AY 20 Fall 2010

Class 1
Organization & Introduction

Reading: Carroll & Ostley, Chapter 6

Ay 20: Basic Astronomy & the Galaxy

_219 Cahill, Mon, Wed, Fri: 2:00 to 3:00pm

Anneila Sargent

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100 Parsons Gates x 6100

afs@caltech.edu

Office Hours: 3-4pm
Mon Wed Fri
(or by appointment)

TA: Kunal Mooley

265 Cahill x6813

kunal@astro.caltech.edu

Office hours TBD

http://www.astro.caltech.edu/~kunal/ay20

Textbook

"An Introduction to Modern Astrophysics"

Bradley Carroll & Dale Ostlie

2nd Edition 2007 ISBN 978-0805304022 (Pearson/Addison Wesley/Benjamin Cummings)

Grading

Homework (5-6 sets)	35%
Lab project	15%
Midterm exam (closed book, open personal notes)	20%
Final exam (closed book, open personal notes)	30%

Instructor's handouts may not be used in either midterm or final

Homework

- Will be handed out on Wednesdays (TBD)
- Due on following Wednesday before 5 pm
- Extensions of up to 24 hrs may be requested from Anneila or Kunal.
- Longer extensions must be requested from Anneila
- Late homework will not be graded unless an extension has been approved

Homework Collaboration Policy

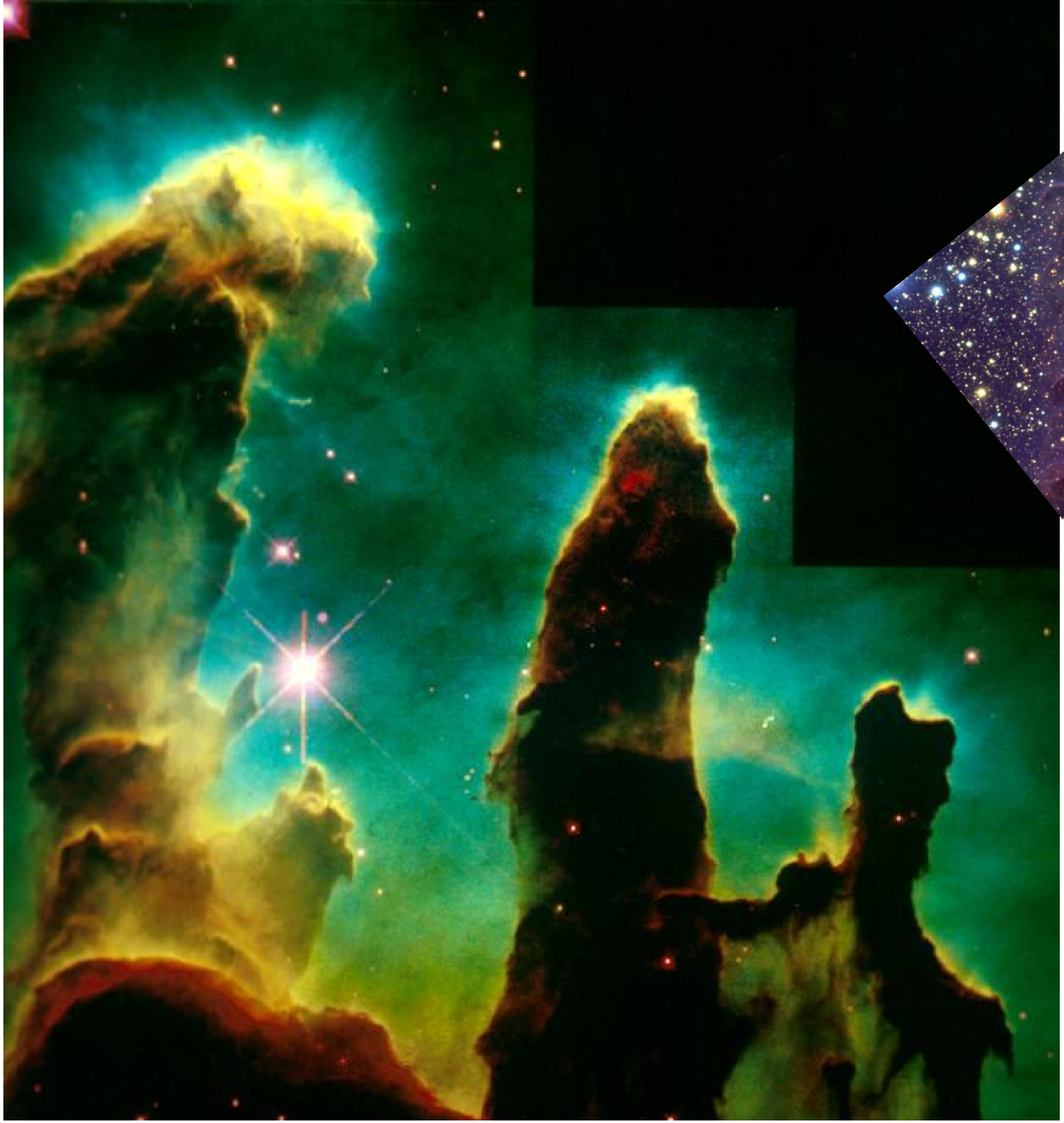
- Try every homework problem by yourself first.
- You may consult books or published papers.
- You may discuss a problem with others or with the TA to reach a better understanding.
- You may NOT show each other graphs, or computer programs.
- You may NOT use solutions from previous years' assignments or the work of other students.

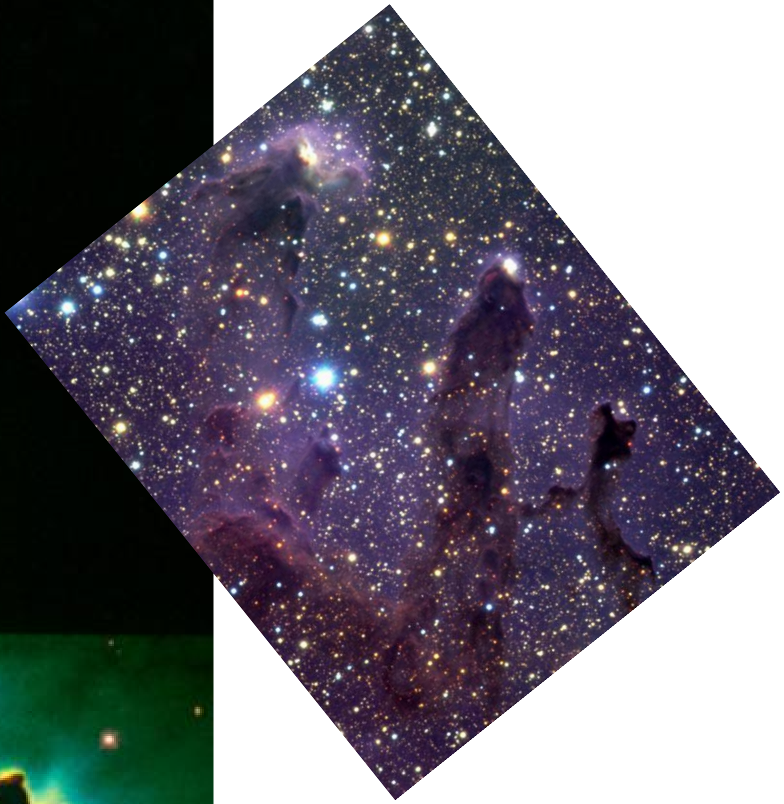
Write up your solutions by yourself

Ay 20 ≡ "basics of astronomy"

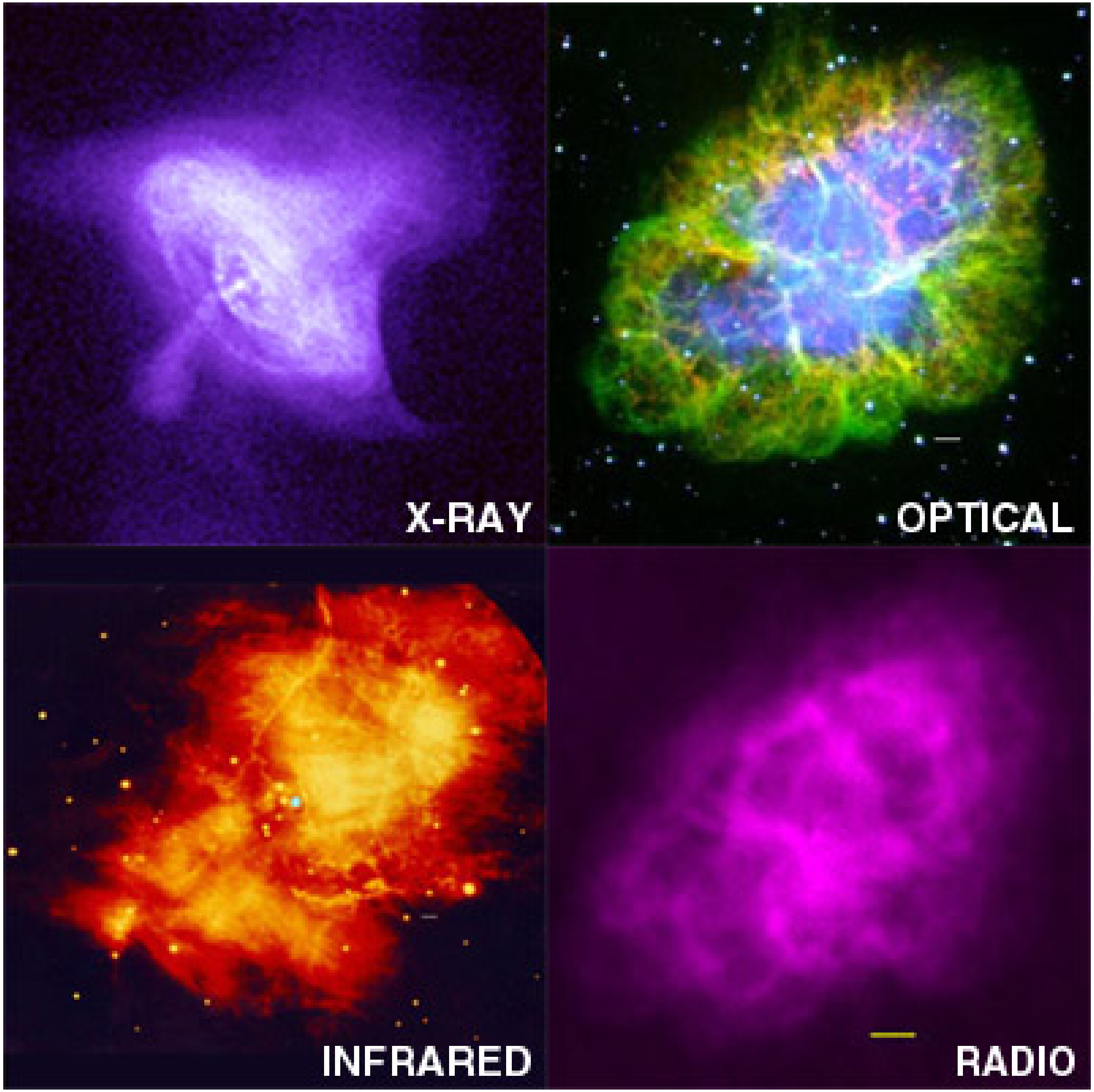
TOPICS
organization, telescopes celestial sphere,coordinates
celestial mechanics,
Kepler's laws, stellar distances
Planck function, astronomical measurements
line radiation, classification of stellar spectra
stellar spectra & Hertzsprung Russell Diagram
binary stars, stellar masses, extra solar planets (intro)
basic optics, telescopes
stellar atmospheres, radiation field, stellar opacity,
stellar atmospheres: radiative transfer, line profiles
stellar interiors, hydrostatic equilibrium
energy sources, energy generation/transport,
Sun
Interstellar medium, extinction
star formation
pre-main sequence evolution
stellar evolution, post-main sequence
remnants of stars
the solar system
Our Galaxy, structure and kinematics

Orion nebula

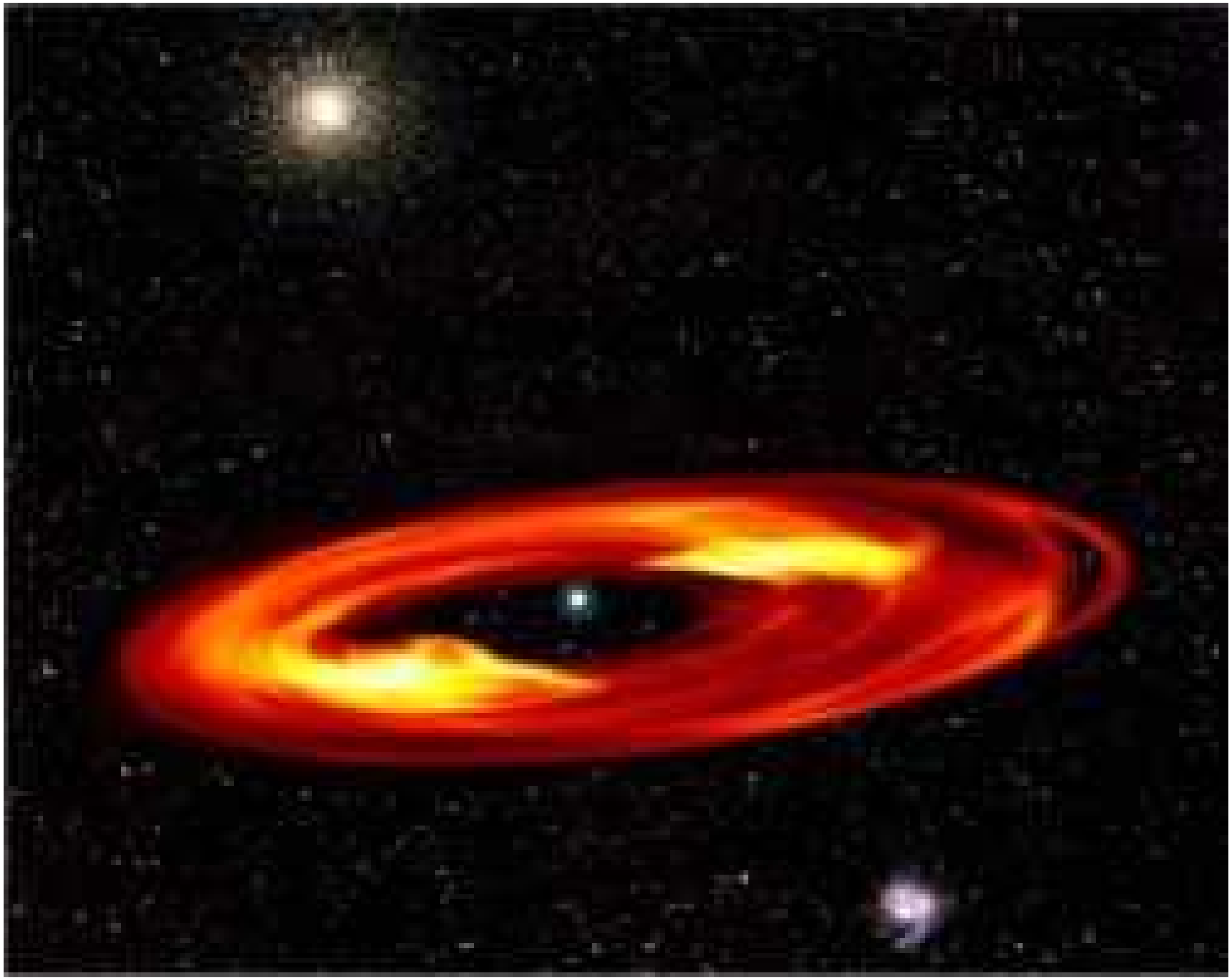




Eagle Nebula

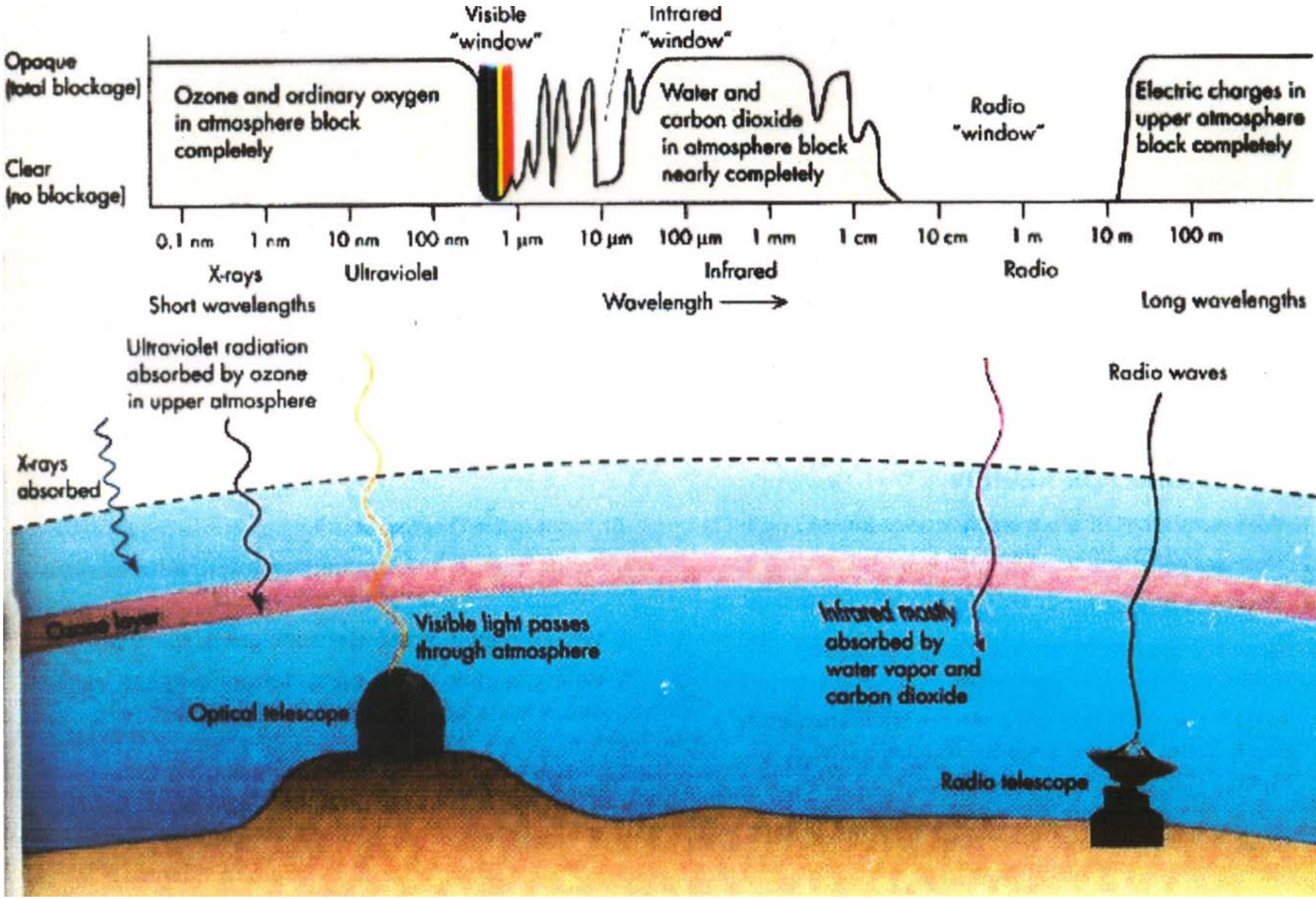


Crab Nebula



Vega

M51
Whirlpool Galaxy



Astronomy - an observational science

Astronomical information gathered from across electromagnetic spectrum

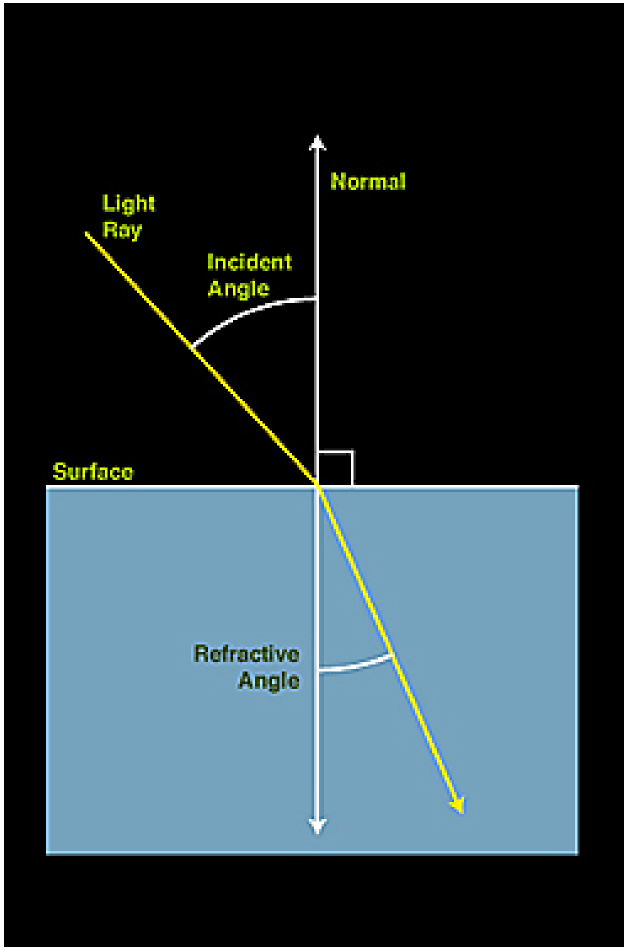
- detectors operate over wide wavelength range
  X-ray < 1nm to radio > 1m
- ultraviolet - optical ~ 100nm – 600 nm
  ~ 1000 Å - 6000 Å

1 Ångstrom = 10^{-8} cm

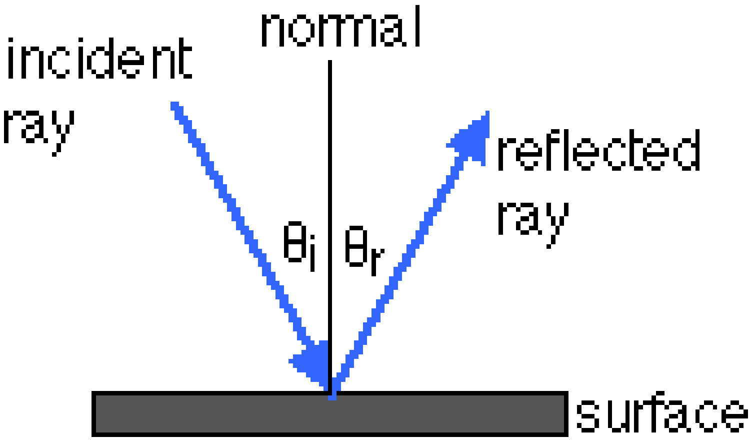
- infrared ~ 10000 nm (1 μm) ~ 400 μm
- sub-millimeter/millimeter ~ 350 μm – 1/3 mm
- radio ~ 10 cm -10 m

Principles from Optical Telescopes
refractors (lenses) reflectors (mirrors)

Refraction

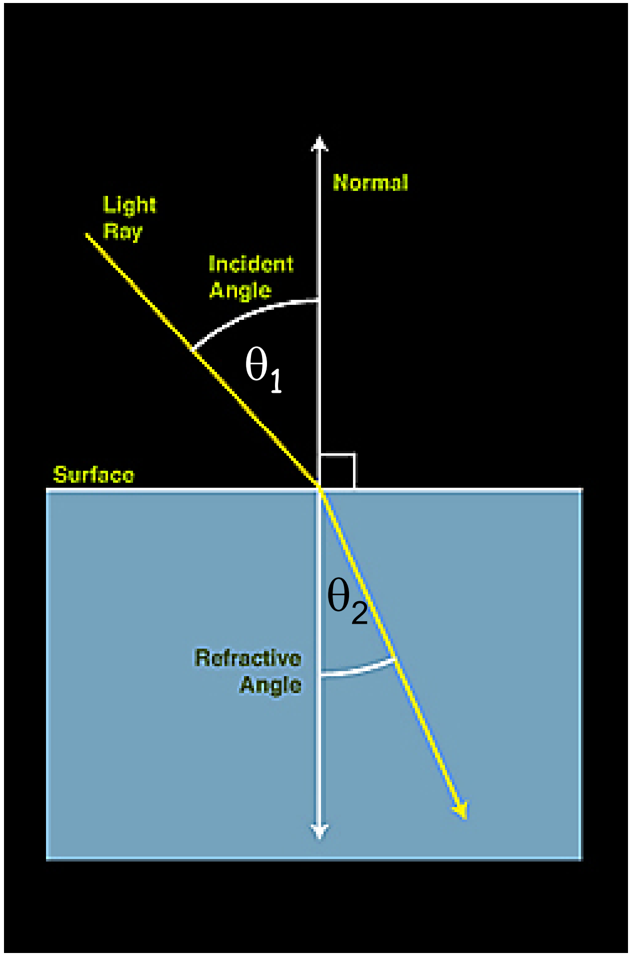


Reflection



$$\theta_1 = \theta_2$$

Incident and
reflected rays
in same plane
as normal



- ray bent at interface between two transparent media
- bending a function of n_λ, index of refraction of each medium at wavelength λ

$$n_\lambda \equiv c/v_\lambda$$

c =velocity of light in vacuum

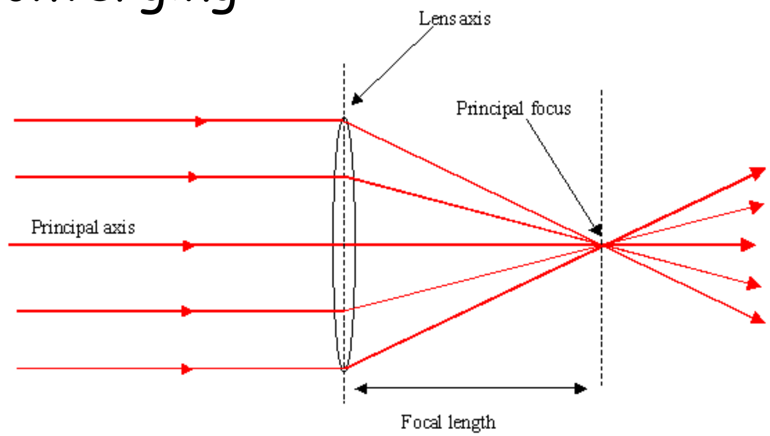
v_λ= velocity of light in medium

Snell's law of refraction

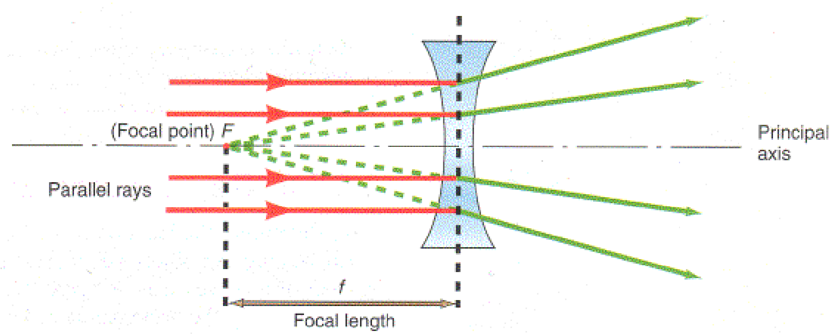
$$n_{1\lambda}\sin\theta_1 = n_{2\lambda}\sin\theta_2$$

Converging and Diverging Lenses

converging



diverging



rays of light come to focus at distance f from lens center

f = focal length (image distance of an object at infinity)

converging: f +ve

diverging: f –ve

lensmaker's formula

$$1/f_\lambda = (n_\lambda - 1)(1/R_1 + 1/R_2)$$

R1, R2 radii of curvature

convex: +ve

concave: -ve

assumes both surfaces spheroidal

Mirrors

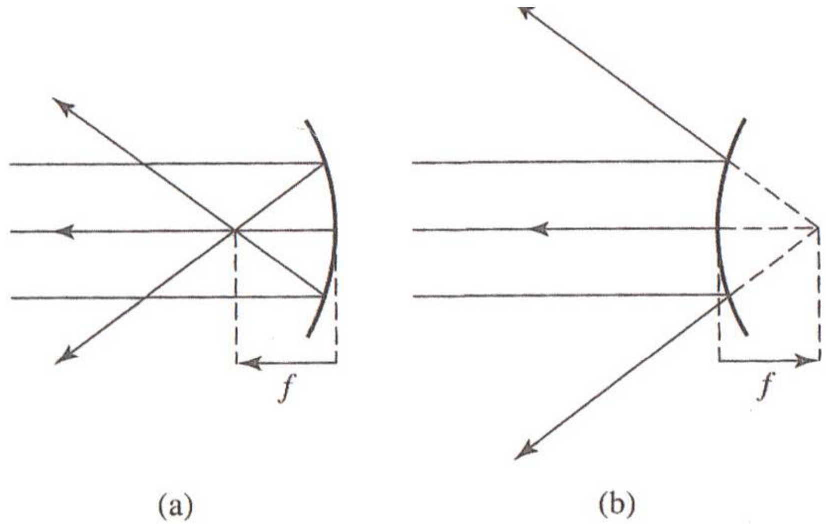
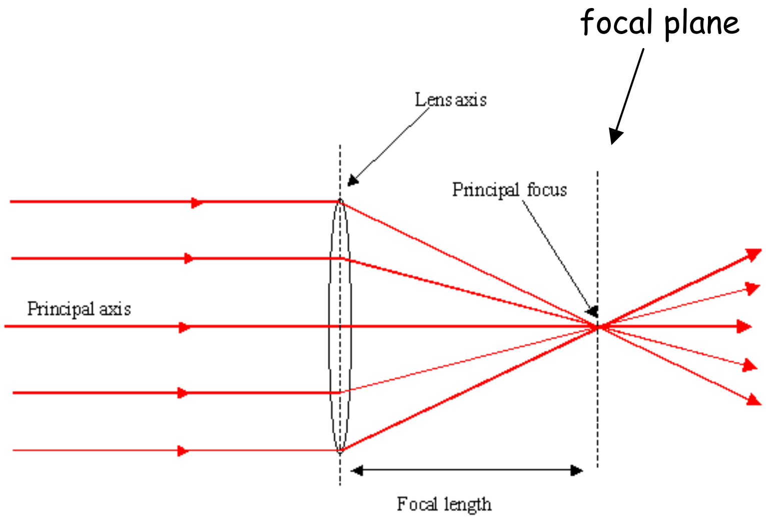
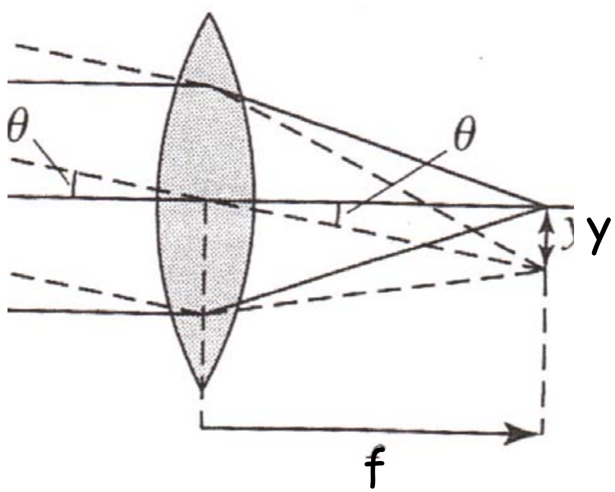


FIGURE 6.5 (a) A converging mirror, $f > 0$. (b) A diverging mirror, $f < 0$

- Most modern telescopes use converging systems as the primary mirrors
- For a spheroidal mirror, lensmaker's formula leads to focal length, $f = R/2$
- $1/f_\lambda = (n_\lambda - 1)(1/R_1 + 1/R_2) = 2/R = 1/f$ (independent of λ)

Plate scale





astronomical sources often extended

∴ images also extended along focal plane

≡ plane passing through focal point, perpendicular to optical axis of system

$\tan\theta = y/f \approx \theta$, if field of view of telescope is small

$\therefore y = f\theta$

$\therefore$ plate scale, $d\theta/dy = 1/f$

relates angular separation on sky (of individual objects or parts of extended sources) to linear separation in image plane

→ increased "resolution" requires lens with longer focal length