p.94 Review: 1-4, 6
  p.94-95 Self-Test: 1,2,9,13
  p.95 Problems: 3, 9

HWK 3: already out
due next tuesday, 23:59

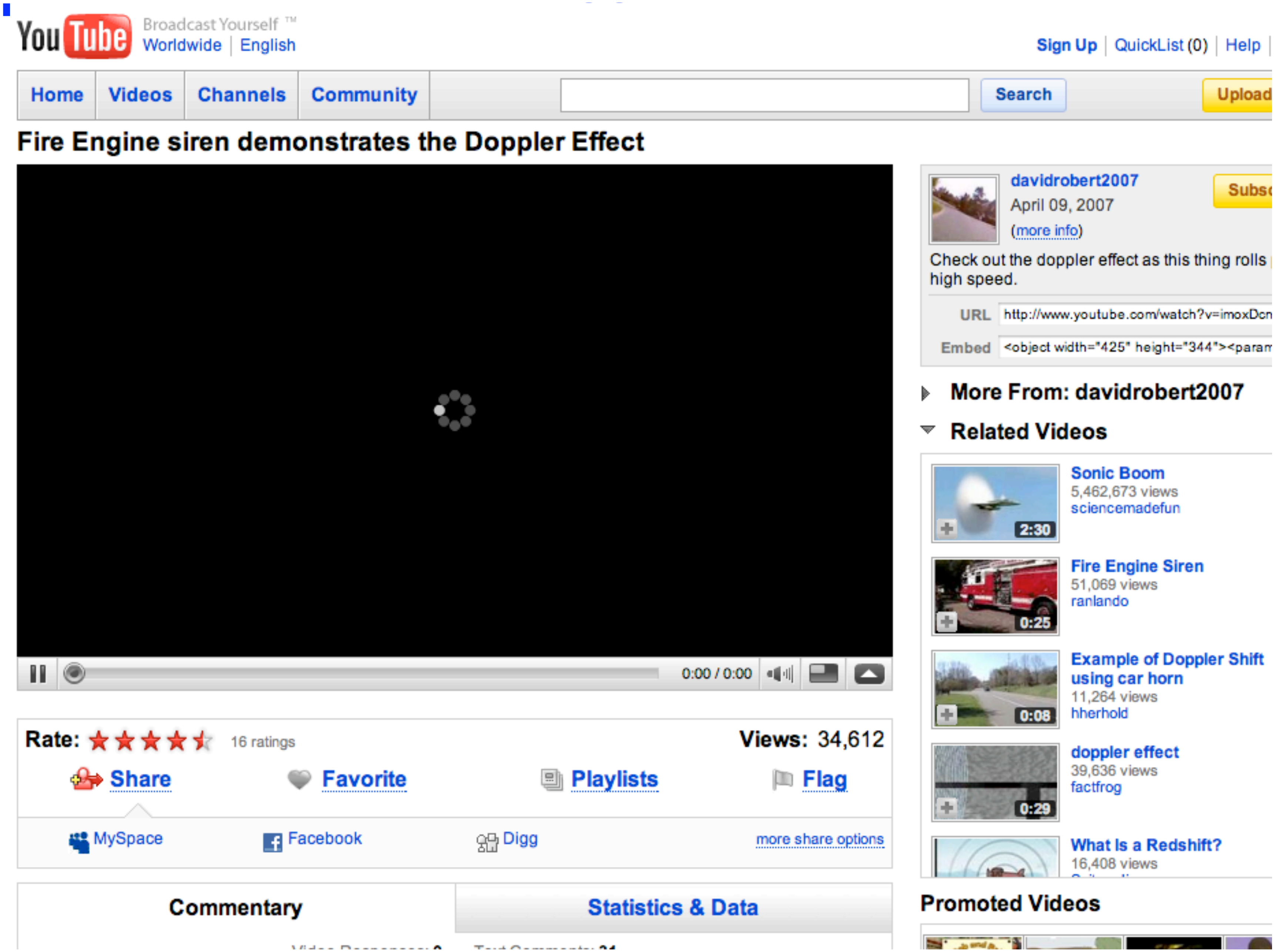
COMPREHENSION 01:
Thursday, 19 Feb 2009

About Comprehension I

- ***When and Where***: Thursday, 19 February 2009 in this classroom, during regular class time
- ***Format and Time Limit:***
  A passage of unseen text relevant to the course.
  20 multiple choice questions; 1 mark per question
- ***What to Bring:***
  - **your PSU ID card**
  - #2 pencils and eraser
  - a calculator
- ***Other Rules and Regulations:***
  - closed book, closed notes
  - work on your own
  - items other than the above out of sight (*especially* cellphones)

The Doppler Effect

- The Doppler effect, (a.k.a. the Doppler Shift) is a very important concept in physics and astronomy. It allows us to tell how fast objects are moving in space.
- On Earth, we are most used to the Doppler effect when dealing with *sound waves*. Think of an ambulance or a race car or a fire engine...



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Fire Engine siren demonstrates the Doppler Effect
0:00 / 0:00
davidrobert2007
April 09, 2007
(more info)
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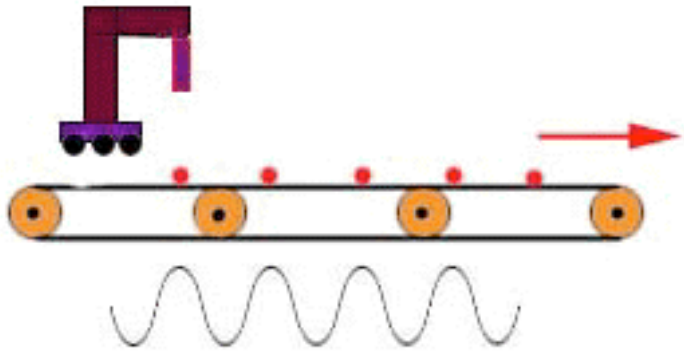
The Doppler Effect

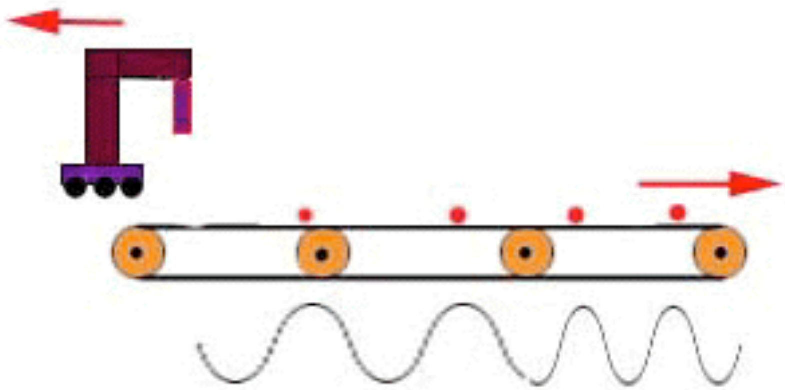
- The Doppler effect, is the shift in *wavelength* and thus *frequency* of a wave, most commonly due to the source of the waves *moving with respect to the observer.*

The Doppler Effect

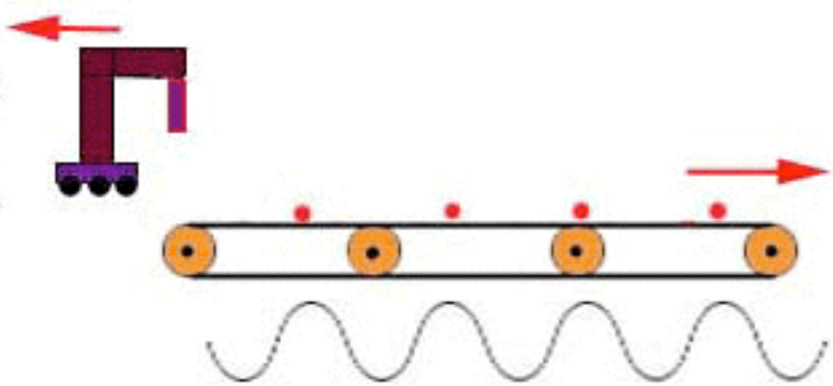
Machine is fixed. Drops candy at reqular intervals, i.e. equal spacings



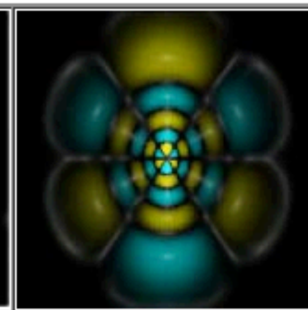
Machine starts to move in directionoposite to the conveyor belt. The candy intervals start to get stretched out.



After a while all the intervals are stretched out and so is the wave.



Physlets®



Welcome to the Physlets resource page. Physlets, **Phys**ics App**lets**, are small flexible Java applets designed for science education. You do not need to become a Java expert in order to use Physlets. The links on the right contain tutorials, download instructions, and example problems to help you use Physlets in your teaching.

Physlets have been tested on Mac OS X and Ubuntu.

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see the *Physlet Quantum Physics* book (over 200 exercises)

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For an introduction to scripting see the *Physlets* book. This book is now available in Spanish!

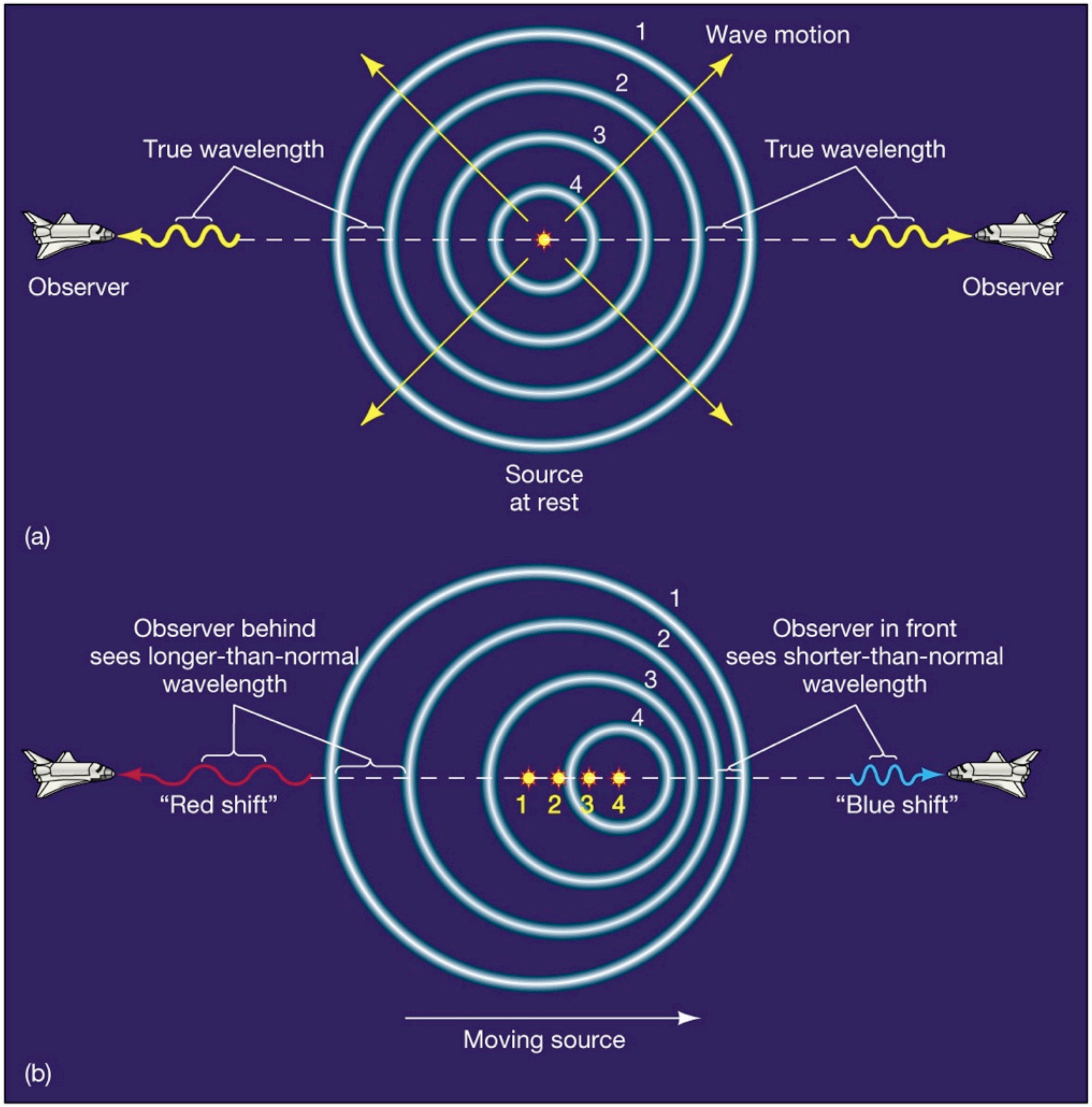
For a discussion of how to use Physlets with Just-in-Time Teaching see the *JiTT* book.

To learn more about Physlets you may want to:

About
Problems
Tutorial
Java 1.1

The Doppler Effect

- The Doppler effect, is the shift in *wavelength* and thus *frequency* of a wave, most commonly due to the source of the waves *moving with respect to the* observer.
- The Doppler effect is heard for sound waves and seen for electromagnetic (EM) waves e.g. light.

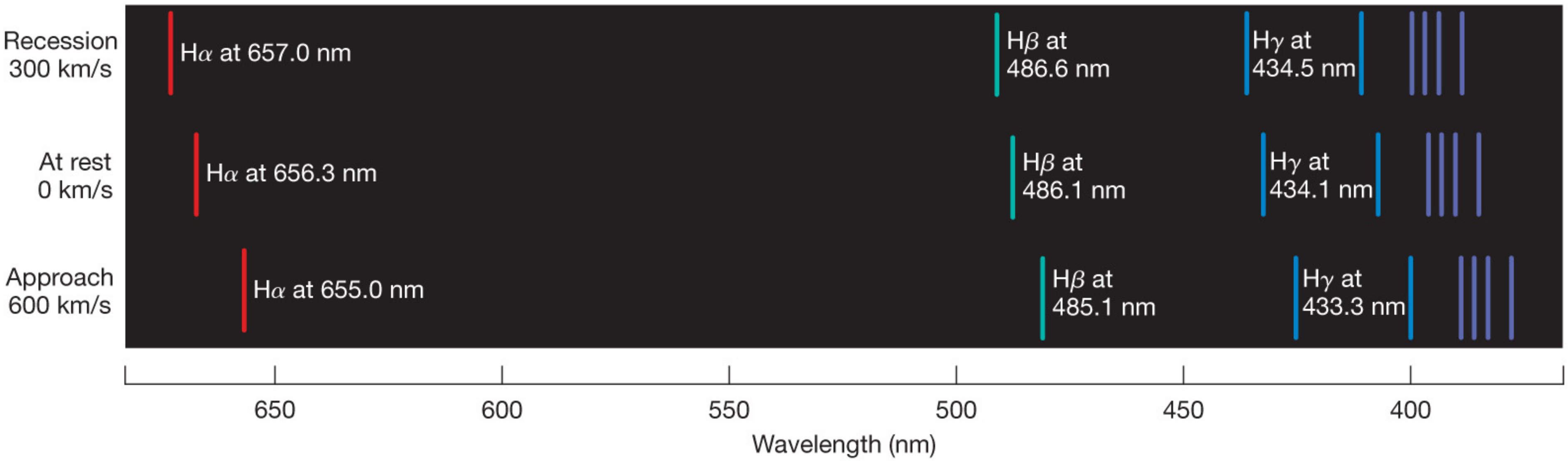


The Doppler Effect

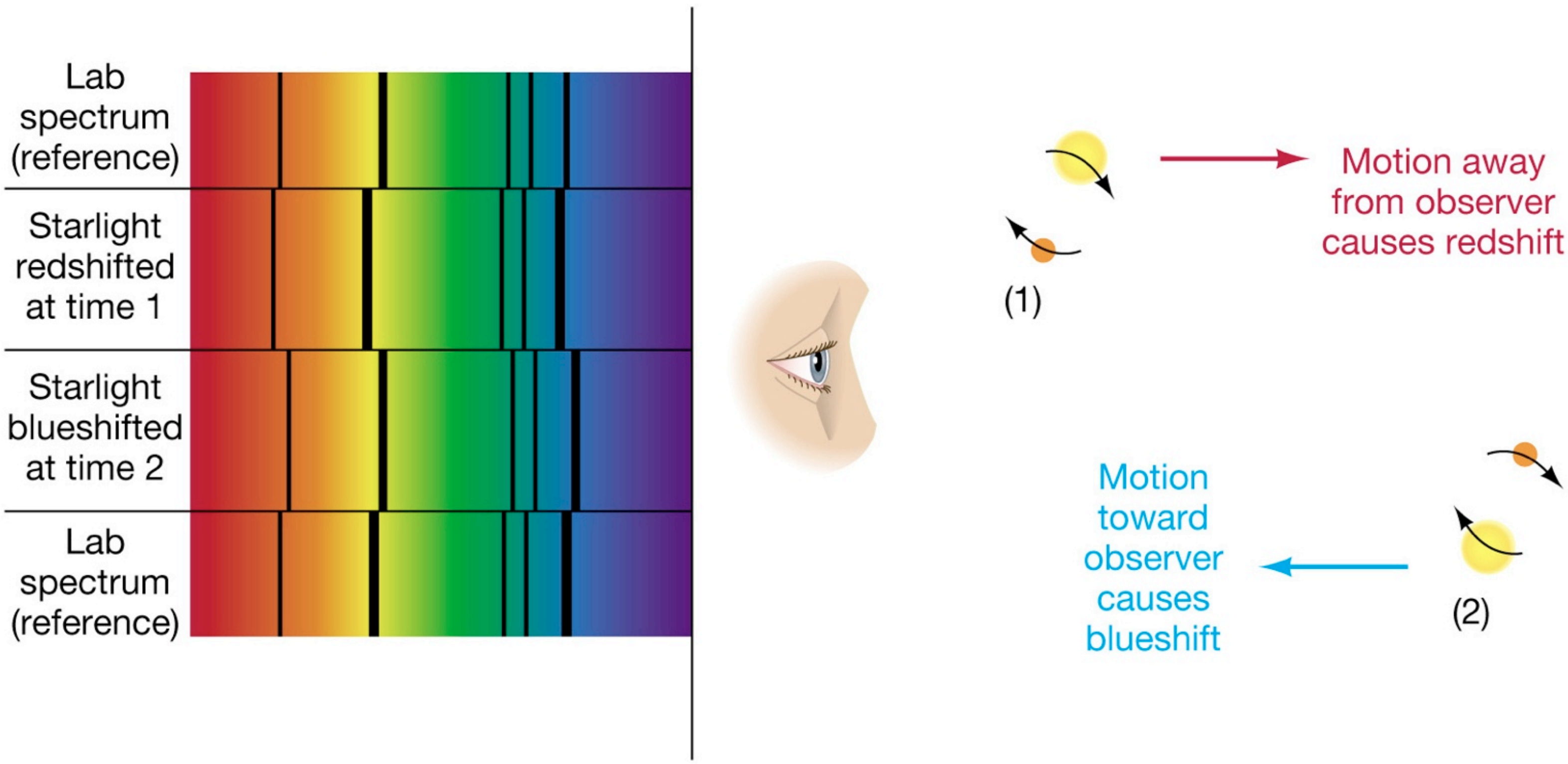
The Doppler Effect

- The Doppler effect, is the shift in *wavelength* and thus *frequency* of a wave, most commonly due to the source of the waves *moving with respect to the* observer.
- The Doppler effect is heard for sound waves and seen for electromagnetic (EM) waves e.g. light.
- With light waves, when objects are moving **away** from us, the wavelength *increases*, the frequency *decreases* and hence you see a shift to the **red** part of the spectrum, a "***redshift***".

Consequences of the Doppler Effect: Redshifts and Blueshifts



Applications of the Doppler Effect: Binary Star Motion



Applications of the Doppler Effect: Exoplanets

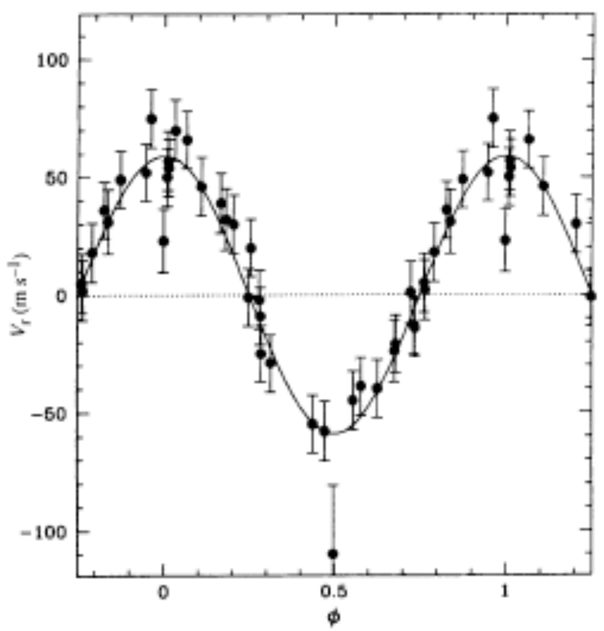
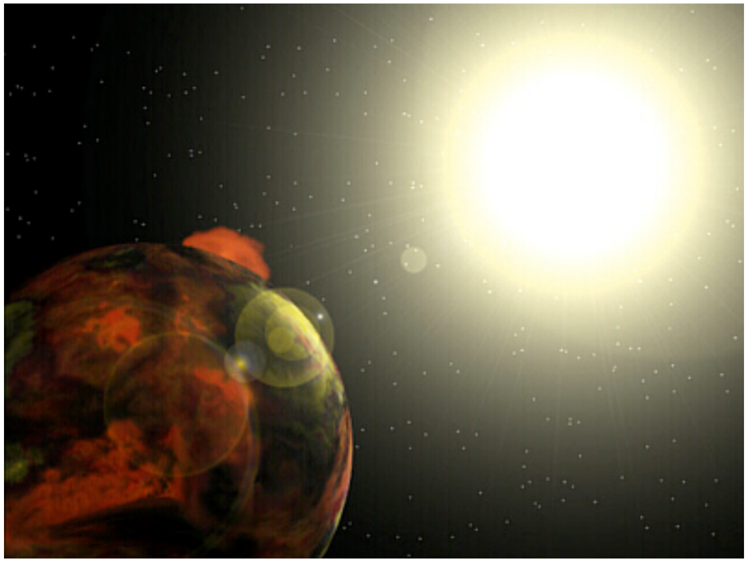


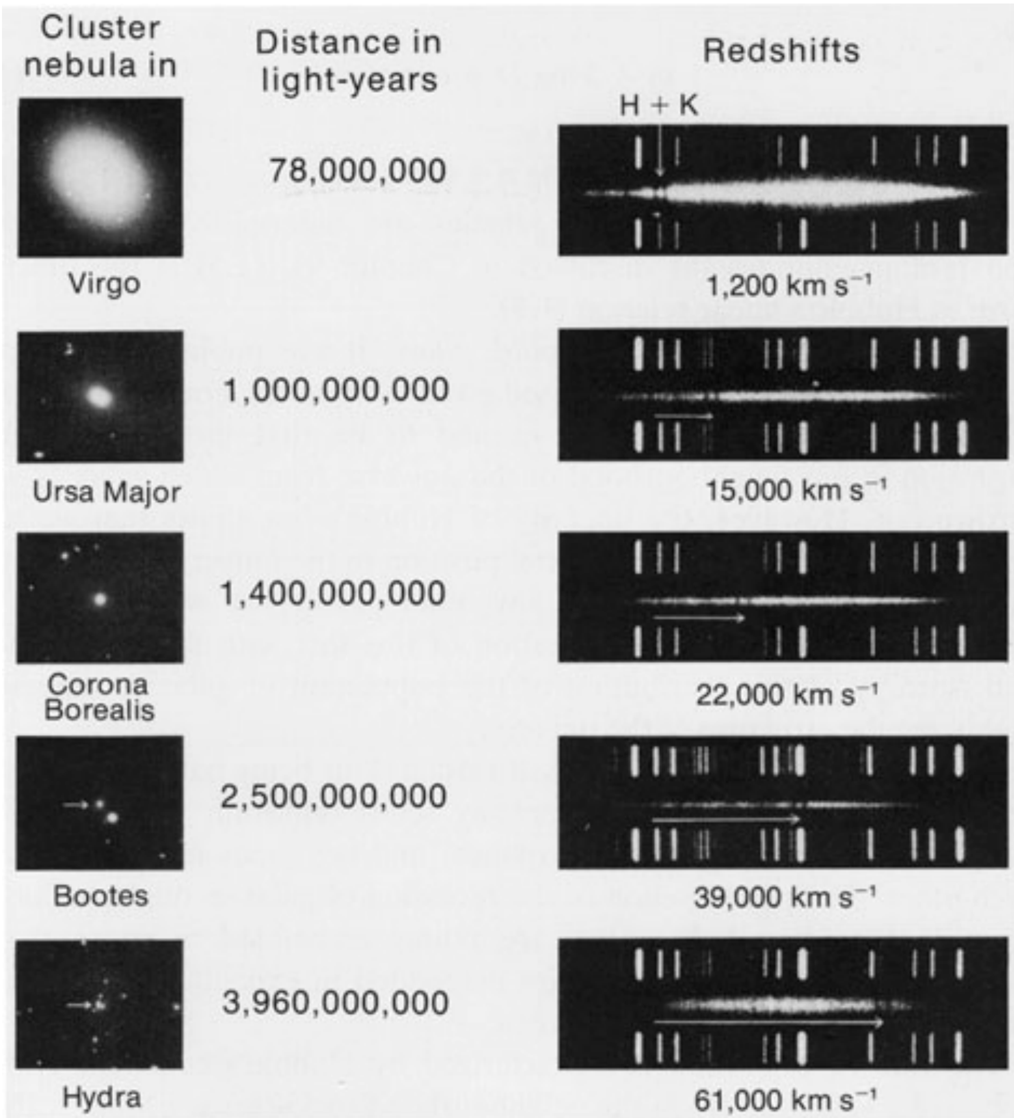
FIG. 4 Orbital motion of 51 Peg corrected from the long-term variation of the γ-velocity. The solid line represents the orbital motion computed from the parameters of Table 1.



http://www.astro.virginia.edu/class/oconnell/astr121/guide11.html

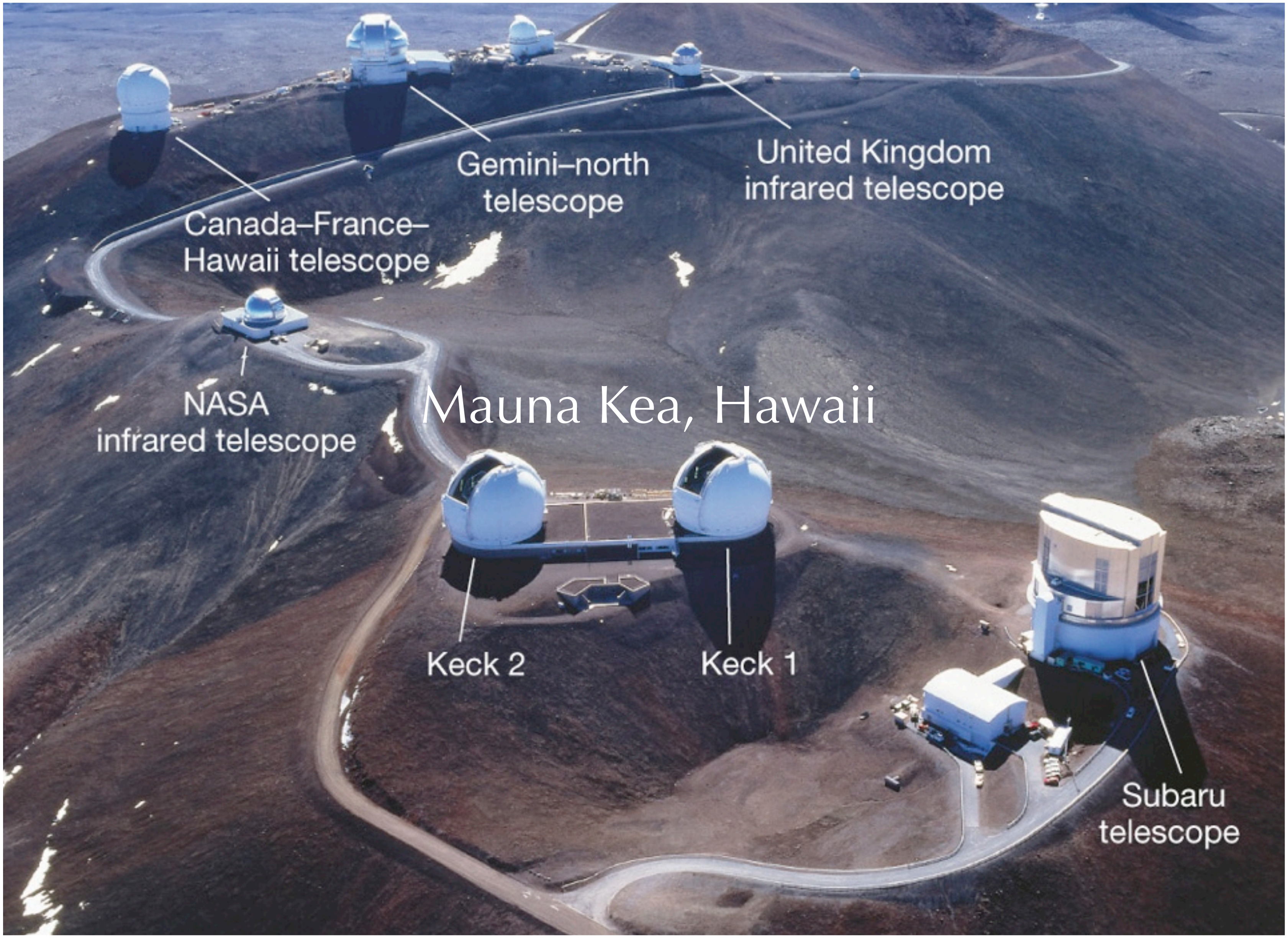
Mayor & Queloz, 1995, Nature

The Redshift of Galaxies

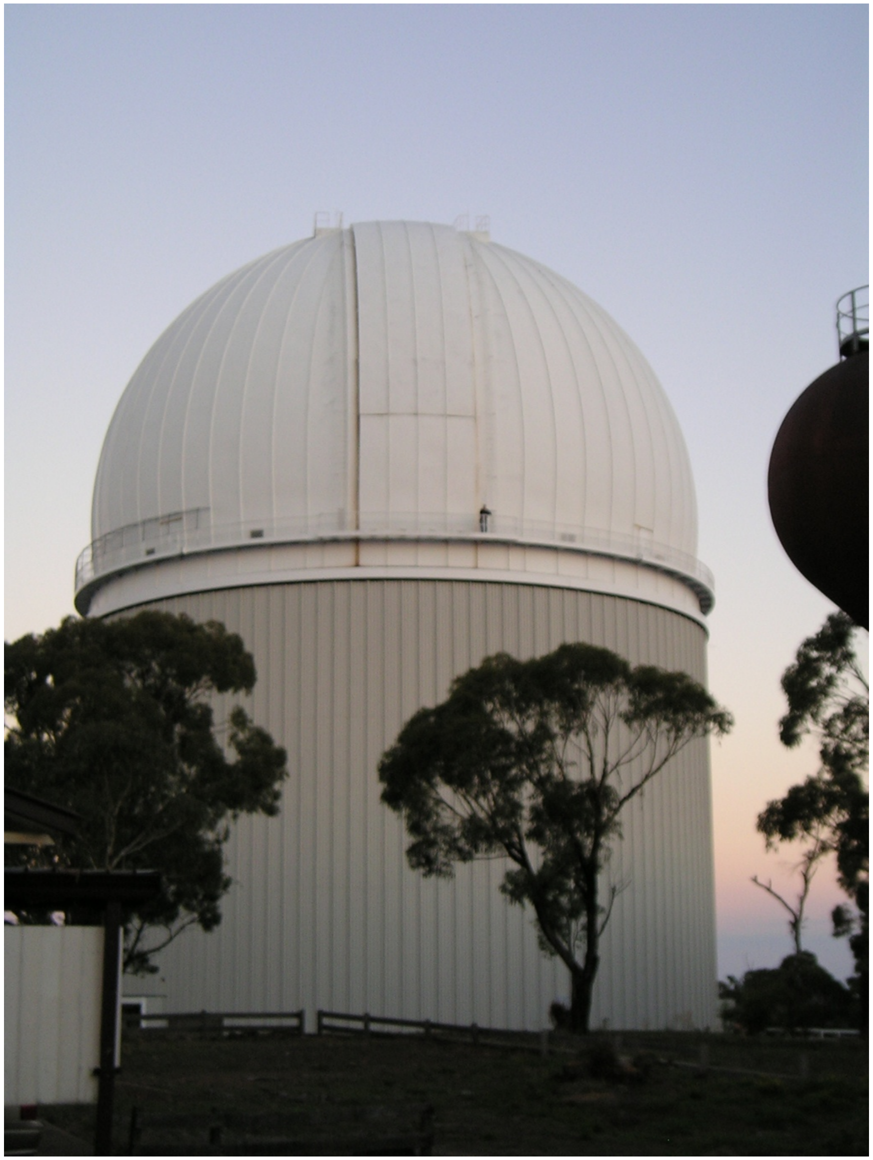


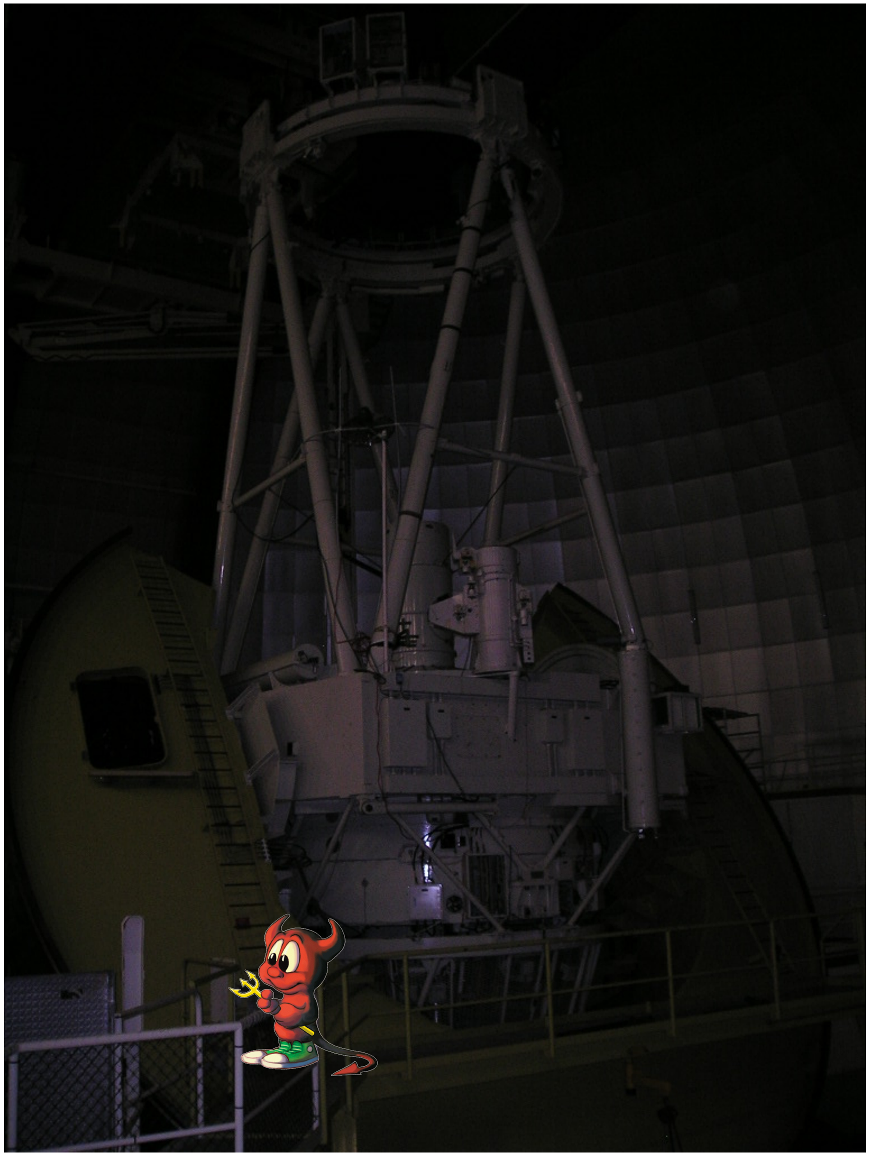
Telescopes: Tools of the Trade

Mauna Kea, Hawaii



Telescopes





Recall the Prism...

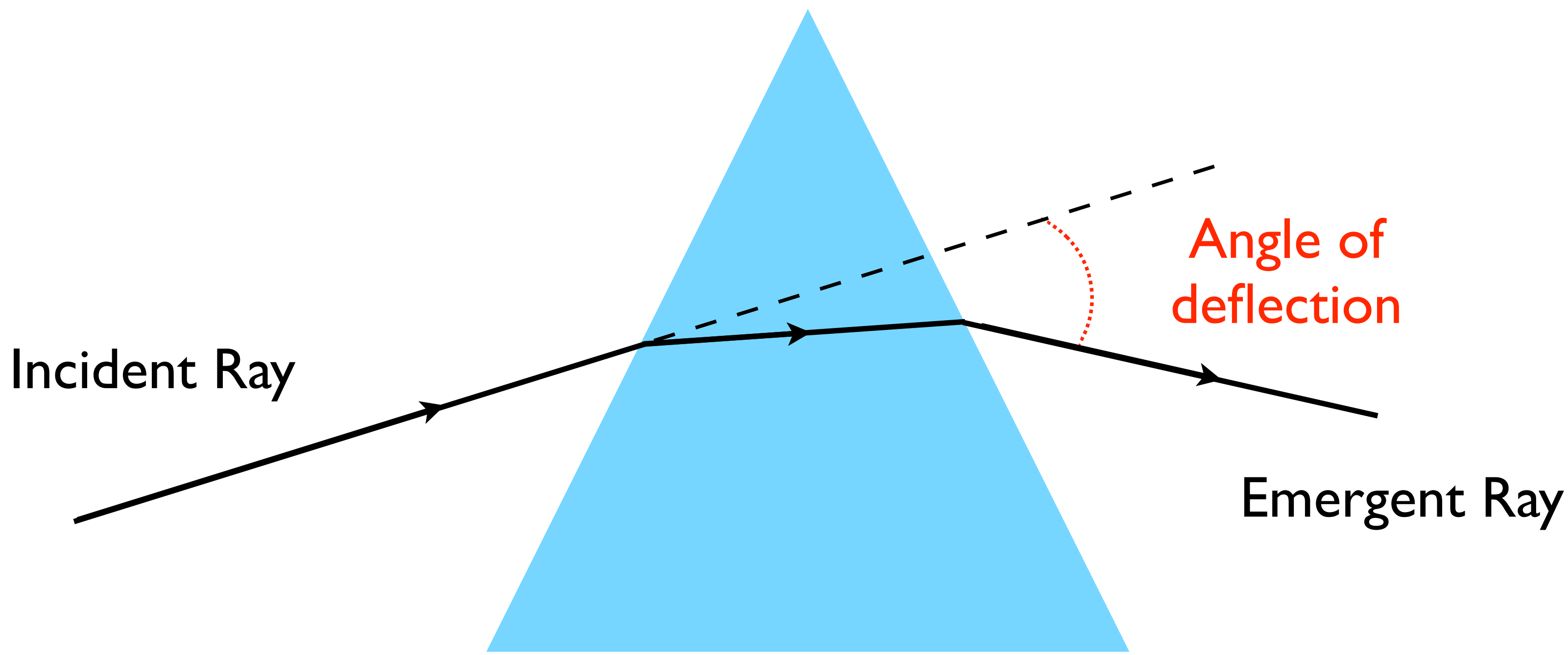
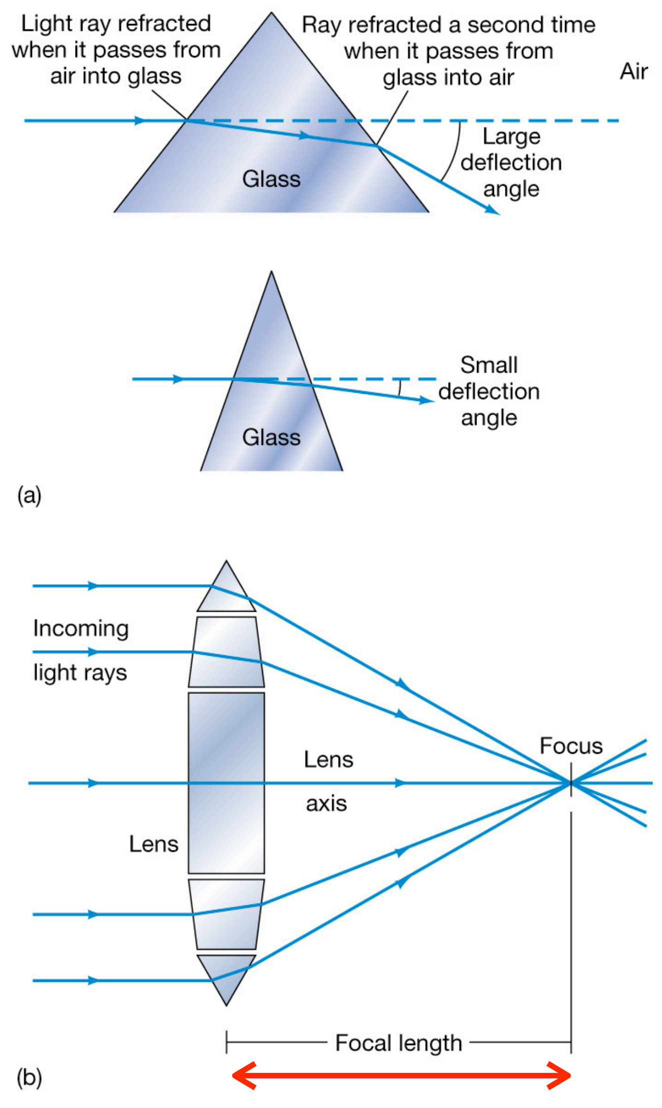
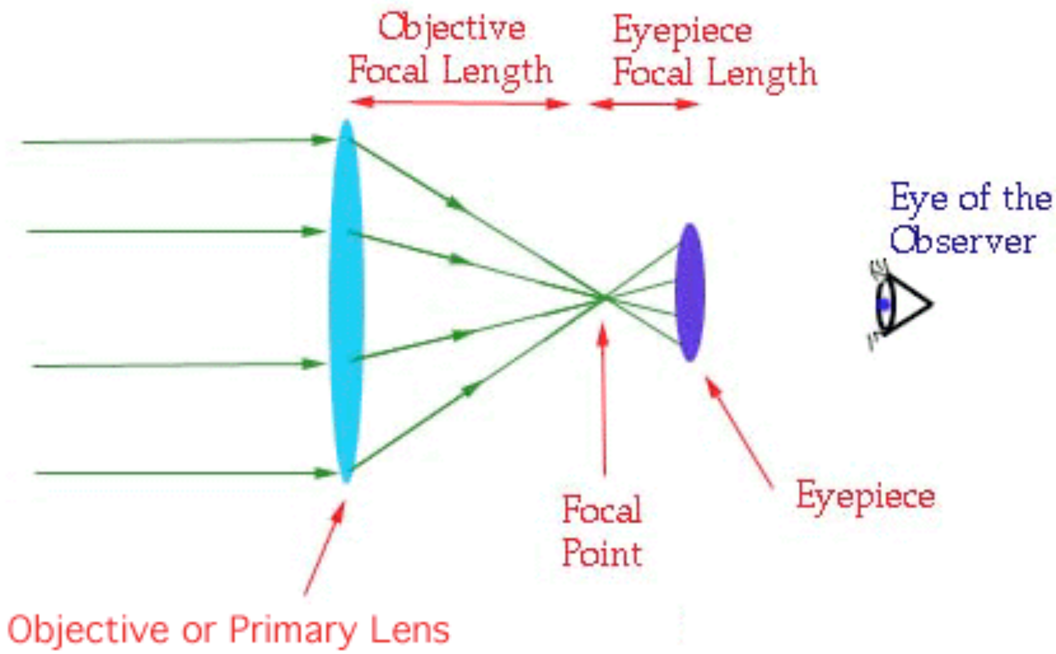


Image formation by a lens (via refration)



- Lens made up of spherical surfaces
- Think of lens as stacked prisms
- Wider opening angles closer to the top, i.e., larger deflections
- All rays converge to a single point: **The Focus**

Galileo's Simple Telescope



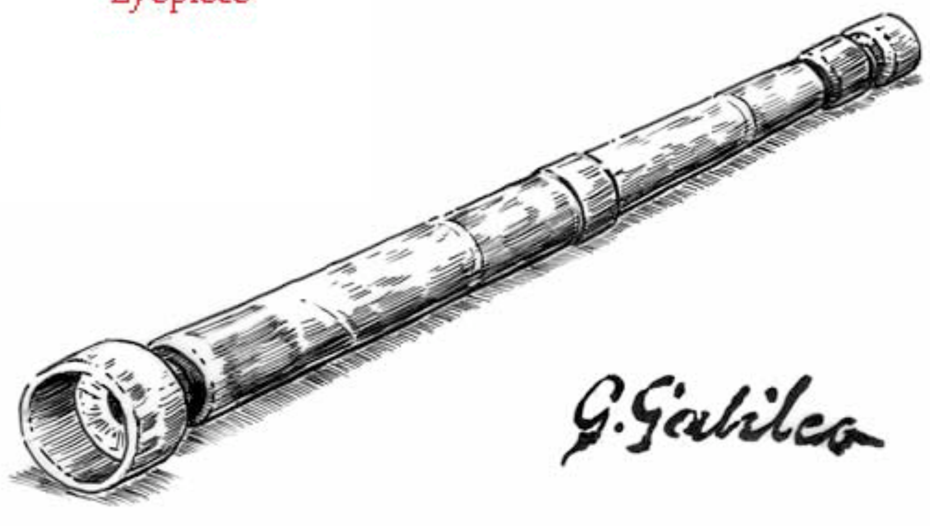
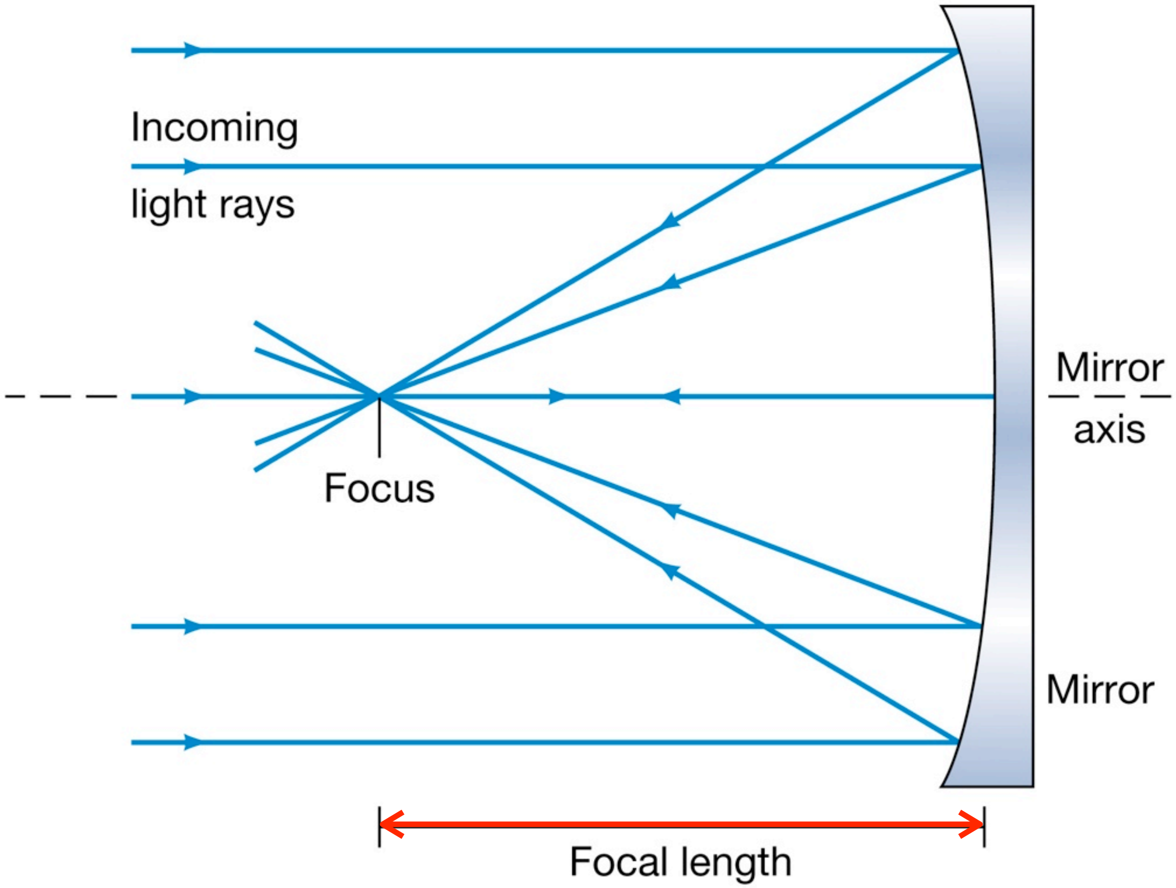
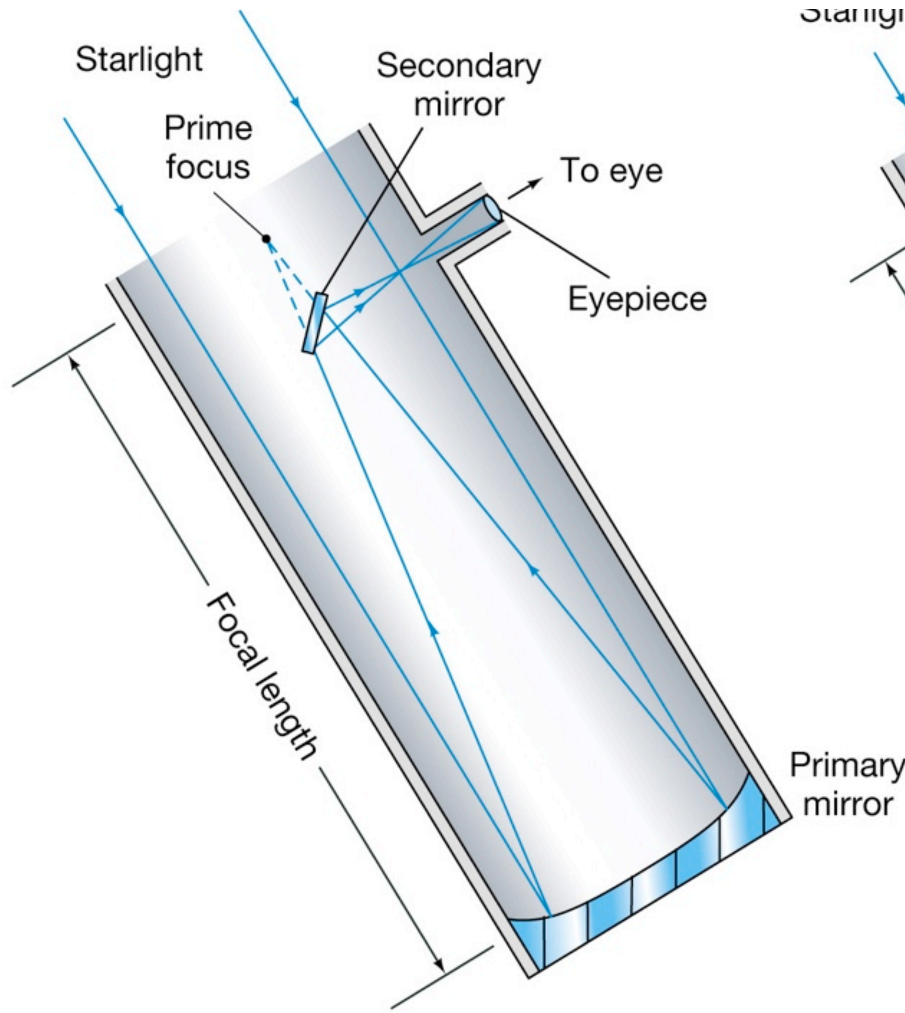


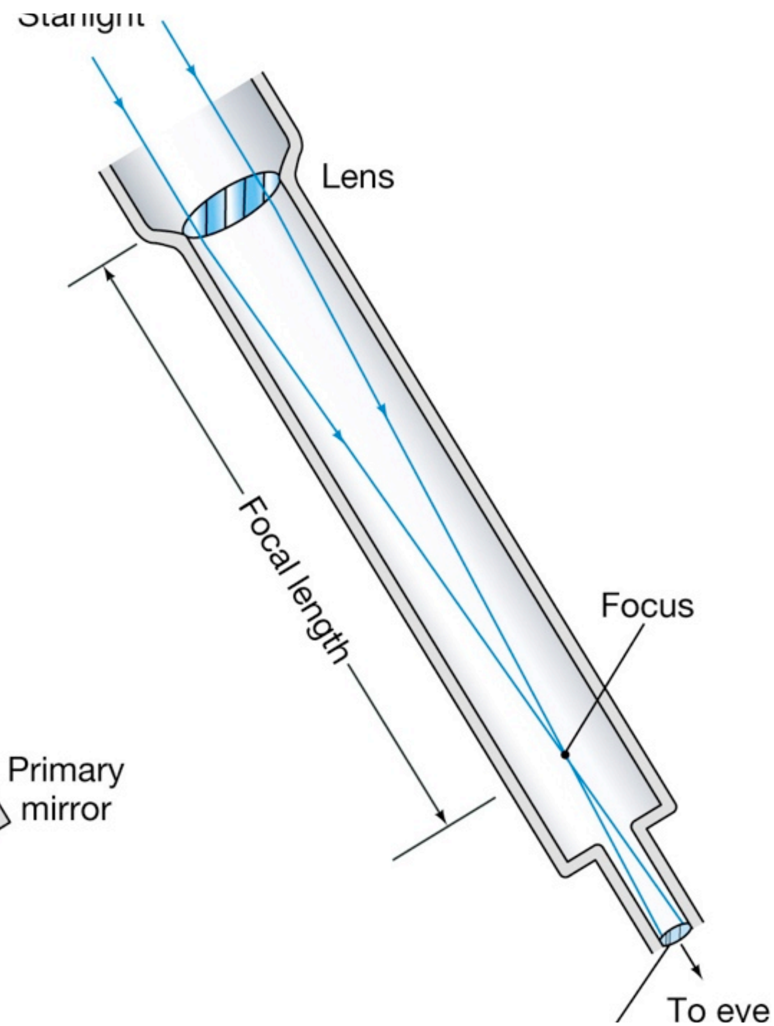
Image formation by a curved mirror (via reflection)



Reflector (mirror at bottom)



Refractor (lens at top)

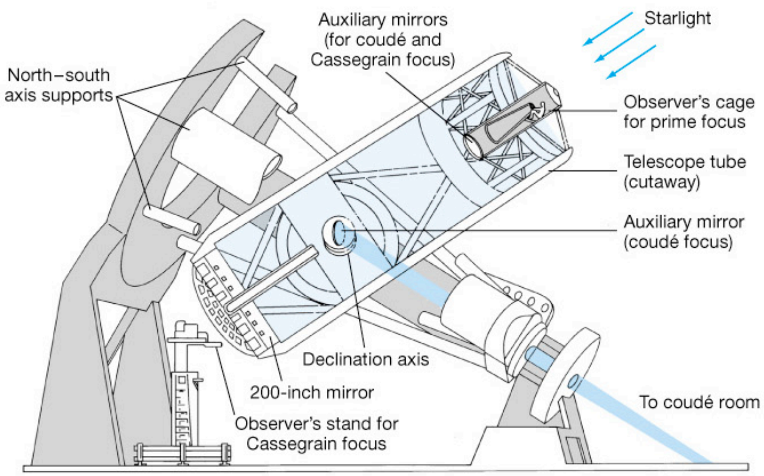


Reflector (mirror at bottom)

- Most modern telescopes are Reflectors
- Much easier to manufacture than lenses, especially as size increases
- Different type of Reflectors, depending on where light is focused e.g. Newtonian, Cassegrain

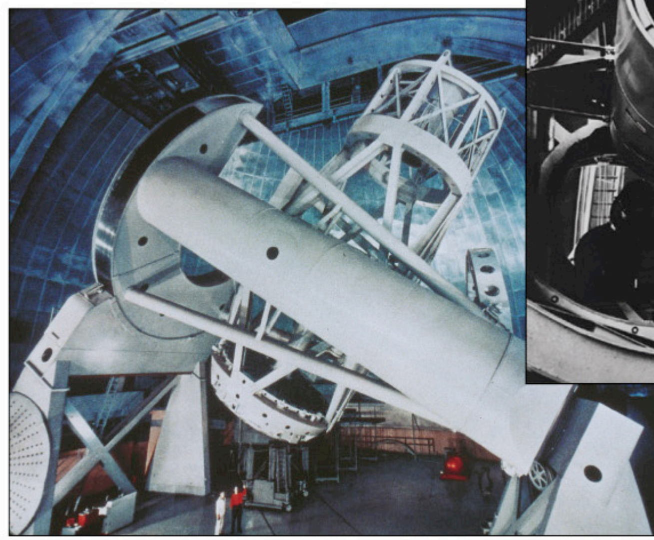
Refractor (lens at top)

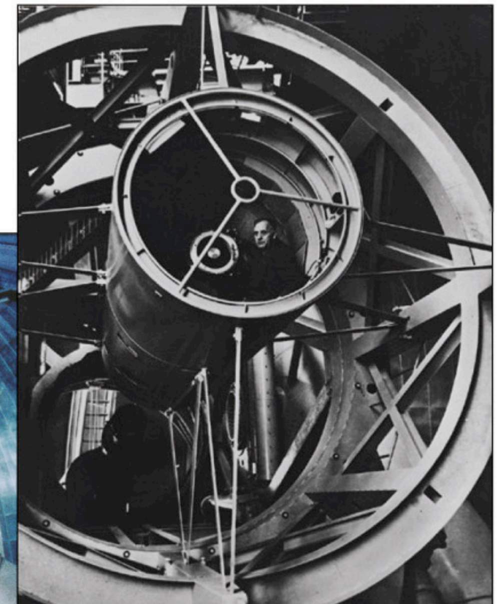
- Large lenses are heavy and difficult to manufacture
- Glass is not perfectly transparent, so light is lost when passing through the lens
- `Chromatic Aberration'. Different colors of light are bent by different amounts, focused at different points



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
To coudé room
Observer's stand for
Cassegrain focus

(a)


(b)


(c)