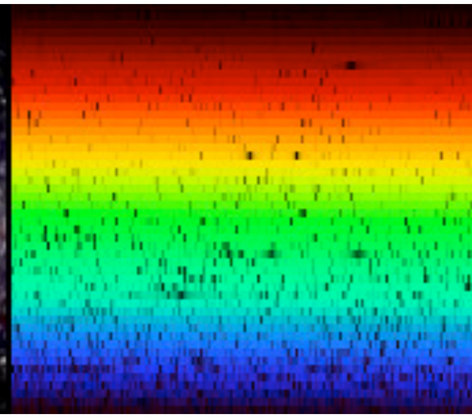
ASTR/PHYS 3070: Foundations Astronomy



Week 6 Tuesday

Today's Agenda

- New astrobiology club!
- Finish "making measurements"
- Group problem
- Observing "invisible" light
- Midterm Q&A

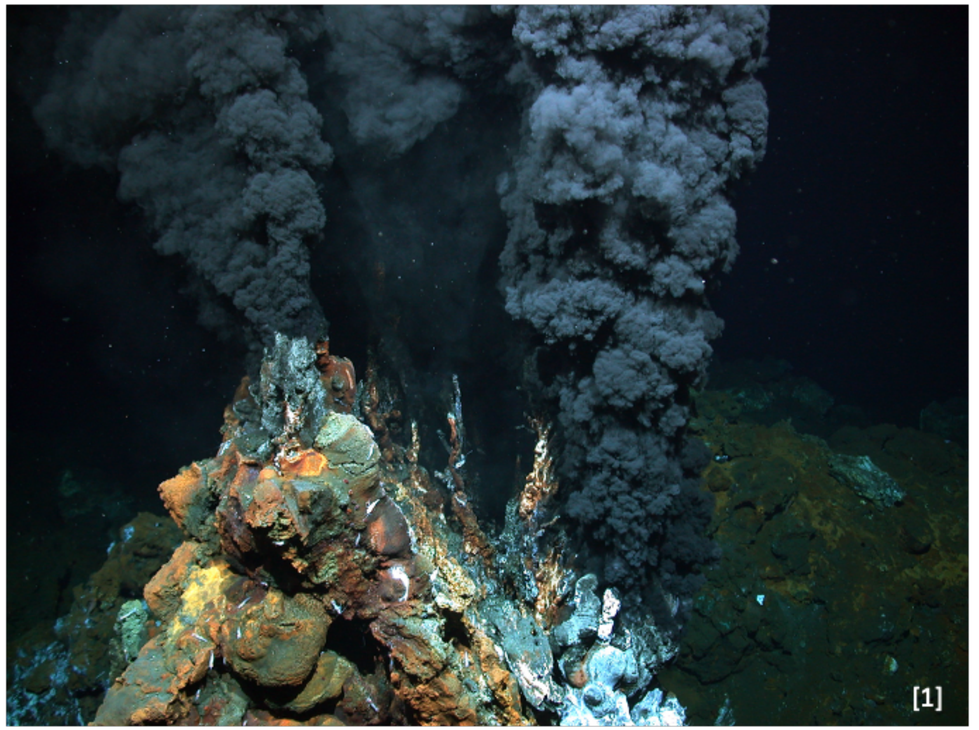
Announcements / Reminders

- Midterm 1 on Thursday!!!

- HEAP talk at 4pm on Thursday
  - Wrangling the Beast: Precision Supermassive Black Hole Mass Measurement With ALMA
- Colloquium at 2pm on Friday
  - AI Dominated the Protein Folding Problem - What are the next frontiers in biophysics?

OASIS (Organization for AStrobiology and Interdisciplinary Science)

Jake Lowe, President & Alli Hoffman, Vice President – **Contact: u1117930@utah.edu**


[1]

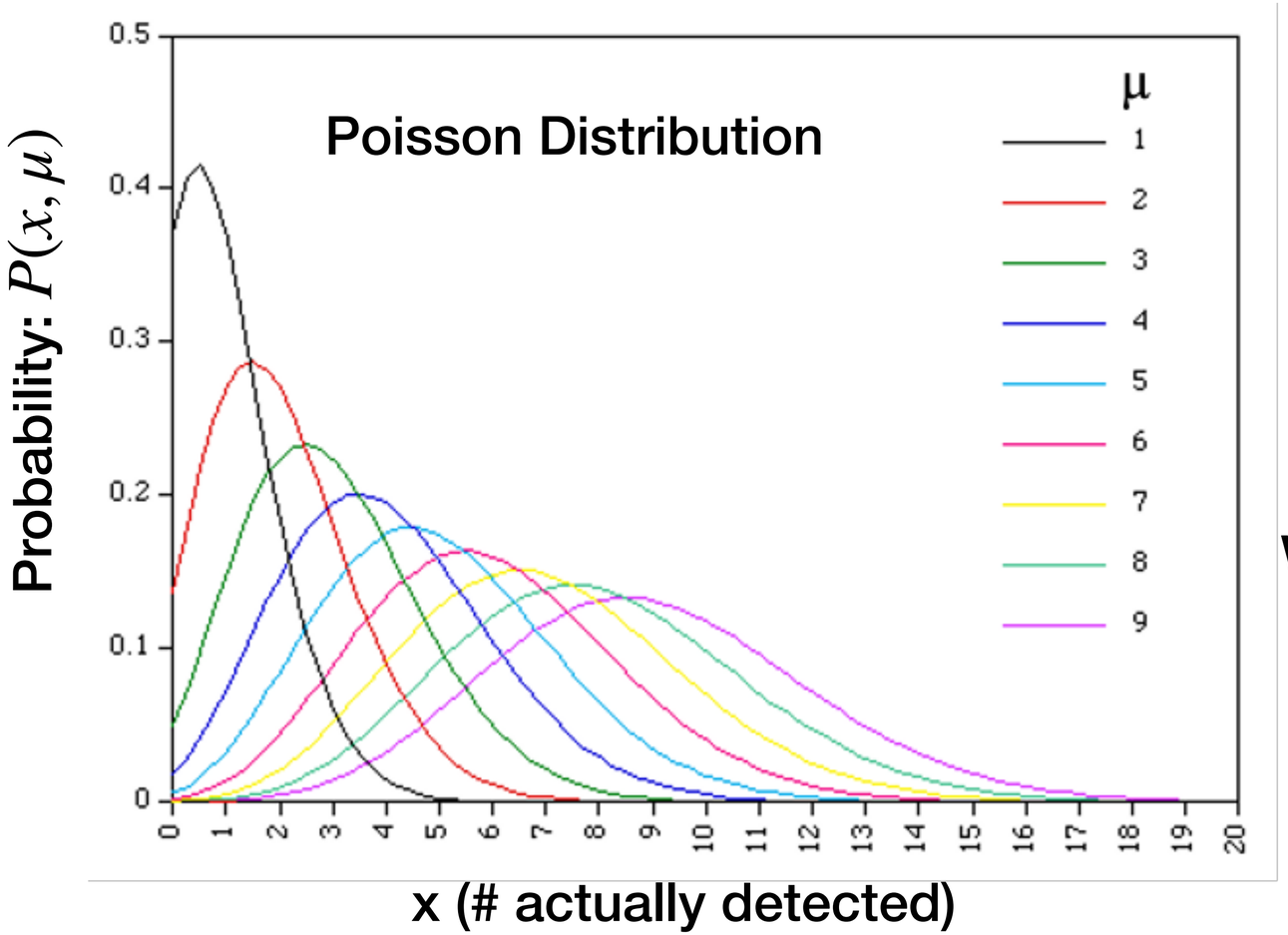

[2]

Open to all majors and experience levels, learn more about astrobiology: the study of life in the universe!

From the seafloor to the stars, microbes to the structure of the universe, astrobiology is a truly interdisciplinary field that investigates the habitability of extreme environments and origins of life. OASIS seeks to facilitate an interest in astrobiology at the University of Utah through research, outreach, and outings. Feel free to reach out with any questions!

Making Measurements

Photons arrive randomly — # detected not necessarily # “should” detect



μ —> # “should” detect

$$P(x,\mu) = \frac{\mu^x}{x!} e^{-\mu}$$

Width of the distribution, which gives the uncertainty (or error) of the measurement, is $\sigma = \sqrt{\mu}$

What is the flux (and uncertainty) of this XRB?

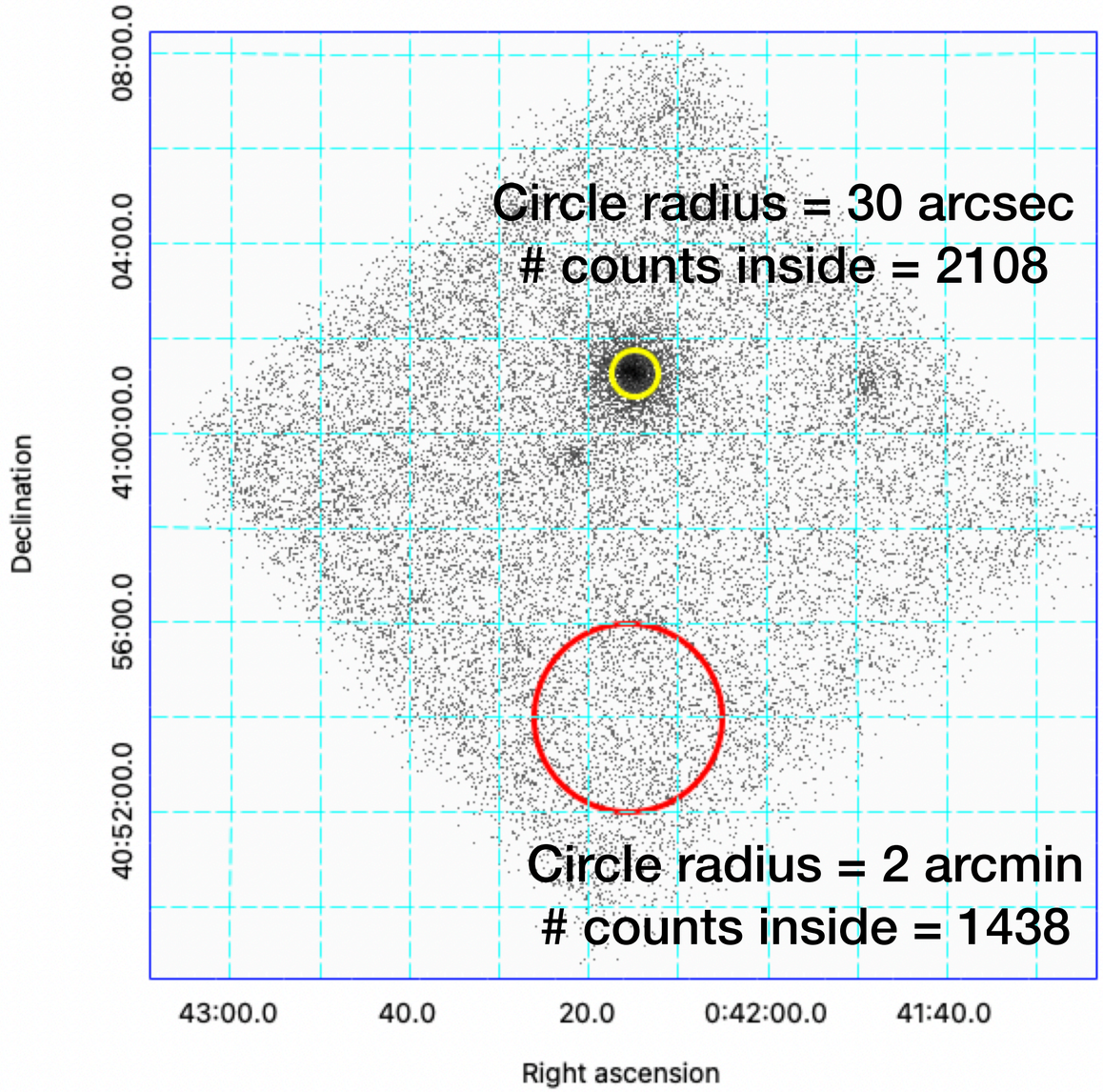


Image from the *NuSTAR* X-ray Observatory

(4-25 keV; $1\ \mathrm{keV} = 1.602 \times 10^{-16}\ \mathrm{J}$)

Exposure time of image = 37,547 s

XRB is in the Andromeda galaxy, 780 kpc away

($1\ \mathrm{kpc} = 3.086 \times 10^{19}\ \mathrm{m}$)

<u>Telescope Properties</u>:

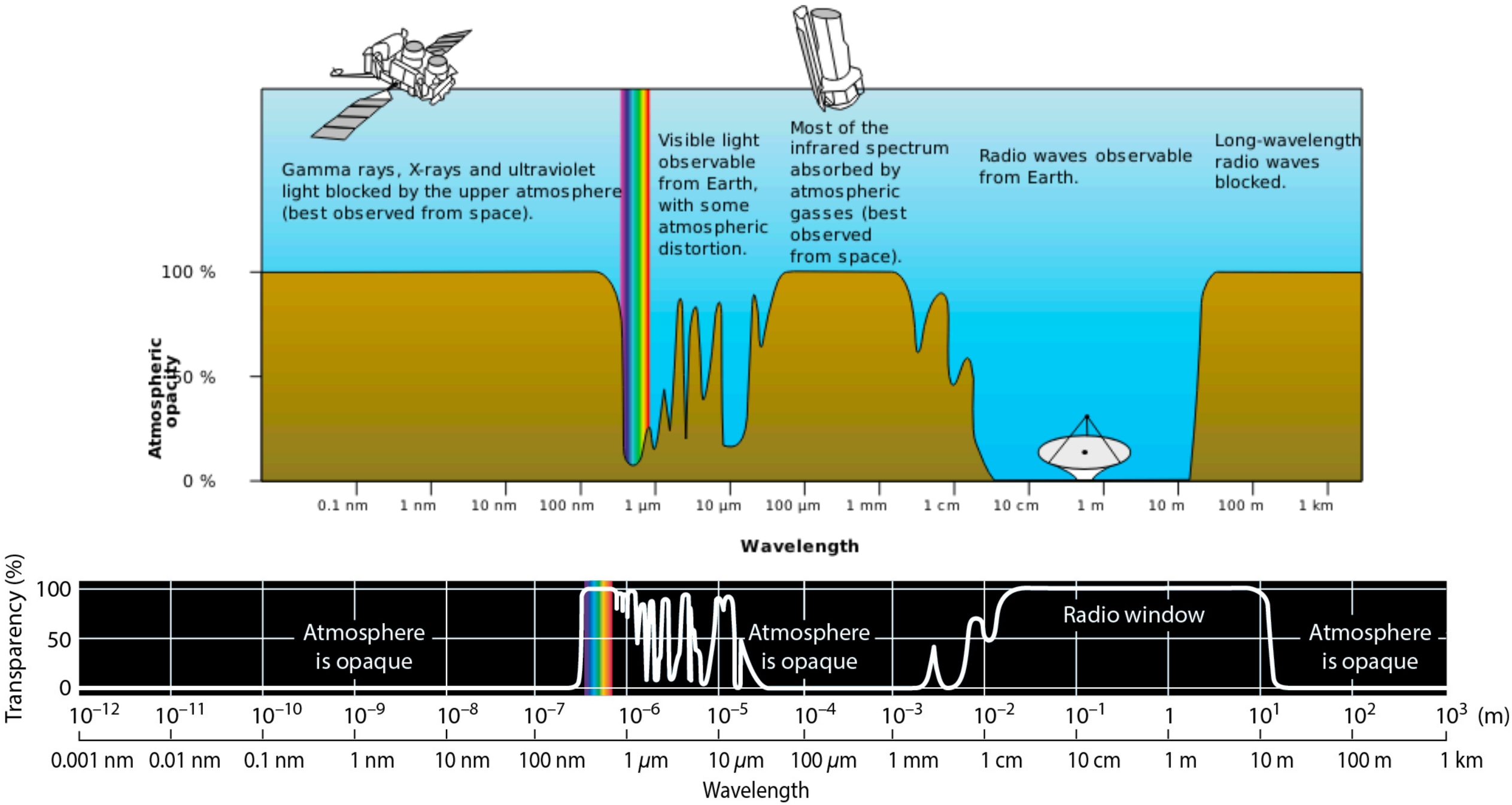
Collecting area = 400 cm^2

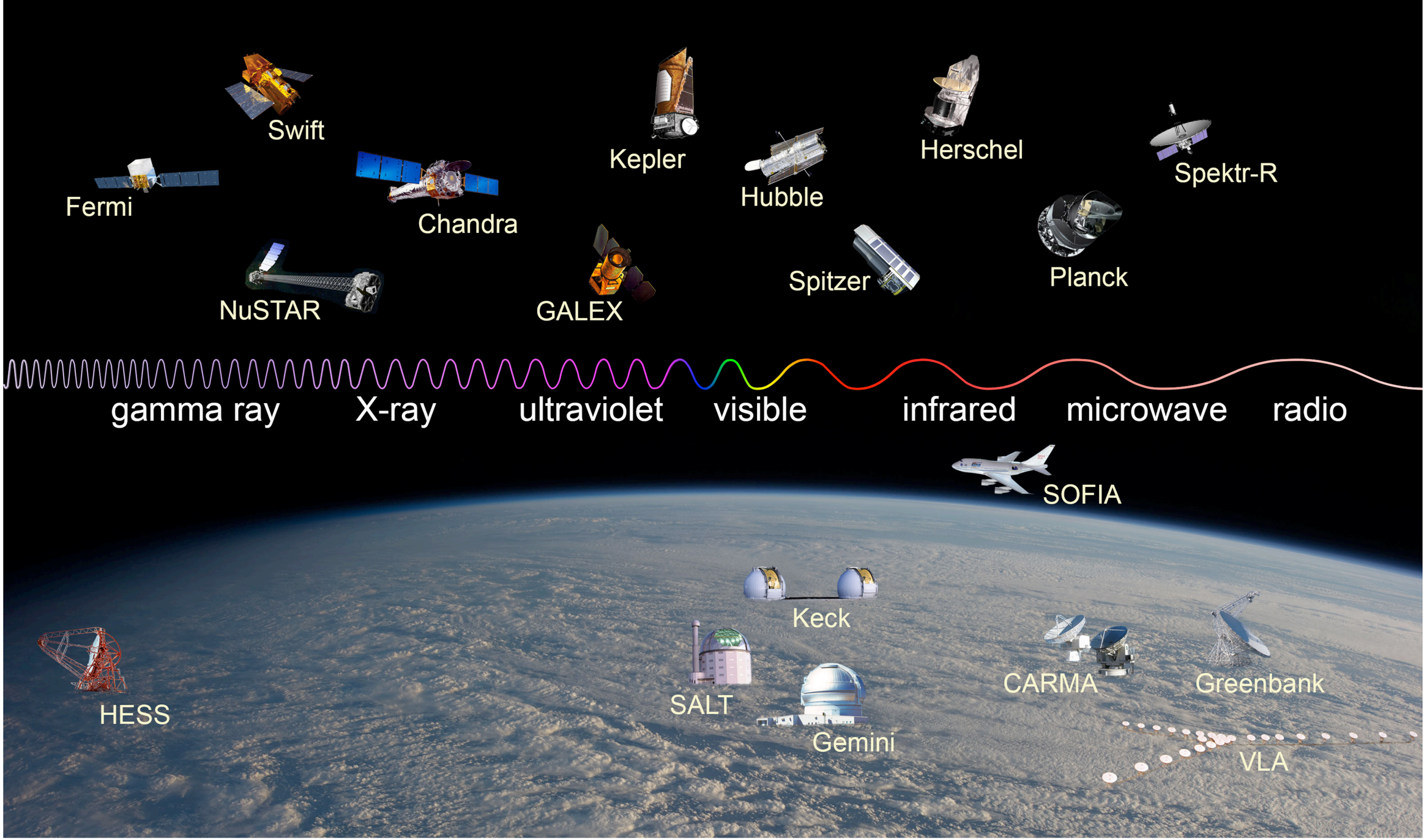
Focal length = 10.15 m

PSF FWHM = 18 arcsec

PSF HPD = 1 arcmin

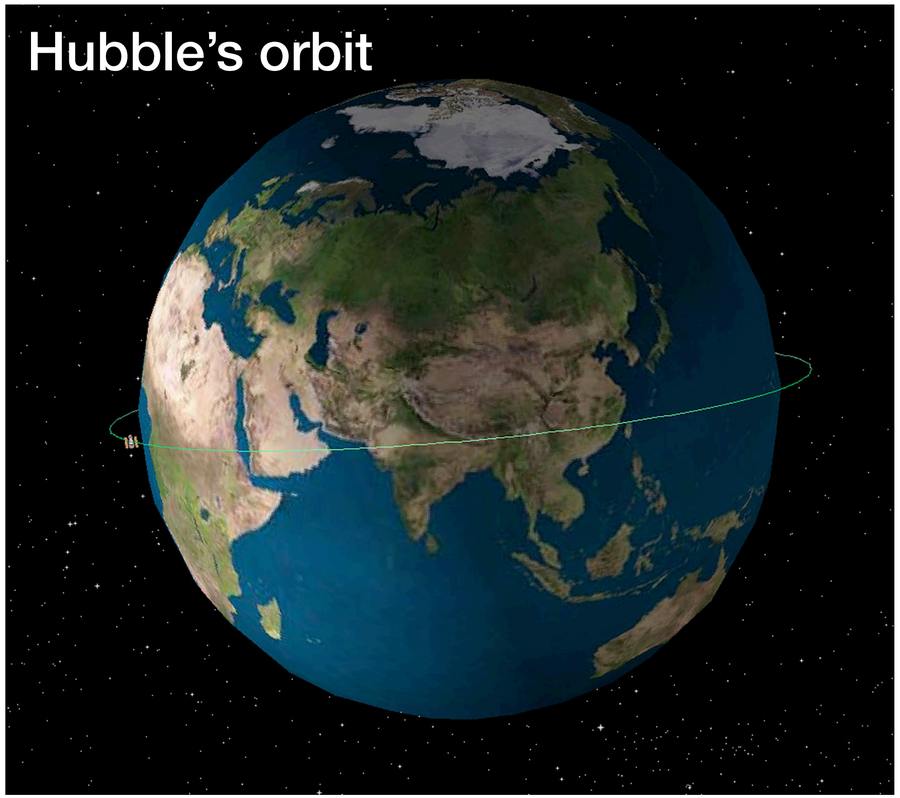
1. Calculate the *total* number of source counts S
2. Convert S to flux (units of $\mathrm{J/m^2/s}$)
3. Convert flux to luminosity
4. Calculate the S/N ratio of the XRB
5. Convert the uncertainty in total S and flux

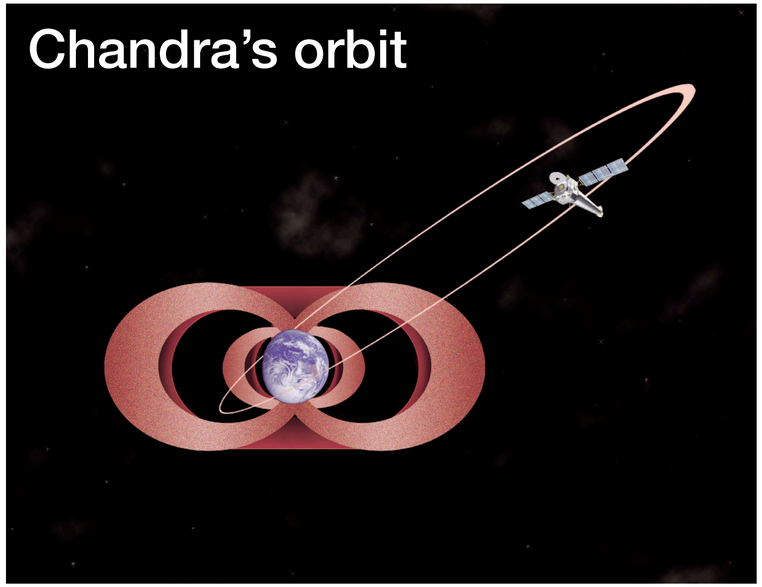

Gamma rays, X-rays and ultraviolet light blocked by the upper atmosphere (best observed from space).
Visible light observable from Earth, with some atmospheric distortion.
Most of the infrared spectrum absorbed by atmospheric gasses (best observed from space).
Radio waves observable from Earth.
Long-wavelength radio waves blocked.
100 %
50 %
0 %
Atmospheric opacity
0.1 nm
1 nm
10 nm
100 nm
1 μm
10 μm
100 μm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1 km
Wavelength
Transparency (%)
100
50
0
Atmosphere is opaque
Atmosphere is opaque
Radio window
Atmosphere is opaque
10^{-12} 10^{-11} 10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} (m)
0.001 nm 0.01 nm 0.1 nm 1 nm 10 nm 100 nm 1 μm 10 μm 100 μm 1 mm 1 cm 10 cm 1 m 10 m 100 m 1 km
Wavelength


Swift
Kepler
Herschel
Spektr-R
Fermi
Chandra
Hubble
Planck
Spitzer
NuSTAR
GALEX
gamma ray
X-ray
ultraviolet
visible
infrared
microwave
radio
SOFIA
Keck
HESS
SALT
Gemini
CARMA
Greenbank
VLA

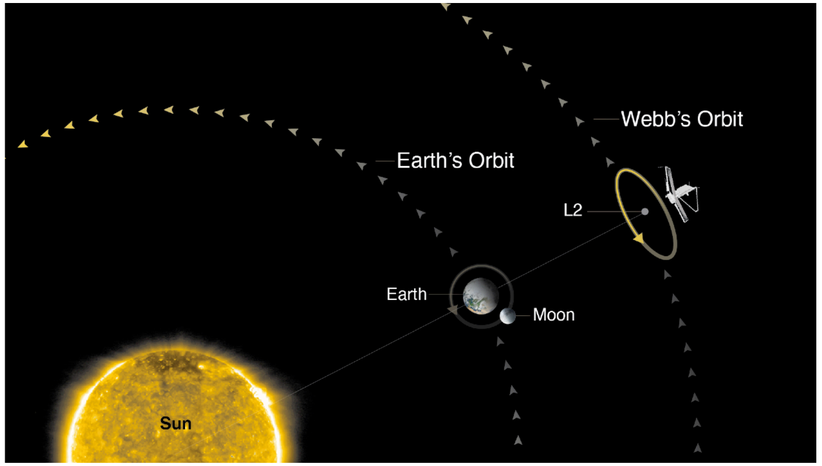
3 Misconceptions about Telescopes in Space

- From space, objects can be observed continuously, even during the day
- The sky is much darker in space than on the Earth
- Observations from space are not affected by weather





JWST's orbit



Midterm 1 Review

Questions?