


Astronomy 103

Survey of Astronomy

A large, tilted, edge-on galaxy with a bright central core and a dense field of stars in the background. The galaxy is oriented diagonally from the bottom-left to the top-right. The central region is very bright and yellowish-white, surrounded by a dense field of stars. The galaxy's structure is somewhat diffuse, with a central concentration and a surrounding cloud of stars and dust. The background is a deep blue-black space filled with numerous individual stars of various colors and sizes.

Physics 137
MWF 9:00 - 9:50 AM

Ralf Kotulla

kotulla@uwm.edu

(414)229 3655

Office hours: Monday & Wednesday 10-11am or
by appointment – in Physics 122



Kitt Peak National Observatory, Tucson, Arizona

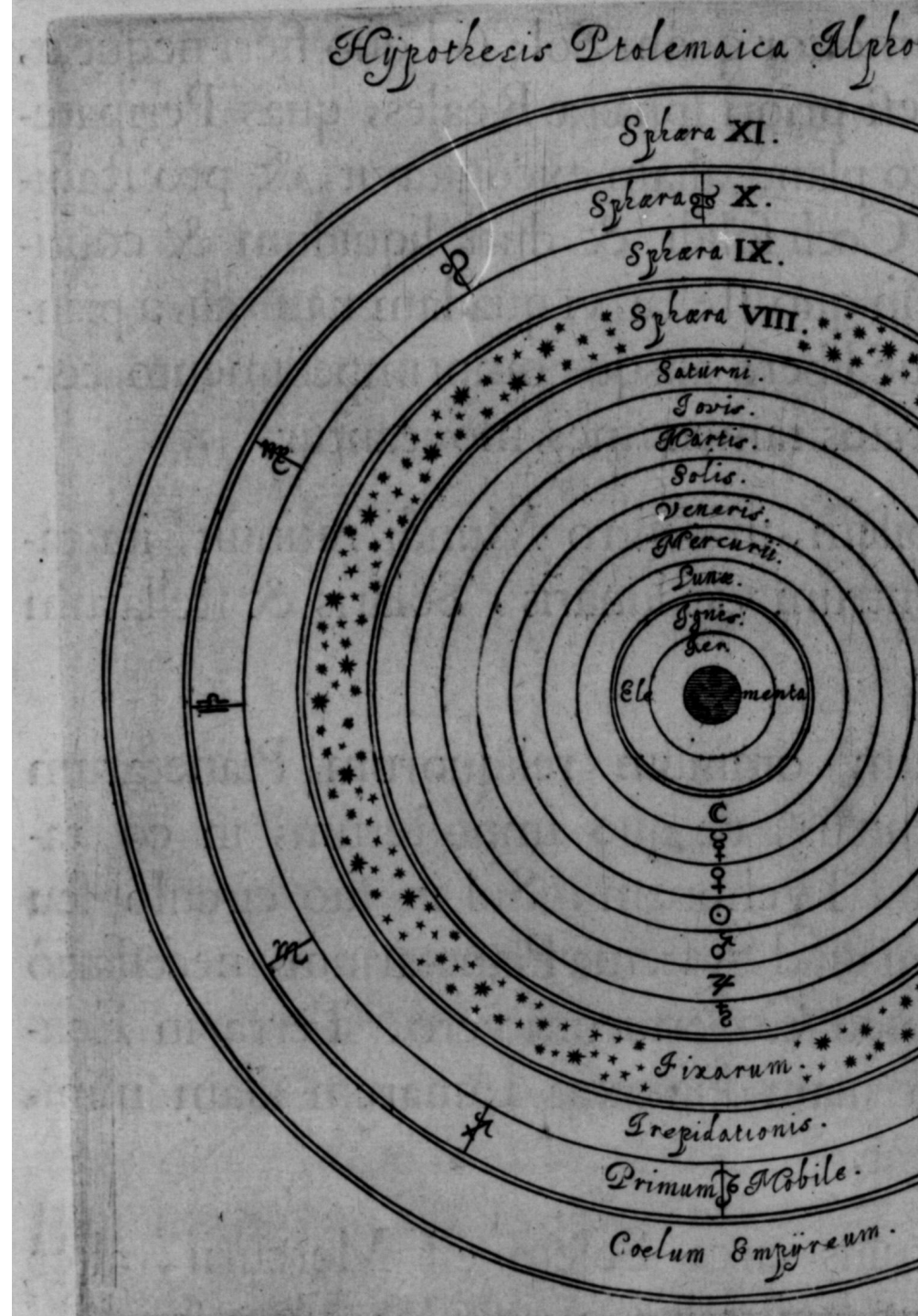
Topics Covered

- Powers of 10 and Scientific Notation
- Motion of the Moon and Planets
- What causes the phases of the moon?
- What causes eclipses?
- What causes the seasons?



Topics Covered

- Copernican Revolution and Scientific Method
- How do we describe what we see?
- What's a theory?



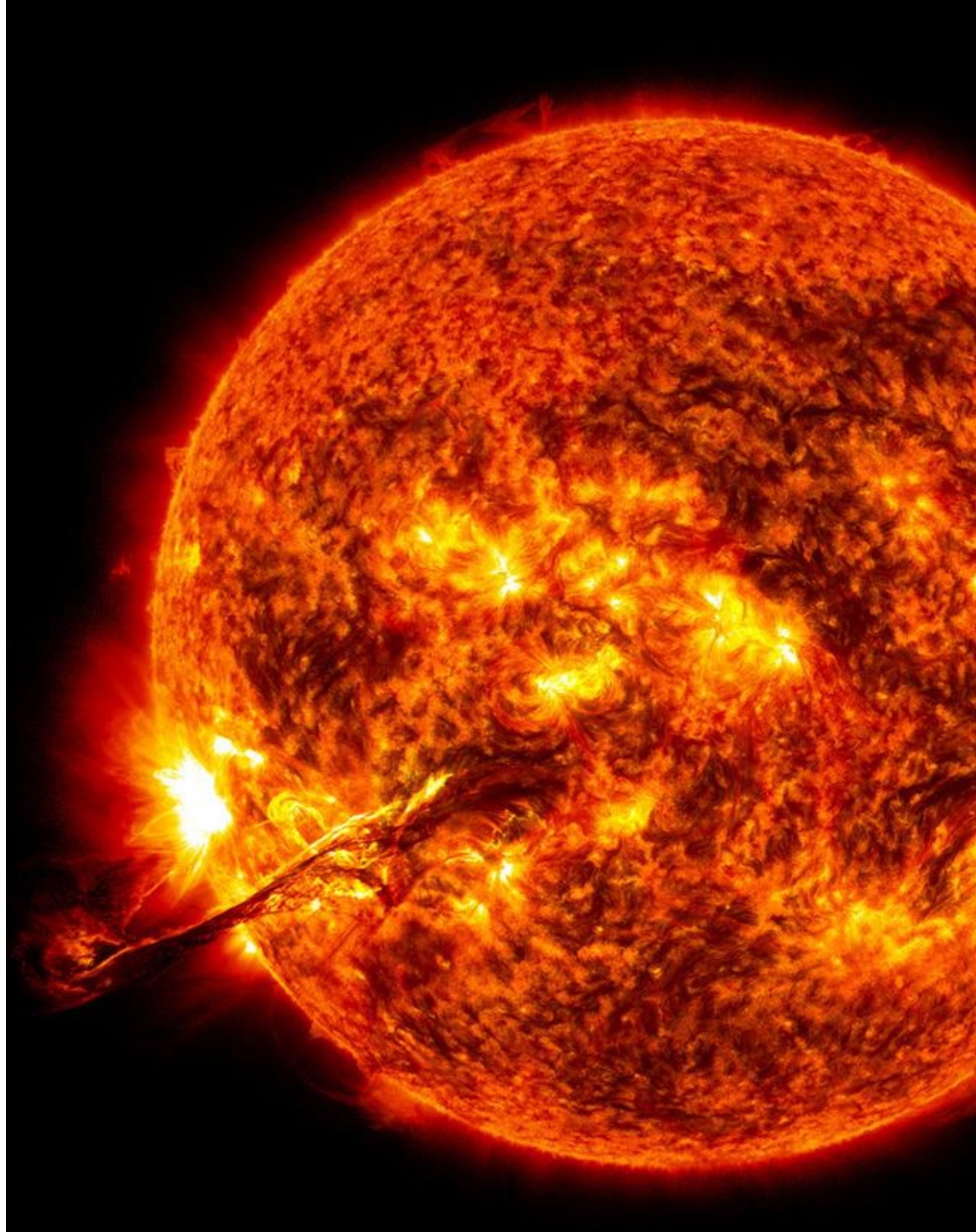
Topics Covered

- Light, Electromagnetic radiation, and Tools of Astronomy



Topics Covered

- Stars
- Why does the Sun shine?
- How are stars born? How do they live and die?
- What do dead stars look like?



Topics Covered

- Planets: What is a planet? How are the planets of the solar system the same? Different? Are there planets around other stars?



Topics Covered

- What are galaxies?
- Does each galaxy have a monster at its center?



Topics Covered

- How big is the universe? How old? How do we know?
- How was the universe born? What's its ultimate fate?



Topics Covered

- Is there life beyond Earth?



Topics Covered

- Astronomy in the news
Recent results, Pretty pictures, etc.
- Your favorite astronomy topic
Send me an email (kotulla@uwm.edu)
with suggestions.

Logistics

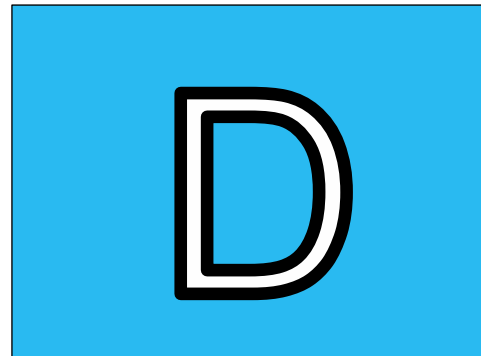
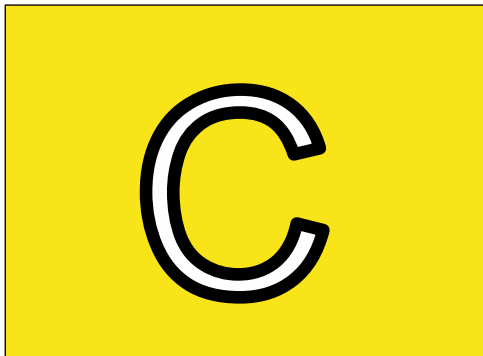
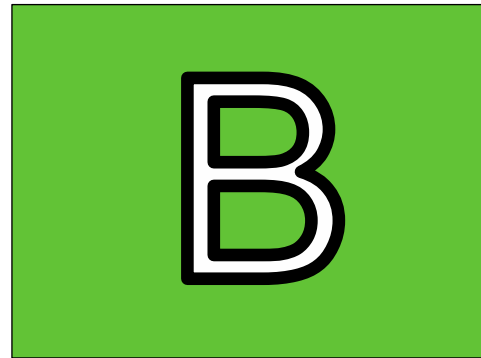
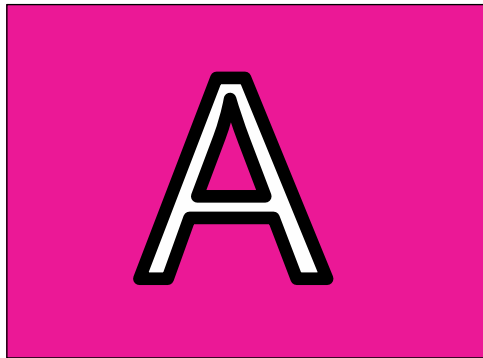
- Homework and quizzes on D2L
 - **17 problem sets, best 12 count for grade**
 - Unlimited attempts, best grade is counted
 - Assigned weekly, but cutoff date is end of semester
 - Don't wait until the last day!
 - **Quiz due every Monday, 11:59 pm**
 - First quiz due Monday, September 8th
 - Best 9/14 quizzes count for grade
 - 4 attempts, 85% to pass

Logistics

- Three midterms
 - Wednesday October 1
 - Wednesday October 29
 - Wednesday November 26
 - Lowest midterm score will be dropped
 - **No makeup midterms!**
- Final exam
 - Wednesday December 17
10:00 am - noon

Logistics

- Cards for discussion questions
- **Save and bring to every class!**



Planetarium Show

- Planetarium shows
 - Across the hall from Physics 137
 - **Entire class: Monday September 22nd**
 - Door locks, so be on time!
 - Attendance will be taken
 - **Planetarium assignment: 100-150 word summary of show, due in class at next class after show**
 - **Summary must contain at least one fact you learn during the show**
 - Planetarium assignment is 5% of course grade

Extra Credit: Stargazing

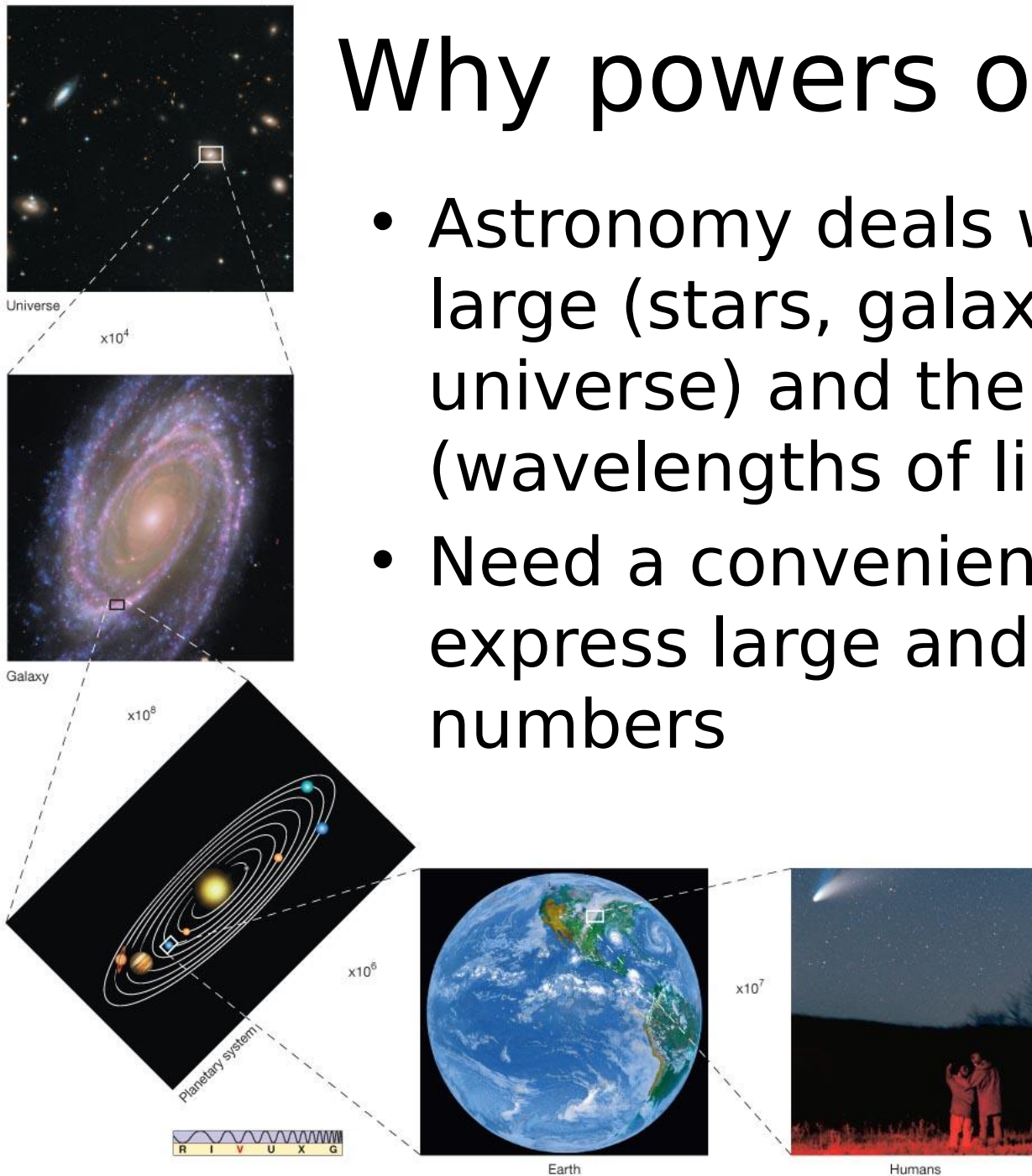
- Several extra credit opportunities throughout the course
- First chance for extra credit: **stargazing sessions**
- For **extra credit** (+1% on final grade), attend one of the sessions listed below, write a short summary of what you did and observed, and turn it in before the last day of classes
- **Where:** UWM Physics Observatory Deck
- **When:** Weather permitting, observing/stargazing will be offered on the following dates:
 - **Wed Sept, 10 at 8:00-9:00 pm**
 - **Wed, Oct 8 at 8:00-9:00 pm**
 - **More dates to be announced soon**
- **More info on D2L**

Preliminaries: Powers of 10

**First reading assignment:
Appendices 1 & 2, Sections
0.1-0.2**

Why powers of 10?

- Astronomy deals with the very large (stars, galaxies, the universe) and the very small (wavelengths of light)
- Need a convenient way to express large and small numbers



Powers of 10

$$10^1 = 10$$

$$10^2 = 10 \times 10 = 100$$

$$10^3 = 10 \times 10 \times 10 = 1000$$

...

$$10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1000000$$

Multiplication

$$\begin{aligned}10^2 \times 10^3 &= 10 \times 10 \times 10 \times 10 \times 10 \\ &= 10^{2+3} \\ &= 10^5\end{aligned}$$

$$10^{11} \times 10^5 = 10^{11+5} = 10^{16}$$

$$2 \times 10^5 \times 3 \times 10^6 = 2 \times 3 \times 10^{5+6} = 6 \times 10^{11}$$

Division

$$\frac{6 \times 10^3}{3 \times 10} = \frac{6}{3} \times \frac{10^3}{10} = 2 \times 10^2 = 200$$

$$\frac{2.1 \times 10^2}{7 \times 10^3} = \frac{2.1}{7} \times \frac{10^2}{10^3} = 0.3 \times 10^{-1} = 3 \times 10^{-2} = 0.03$$

Which of the following correctly ranks locations from closest to Earth to farthest from Earth?

A

the Sun, the edge of our solar system, the nearby star Alpha Centauri, center of Milky Way galaxy, Andromeda Galaxy

B

the nearby star Alpha Centauri, the Sun, edge of our solar system, Andromeda Galaxy, center of Milky Way galaxy

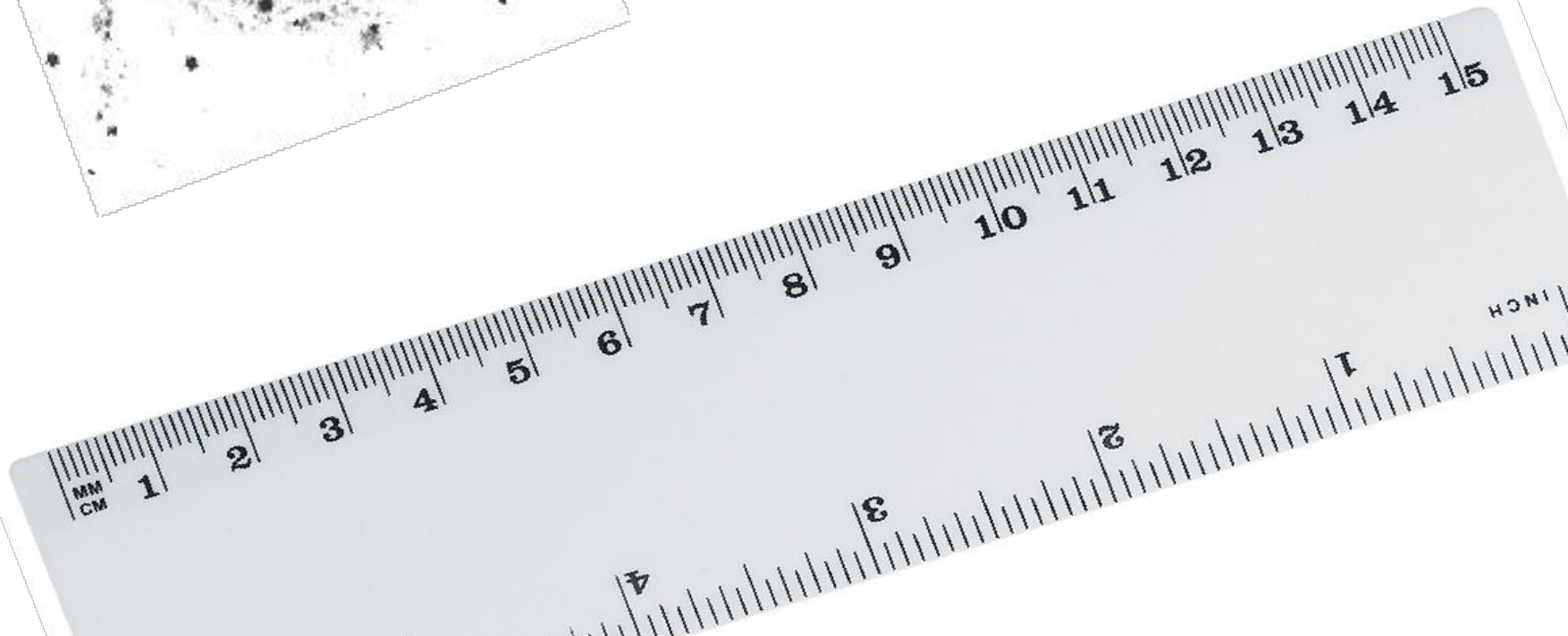
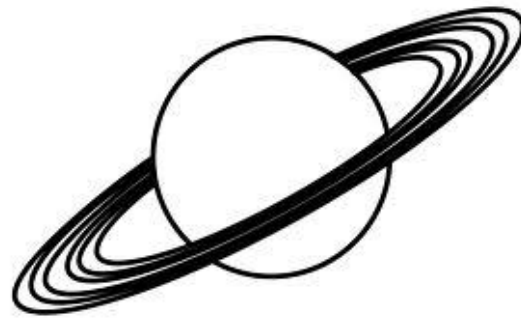
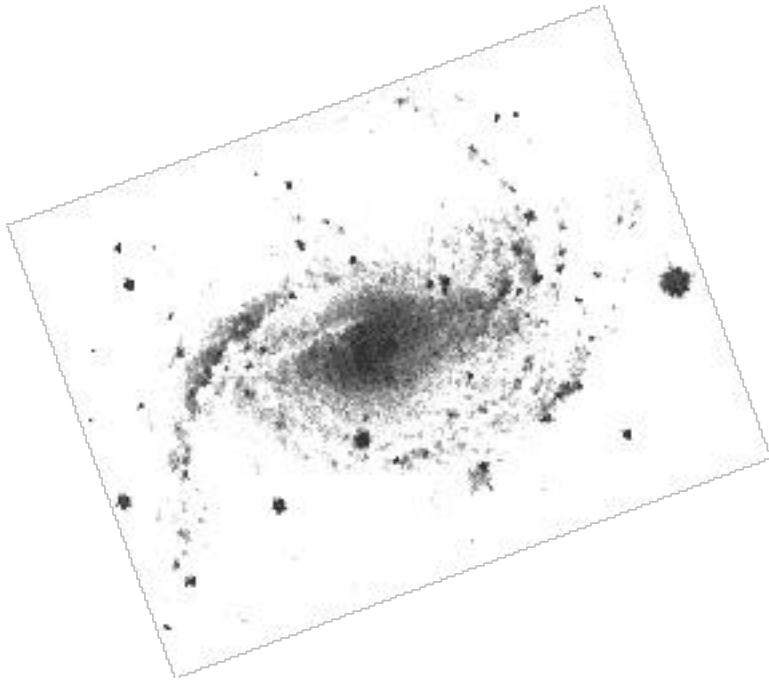
C

the edge of our solar system, the Sun, the nearby star Alpha Centauri, center of Milky Way galaxy, Andromeda Galaxy

D

the Sun, the nearby star Alpha Centauri, edge of our solar system, Andromeda Galaxy, center of Milky Way galaxy

Preliminaries: Yardsticks



Geography of the Universe

- Yardsticks

1 cm = 0.39 in

1 km = 1000 m = 0.62 mi

1 AU = 1.5×10^8 km (distance from Earth to Sun)

- Can use distances based on how far light travels:
speed of light = 300,000 km/s = 3×10^5 km/s

$$d = c t \quad (\text{distance} = \text{speed} \times \text{time})$$

Geography of the Universe

$$d = c * t$$

$$1 \text{ year} = 365 \text{ days}$$

$$= 365 * 24 * 60 * 60 \text{ seconds}$$

$$= 3.16 \times 10^7 \text{ seconds}$$

1 Light-year:

$$d = 3 \times 10^5 \text{ km/s} \times 3.16 \times 10^7 \text{ s} \approx 0.9 \times 10^{13} \text{ km}$$

NOTE:

A LIGHT-YEAR IS A DISTANCE, NOT A TIME

GEOGRAPHY OF THE UNIVERSE

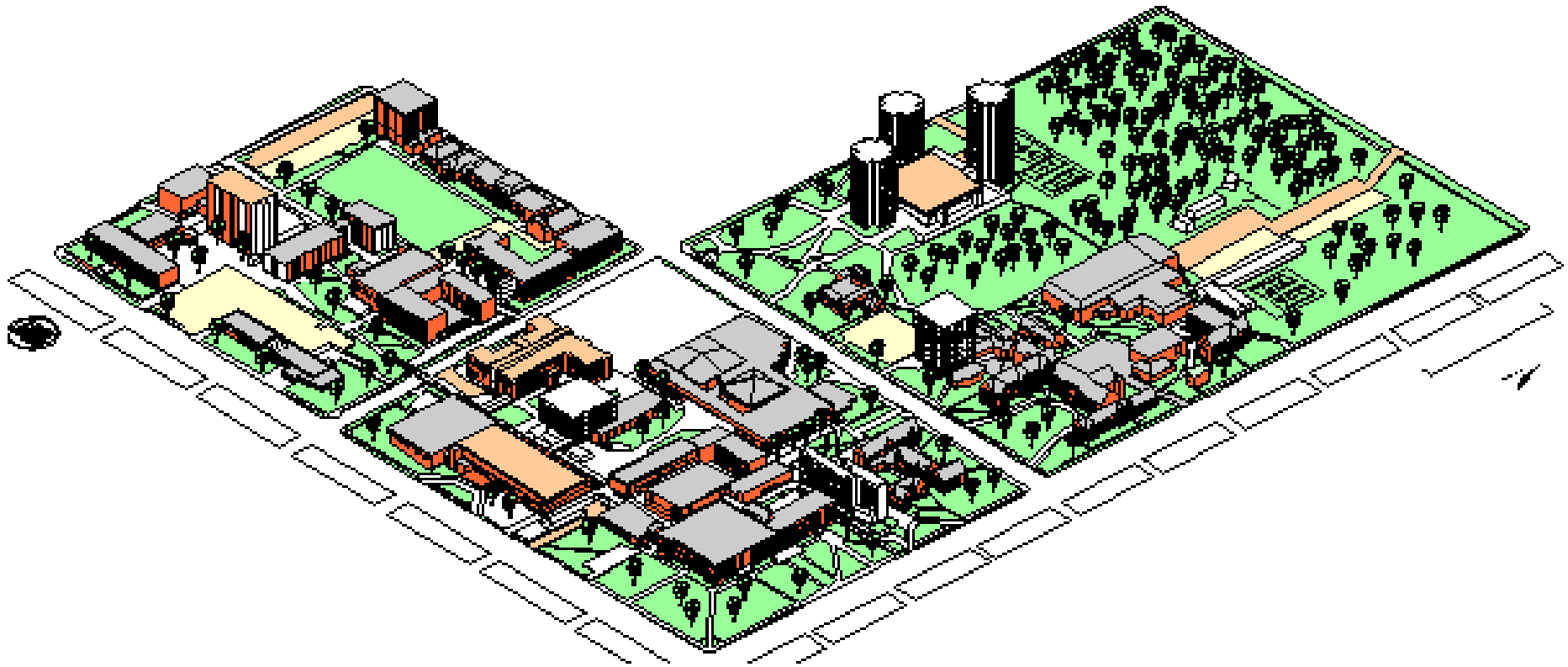
	km	ly		
	10^{-2}		10m = 1/100 km	FRONT OF LECTURE HALL
x100	1			UWM CAMPUS
x100	10^2			SOUTHEAST WISCONSIN
x100	10^4			DIAMETER OF EARTH (1.3x10 ⁴ km)
x100	10^6			DIAMETER OF MOON'S ORBIT (.8 x10 ⁶ km)
x100	10^8			DISTANCE FROM SUN TO EARTH (1.5x10 ⁸ km)
x100	10^{10}			DIAMETER OF SOLAR SYSTEM (1.2x10 ¹⁰ km)
	(10 ¹²)			
x1000	10^{13} km =	1 ly		DISTANCE TO PROXIMA CENTAURI (4 ly)
x100		10^2 ly		DISTANCE TO TYPICAL CLUSTER OF STARS
x100		10^4 ly		DISTANCE TO CENTER OF MILKY WAY (3x10 ⁴ ly)
x100		10^6 ly		DISTANCE TO NEARBY GALAXIES
x100		10^8 ly		DISTANCE TO LARGE CLUSTERS OF GALAXIES
x100		10^{10} ly		SIZE OF VISIBLE UNIVERSE

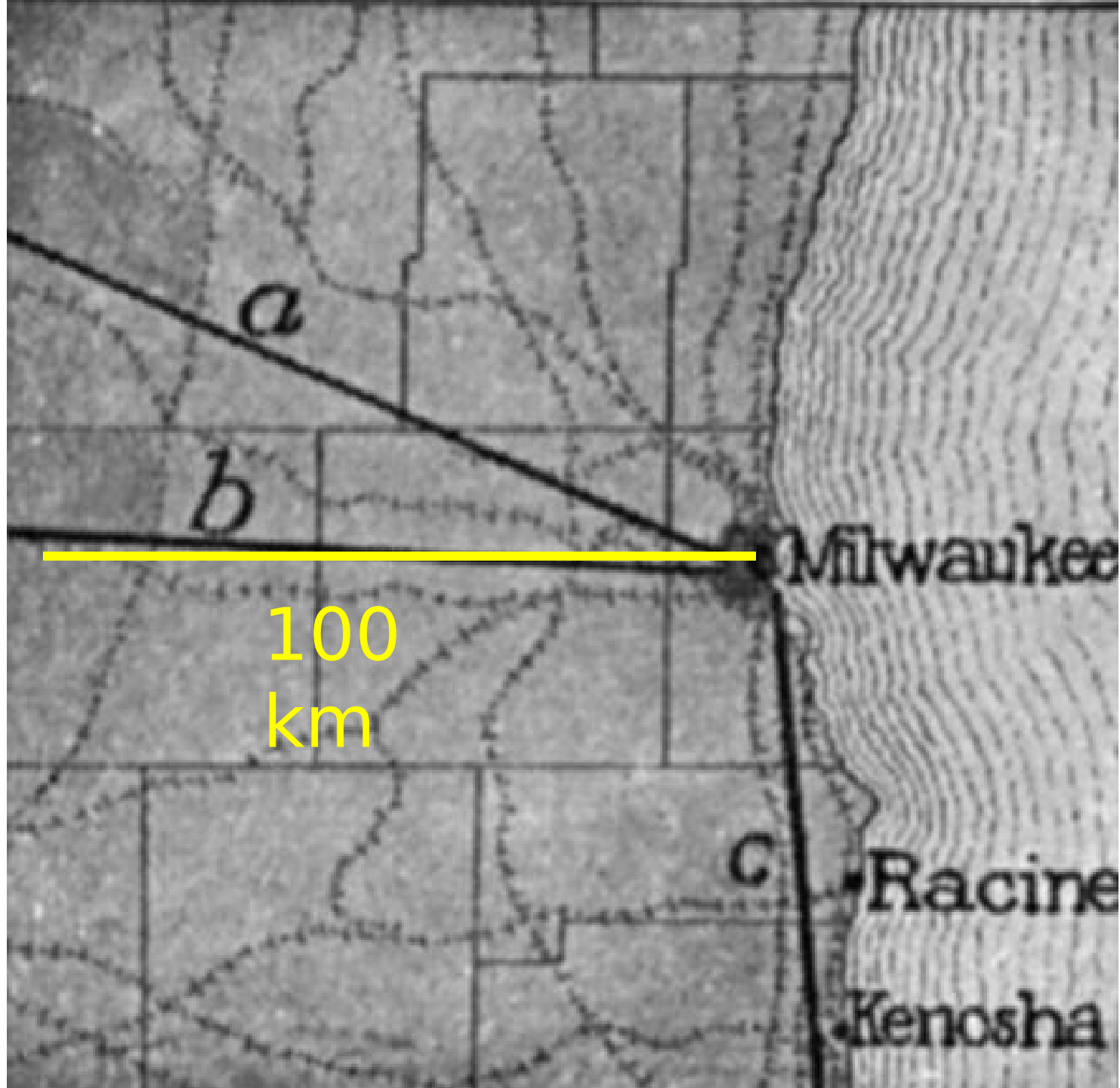
10 m
Front of the lecture hall



1km

UWM Campus





a

b

c

Milwaukee

Racine

Kenosha

100
km

1.3×10^4 km

Diameter of
Earth

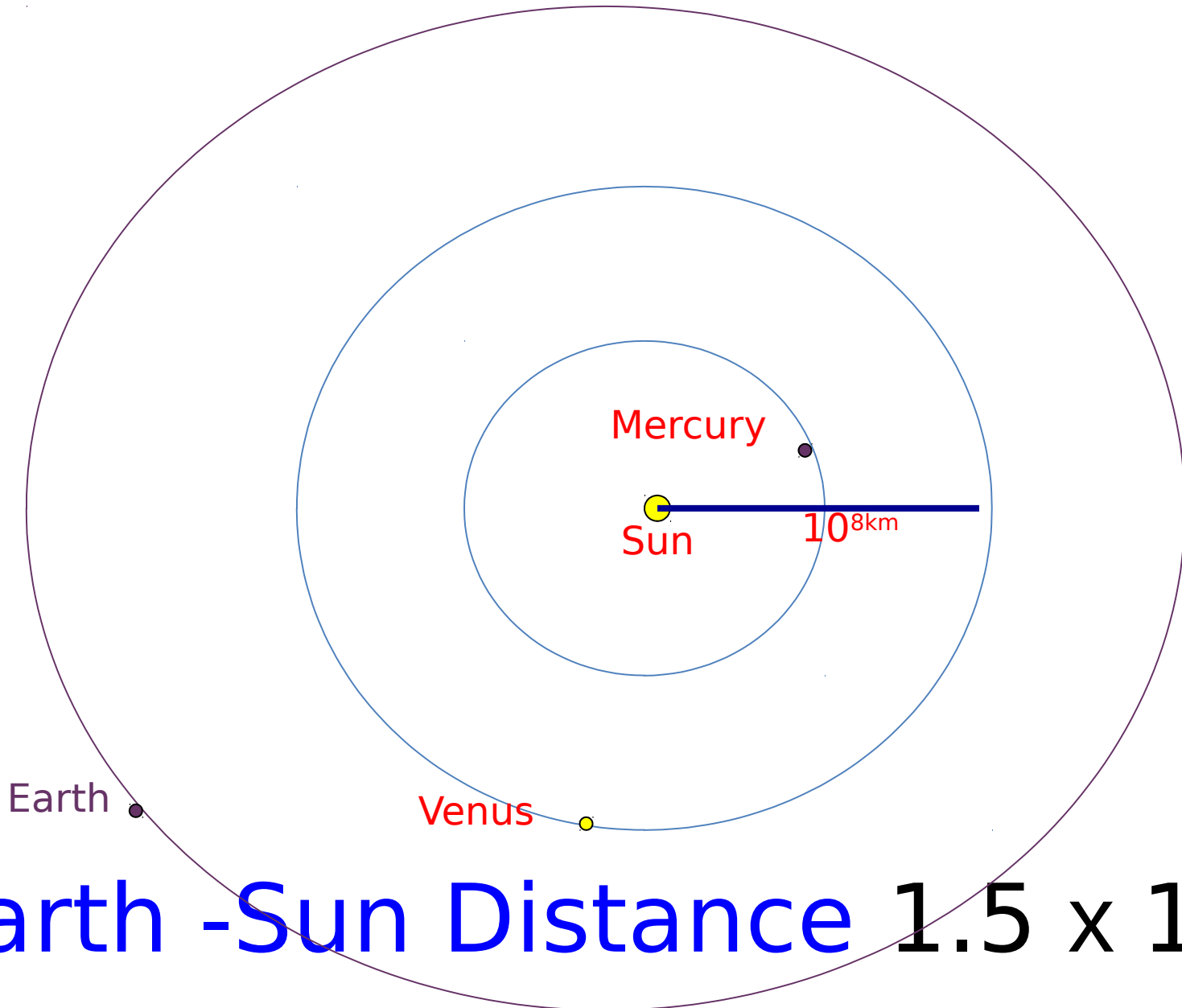


$3/4 \times 10^6 \text{ km}$

Diameter of
Moon's
Orbit



10^8 km



Earth - Sun Distance 1.5×10^8 km

10^{10} km



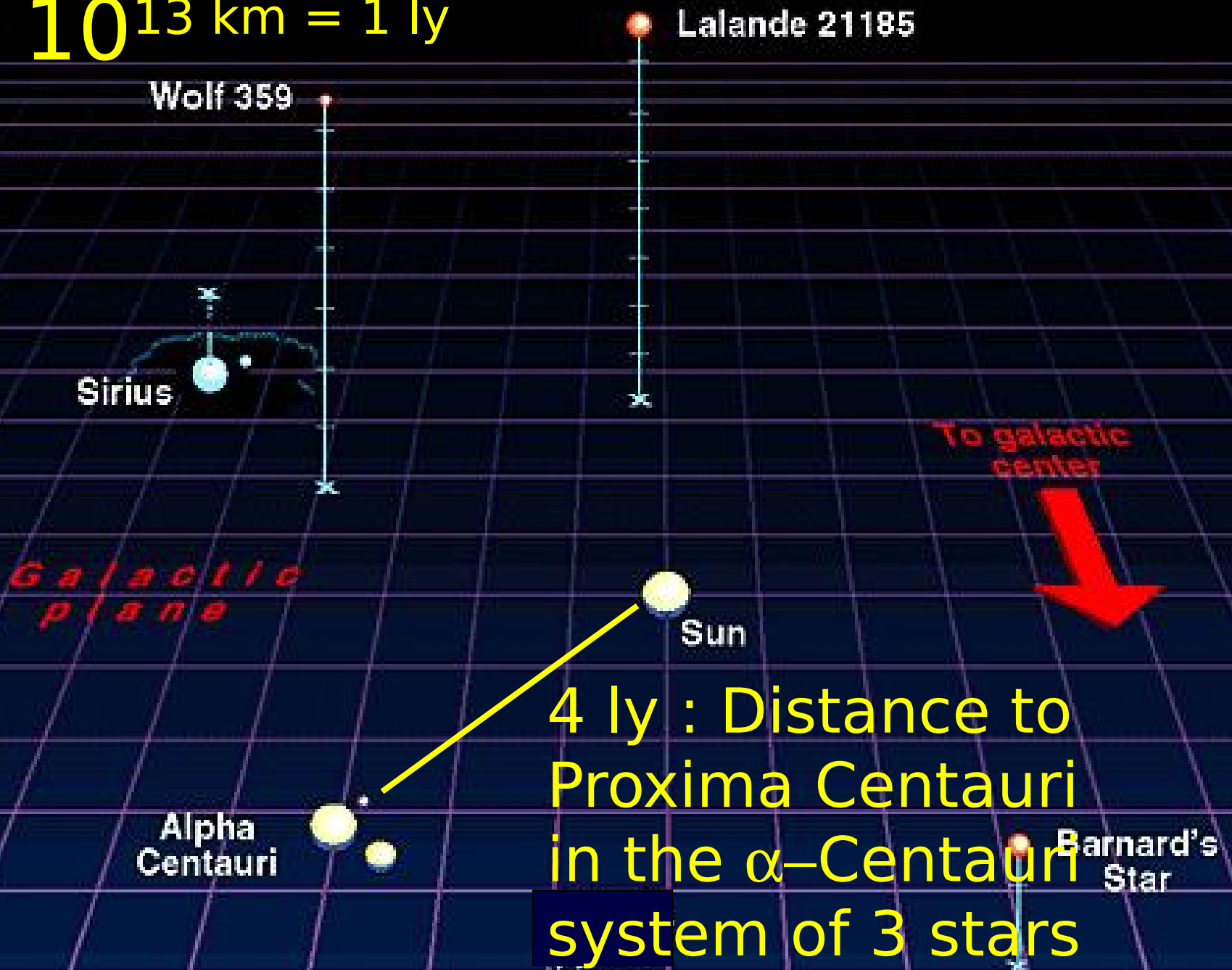
Diameter of Solar System

10^{12} km

Nothing new: The galaxy (and the universe) is nearly empty.
The solar system is a small disk surrounded by empty space.

Only after traveling 10^{13} km, more than 1000 times the size of
the solar system, do we find another star.

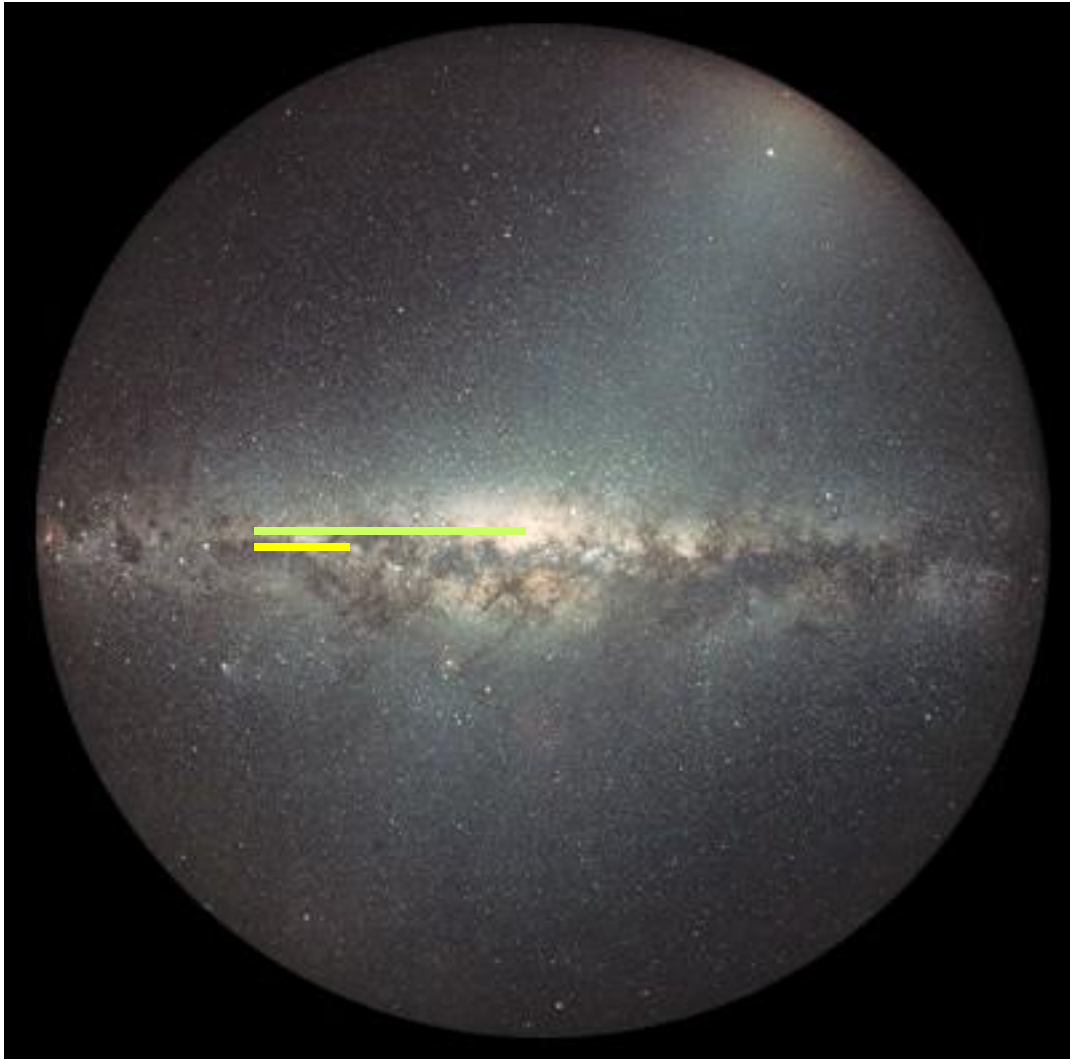
10^{13} km = 1 ly



10^2 ly

Distance to Pleiades: 440 ly

10^4 ly



Distance to Center of Milky Way: 3×10^4 ly

10^6 ly

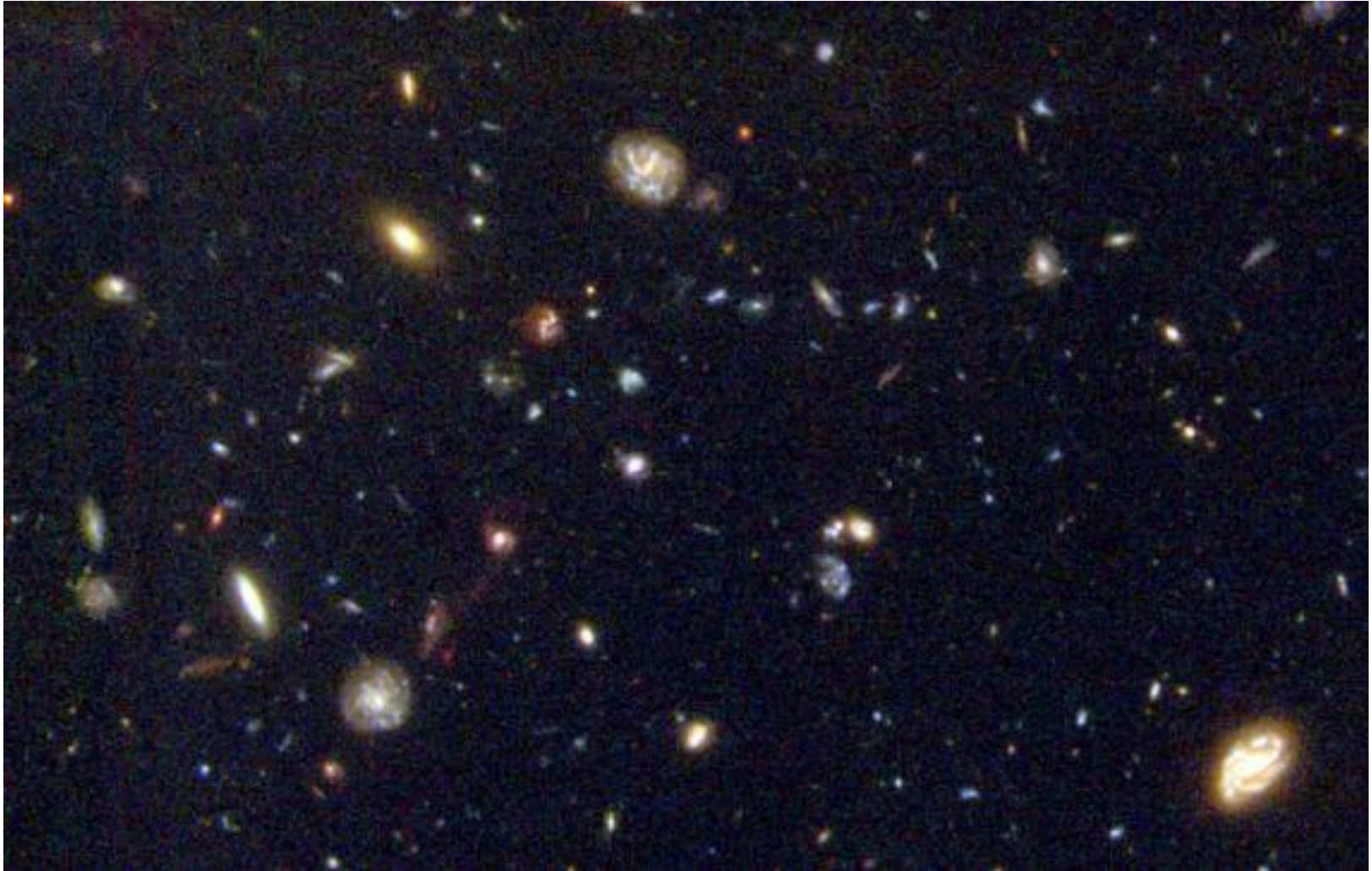
Distance to Andromeda Galaxy: 2×10^6 ly

10^8 ly



Distance to Virgo Cluster of Galaxies: 0.5×10^8 ly

10^{10} ly



Size of Visible Universe:

Distance to furthest observed galaxies

Which of the following correctly ranks locations from closest to Earth to farthest from Earth?

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Powers of 10 Video: <https://www.youtube.com/watch?v=0fKBhvDjuy0>