Astronomy 103
Survey of Astronomy

Physics 137

MWF 11:00 - 11:50 AM

Keck Telescopes
Mauna Kea, Hawaii

Dawn Erb

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414 229 3654

Physics 472

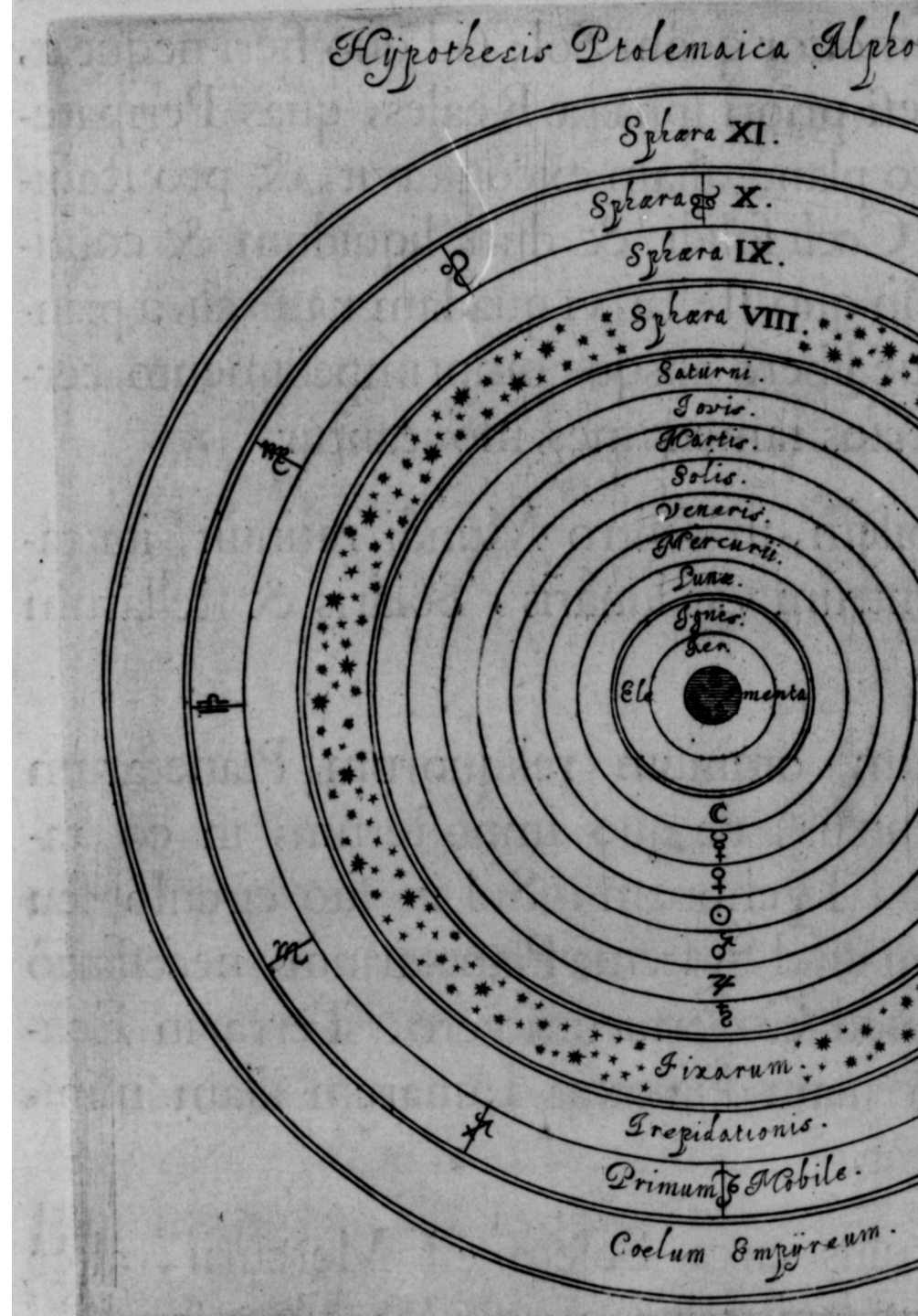Office hours Monday & Wednesday 1-2 pm or by appt

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?
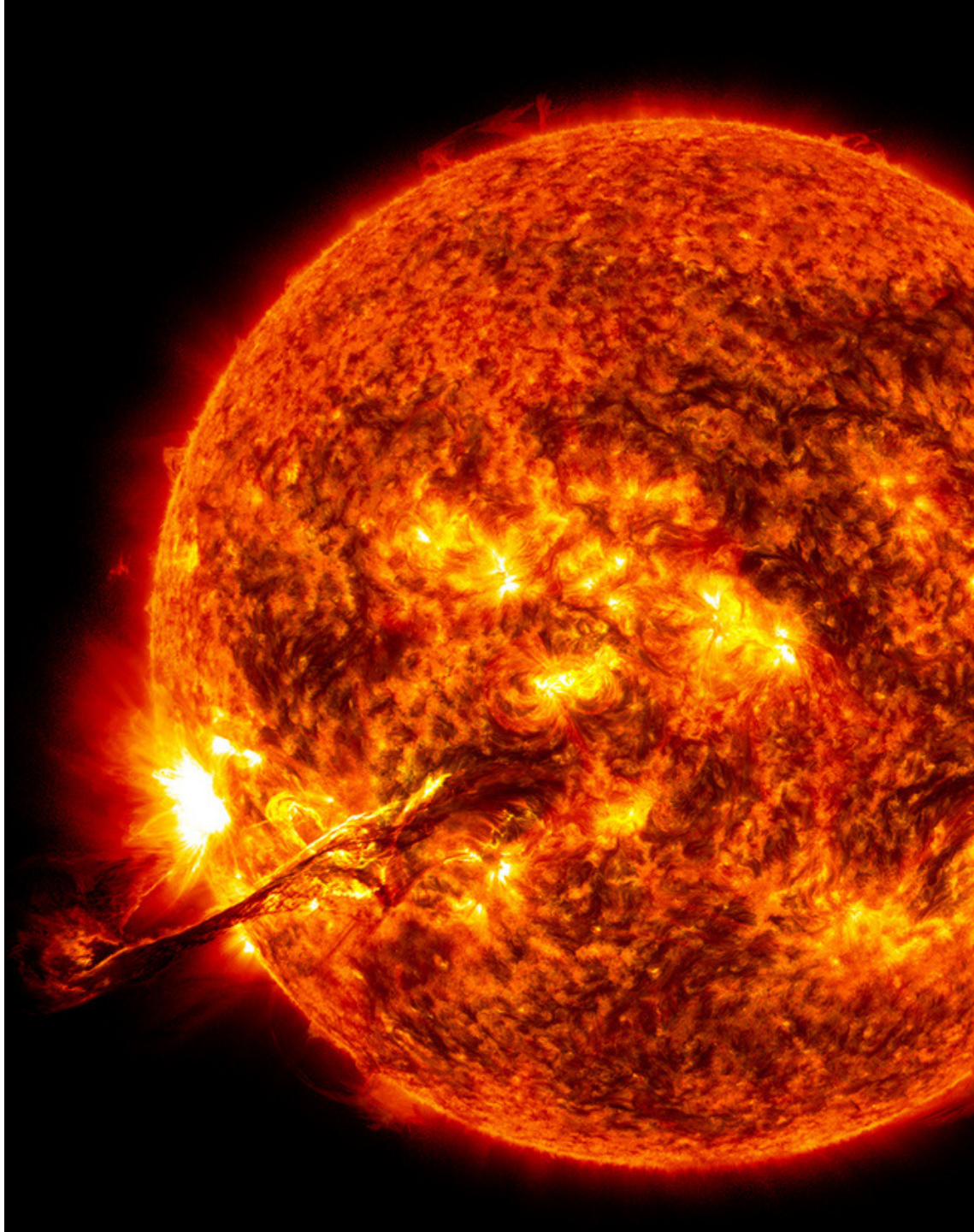
- What's a theory?

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?

Credit: NASA

Topics Covered

- What are galaxies?

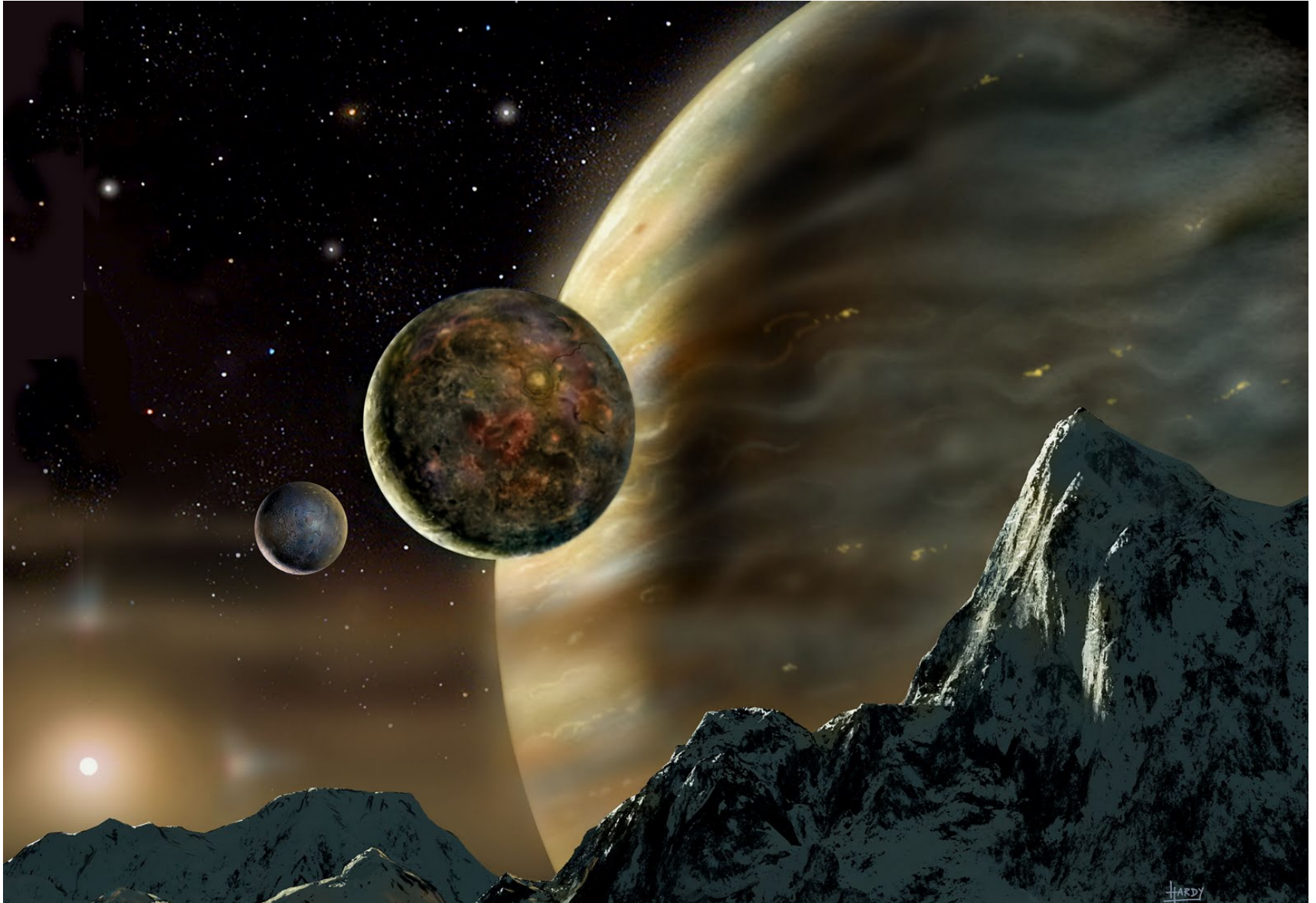- Does each galaxy have a monster at its center?

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?

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 January 27
  - Best 9/14 quizzes count for grade
    - 4 attempts, 85% to pass

Logistics

- Three midterms
  - Wednesday February 19
  - Wednesday March 26
  - Wednesday April 21
  - Lowest midterm score dropped
  - **No makeup midterms!**
- Final exam
  - Monday May 12, 10:00 am - noon

Logistics

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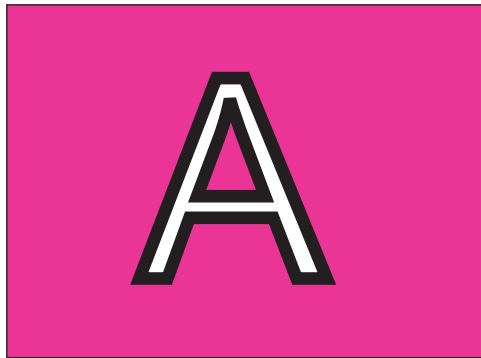
Review Sessions and Tutoring

- Panther Academic Support Services (PASS) offers Supplemental Instruction (SI) review sessions

- Review sessions will be conducted by Renee Spiewak in the Library E170
  - Mondays 3-4 pm
  - Tuesdays 11 am-12 pm
  - Wednesdays 3-4 pm
  - Fridays 10-11 am and 2-3 pm

Planetarium Show

- Planetarium shows
  - Across the hall from Physics 137
  - **Last names A-K during class Wednesday Jan 29**
  - **Last names L-Z during class Friday January 31**
  - 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

- There will be 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:
  - **Feb 3, 4, 5, 6 at 8:00-9:00 pm**
  - **Wed, Feb 12 at 8:00-9:00 pm**
  - **Wed, March 12 at 8:00-9:00 pm**
  - *Note the later time for the following sessions!*
  - **Wed April 9 at 9:00-10:00 pm**
  - **April 21, 22, 23, 24 at 9:00-10:00 pm**
  - **May 14 at 9:00-10:00 pm**
- **More info on D2L**

Preliminaries: Powers of 10

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

Why powers of 10?

Universe
$\times 10^4$

Galaxy
$\times 10^8$

Planetary system
$\times 10^6$

Earth
$\times 10^7$

Humans

R I V U X G

- 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

$$10^1 = 10$$

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

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

$$\ldots$$

$$10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1,000,000$$

Multiplication

$$10^2 \times 10^3 = 10 \times 10 \quad \times \quad 10 \times 10 \times 10$$

$$= 10^{2+3}$$

$$= 10^5$$

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

$$= 10^{16}$$

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

Division

$$\frac{10^2}{10^3} = \frac{10 \times 10}{10 \times 10 \times 10} = \frac{1}{10} \text{ or } 10^{-1}$$

$$\frac{10^2}{10^3} = 10^{2-3} = 10^{-1} = 0.1$$

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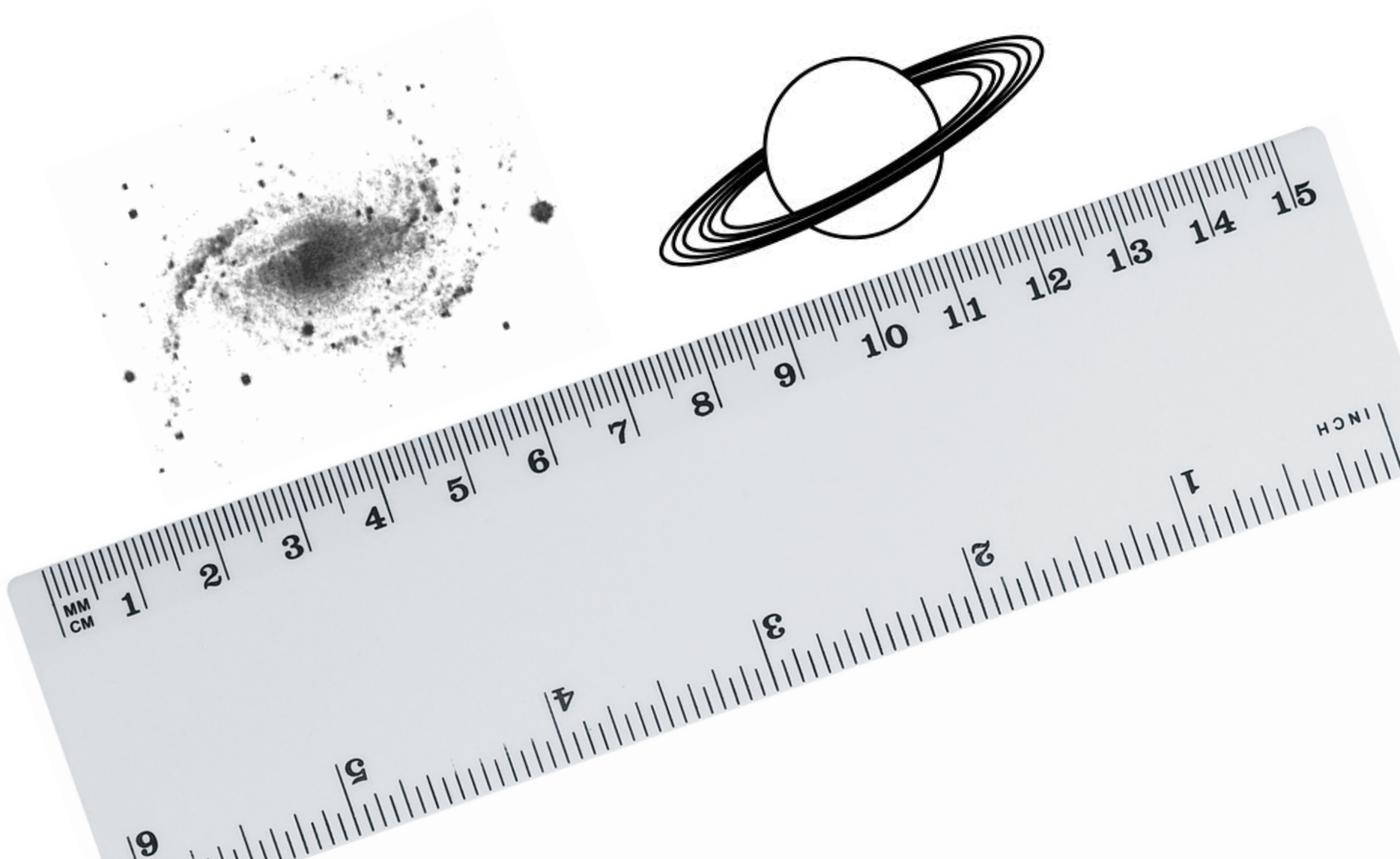
C the edge of our solar system, the Sun, the nearby star Alpha Centauri, center of Milky Way galaxy, Andromeda Galaxy

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   (distance = speed x time)

d = c t

1 year = 365 days = 3.16×10^7 seconds

distance = 0.9×10^{13} km

1 light-year = 0.9×10^{13} km

Check:

1 year = 365 days

$\qquad$ = 365 x 24 x 60 x 60 s = 3.16 x 10^7 s

d=ct = 3x 10^5 km/s x 3.16 x 10^7 s

$\qquad$ = 9.48 x 10^{12} km

$\qquad$ $\cong$ 0.9 x 10^{13} km

1 light-year = 0.9 x 10^{13} km

NOTE:

A LIGHT-YEAR IS A DISTANCE (10^{13} km)

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 $\qquad$ (1.3×10^4 km)
x100	10^6		DIAMETER OF MOON'S ORBIT $\qquad$ ($.8 \times 10^6$ km)
x100	10^8		DISTANCE FROM SUN TO EARTH $\qquad$ (1.5×10^8 km)
x100	10^{10}		DIAMETER OF SOLAR SYSTEM $\qquad$ (1.2×10^{10} km)
	(10^{12})		
x1000	10^{13} km =	1 ly	DISTANCE TO PROXIMA CENTAURI $\qquad$ (4 ly)
x100		10^2 ly	DISTANCE TO TYPICAL CLUSTER OF STARS
x100		10^4 ly	DISTANCE TO CENTER OF MILKY WAY (3×10^4 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_

100 km

_c_

Milwaukee

Racine

Kenosha

1.3×10^4 km

Diameter
of Earth

$3/4 \times 10^6$ km

Diameter of Moon's Orbit

10^8 km

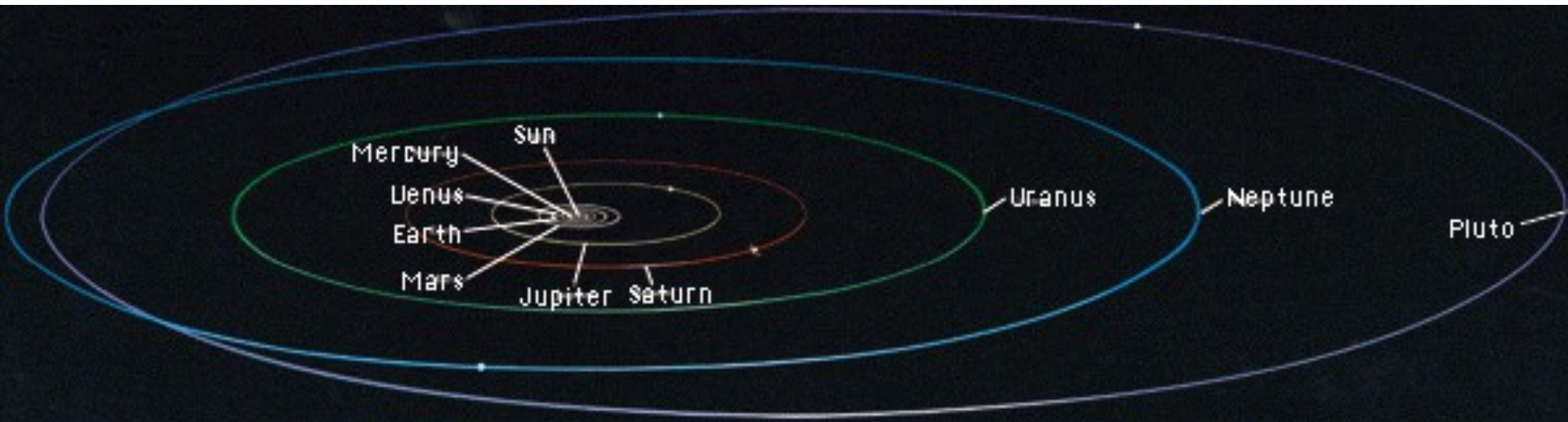Mercury

Sun

10^8km

Earth

Venus

Earth -Sun Distance 1.5×10^8 km
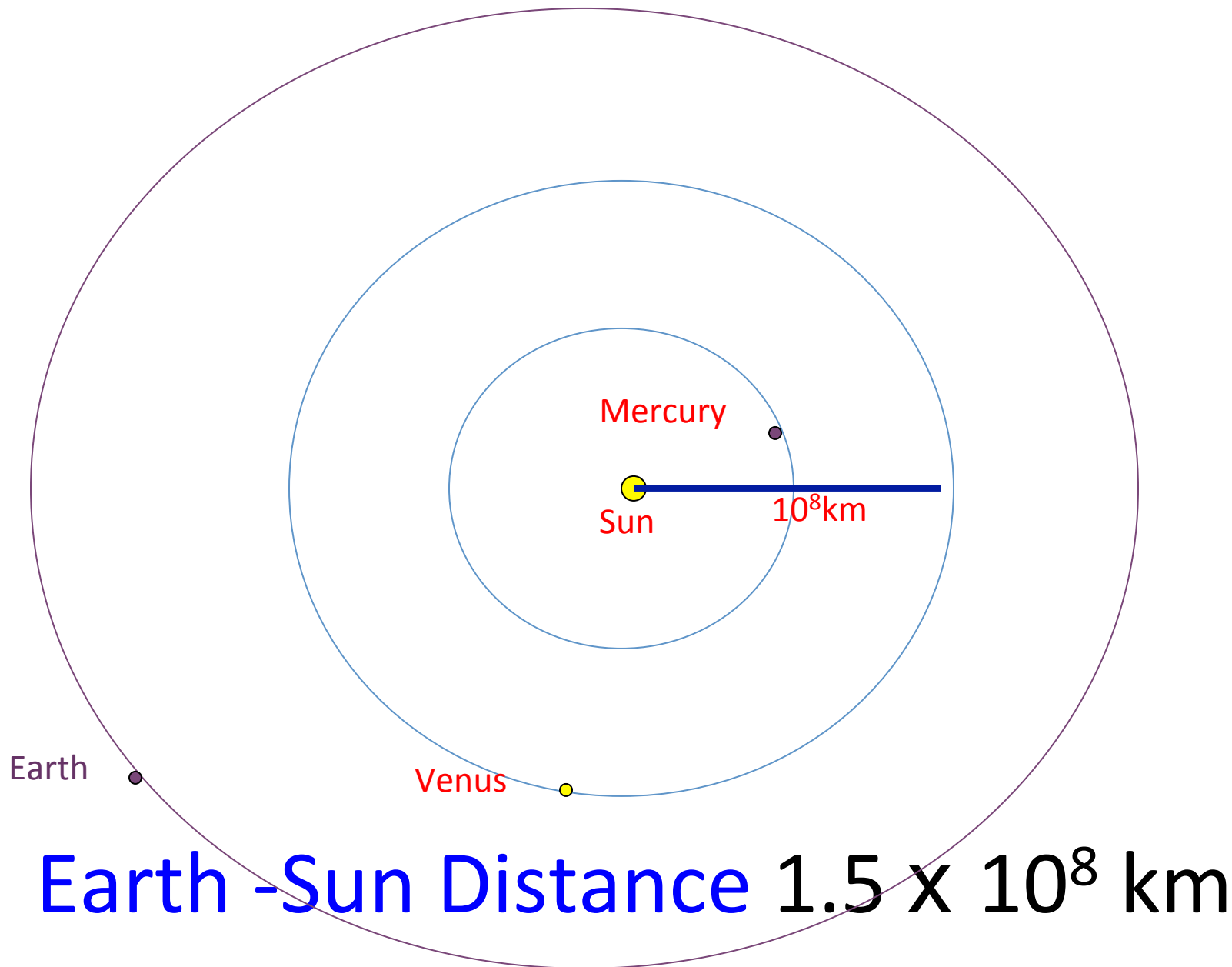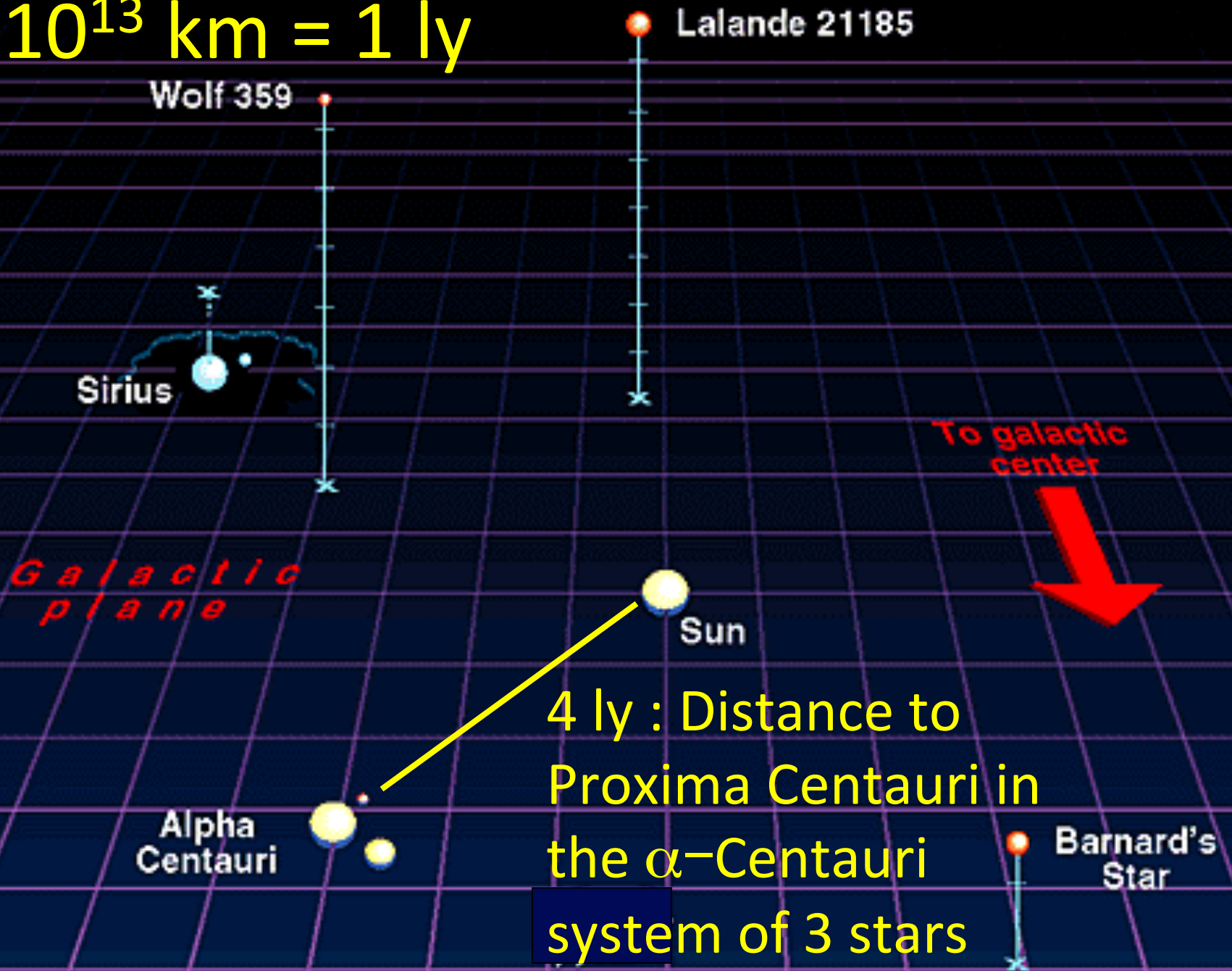
10^{10} km

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,
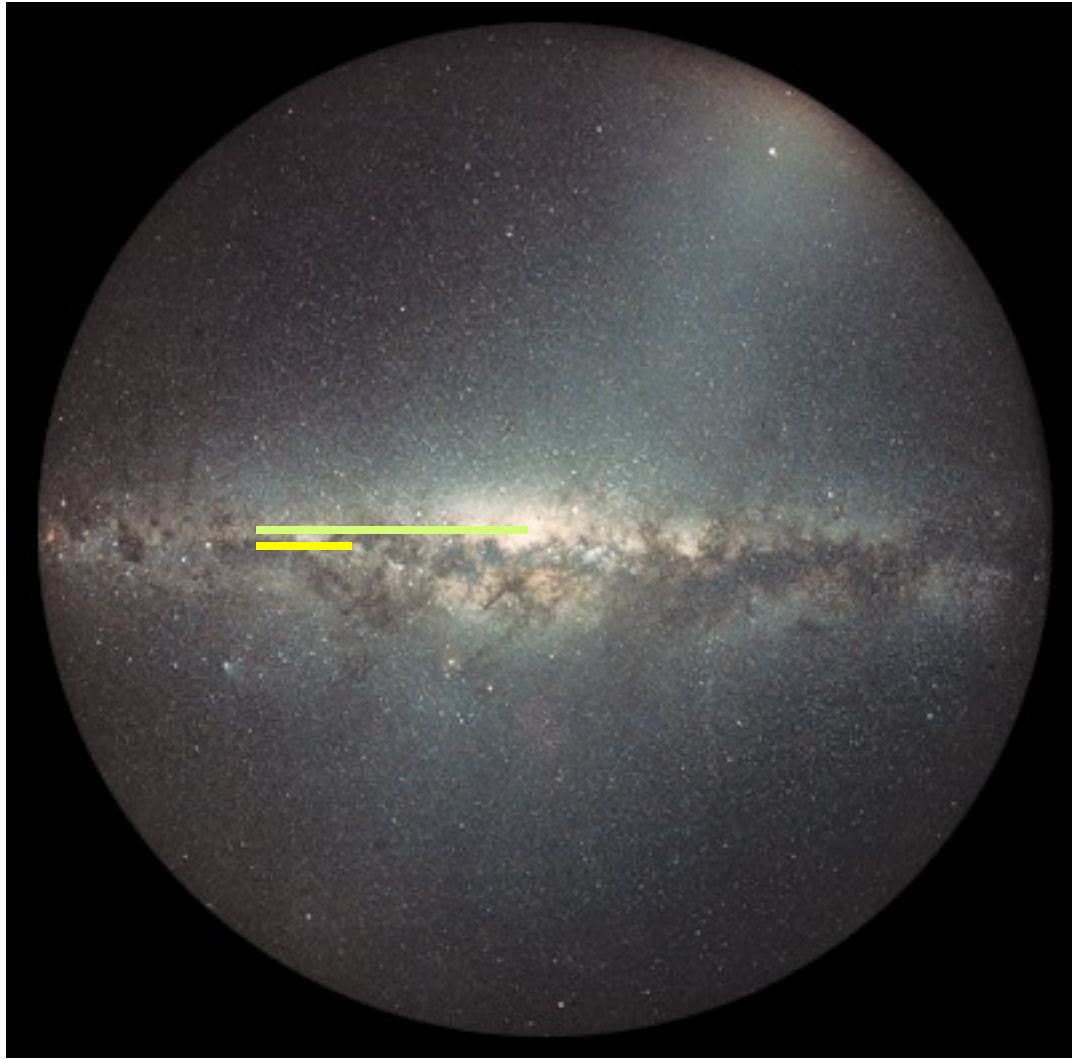do we find another star.

10^{13} km = 1 ly
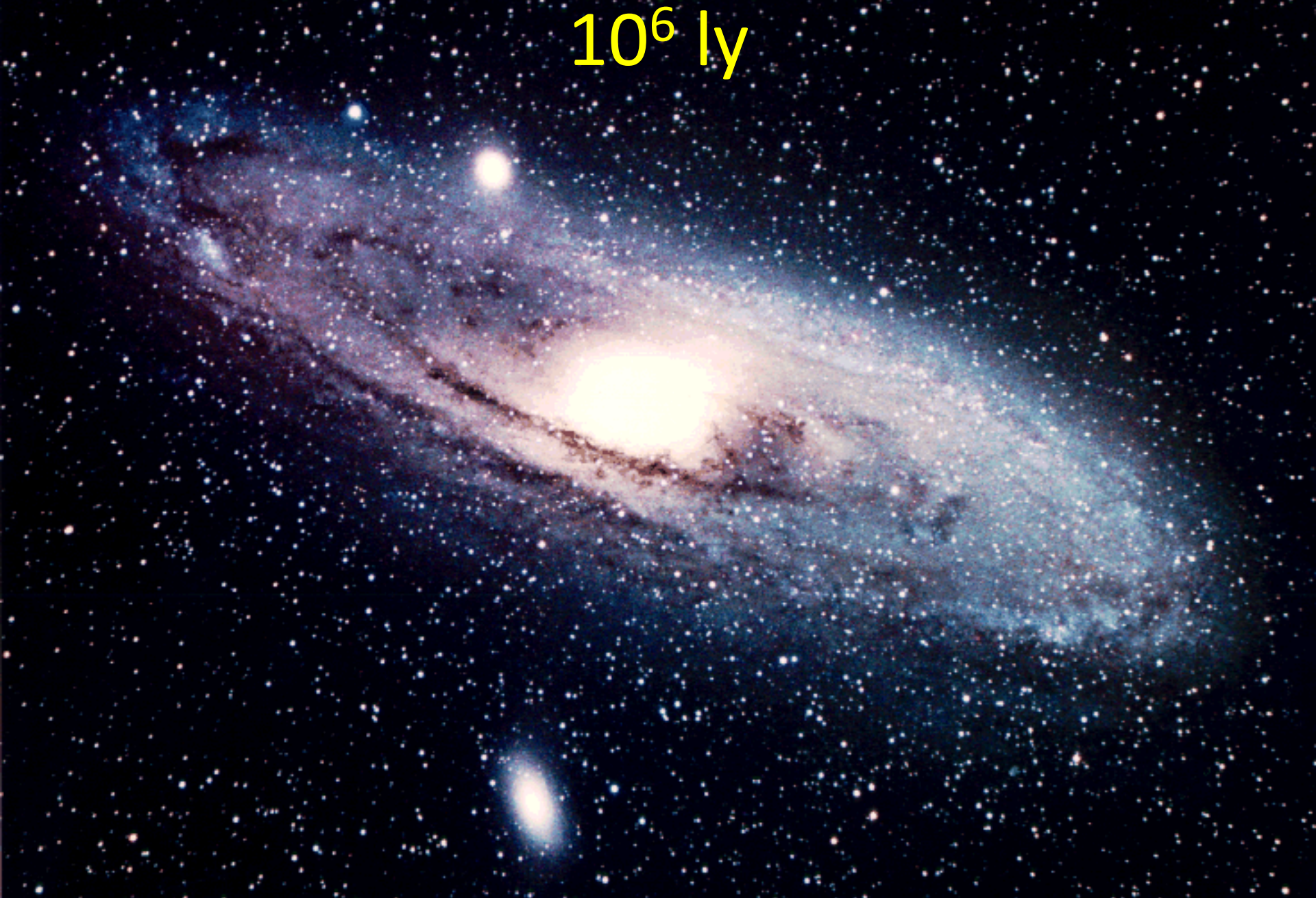
Lalande 21185

Wolf 359

Sirius

To galactic center

Galactic plane

Sun

4 ly : Distance to Proxima Centauri in the α–Centauri system of 3 stars

Alpha Centauri

Barnard's Star

10^2 ly

Distance to Pleiades: 440 ly

10^4 ly

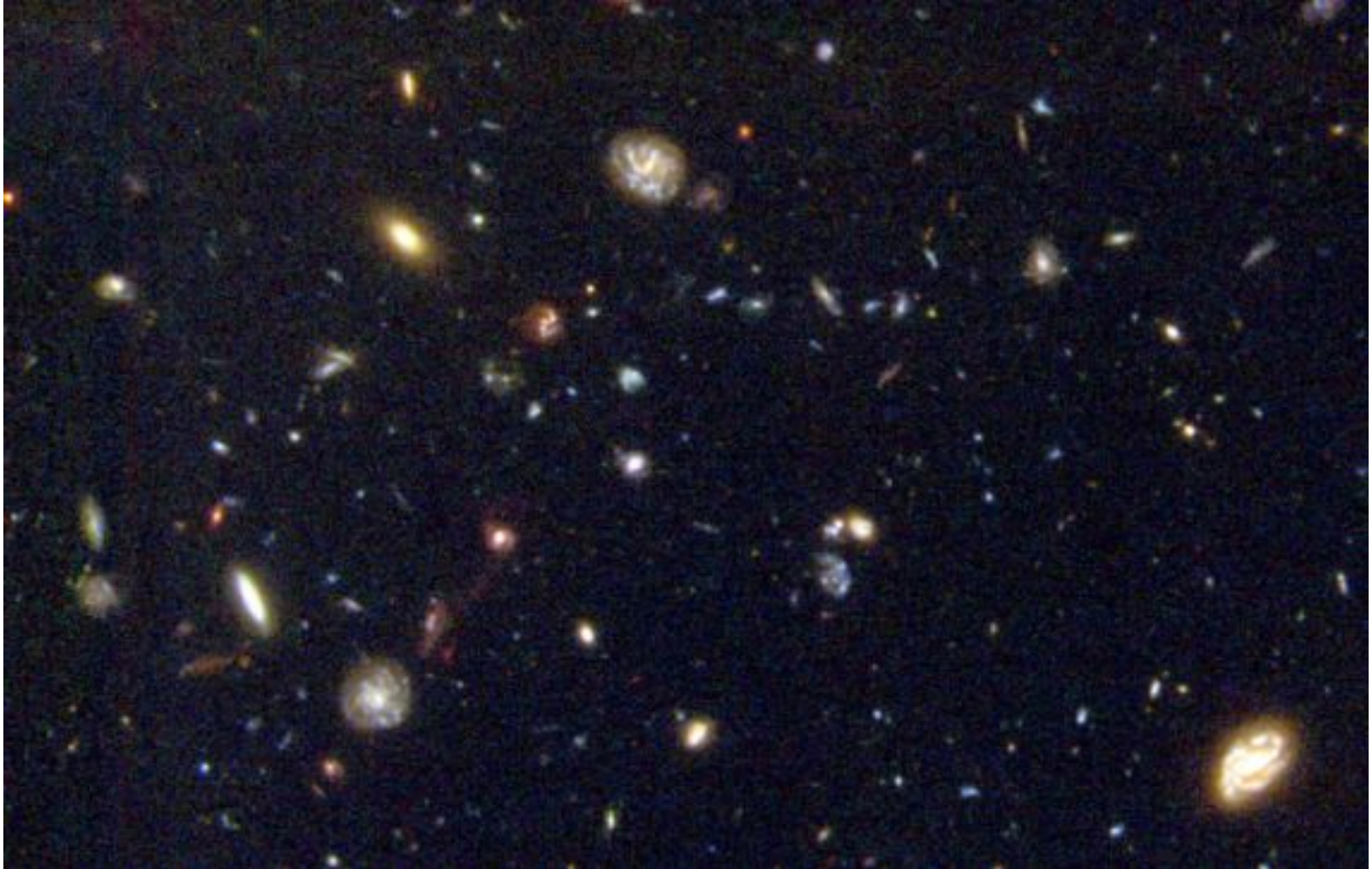Distance to Center of Milky Way: 3×10^4 ly

10^6 ly

Distance to Andromeda Galaxy: 2×10^6 ly

10^8 ly

Distance to Virgo Cluster of Galaxies: 1/2 x10^8 ly

10^{10} ly

Size of Visible Universe:

Distance to furthest observed galaxies

Which of the following correctly ranks locations from <u>closest to Earth to farthest from Earth</u>?

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

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