

## Outline for 29 August (Tuesday)

- **Course Outline and Syllabus**  
( ~15 minutes)
- **Introduction to ASTR 111**  
(~30 minutes)
- **Review of Math that is used in Astronomy** (~30 minutes)

## Lecture Outline

- **Course Outline and Syllabus**  
( ~15 minutes)



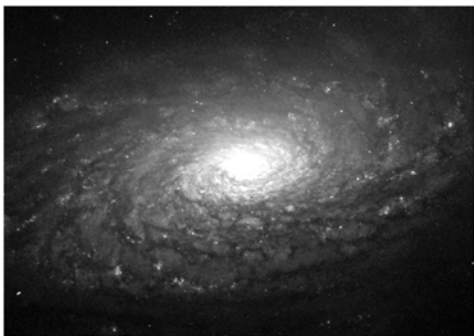
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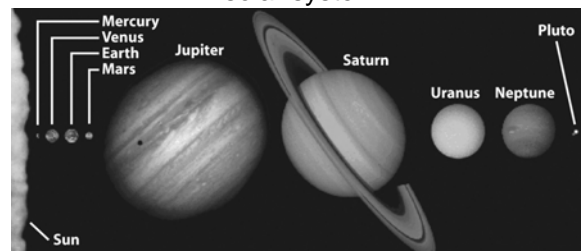
## Introduction to ASTR 111

- What does an astronomer do?
- The Pluto Problem
- Estimation of angles
- Astronomical distances

By observing galaxies, astronomers learn about the origin and fate of the universe

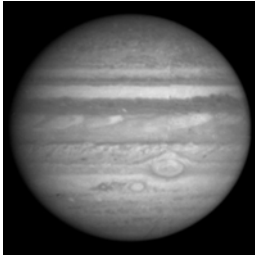


By exploring the planets, astronomers uncover clues about the formation of the solar system



- The star we call the Sun and all the celestial bodies that orbit the Sun
  - including Earth
  - the other eight planets
  - all their various moons
  - smaller bodies such as asteroids and comets (and dwarf planets such as Pluto)

What does an astronomer see in this picture?



To understand the universe, astronomers use the laws of physics to construct testable theories and models

- **Scientific Method**
  - based on observation, logic, and skepticism
- **Hypothesis**
  - a collection of ideas that seems to explain a phenomenon
- **Model**
  - hypotheses that have withstood observational or experimental tests
- **Theory**
  - a body of related hypotheses can be pieced together into a self consistent description of nature
- **Laws of Physics**
  - theories that accurately describe the workings of physical reality, have stood the test of time and been shown to have great and general validity



## Introduction to ASTR 111

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## Pluto: Problem “Planet”

Of Cosmic Proportions  
Astronomers decide Pluto isn't a real planet anymore. Why they did it—and how our view of the universe is changing.

12 Planets? Just days before Pluto's demotion, three new planets were expected to be added to the planetary definition.

## We almost had 12 planets

- “a planet is any body that orbits a star, is neither a star nor a satellite of a planet, and has gravity strong enough to pull it into a rounded shape”
- ... and “a planet must be heavy enough to clear other objects from its path”  
[http://www.space.com/scienceastronomy/060819\\_new\\_proposal.html](http://www.space.com/scienceastronomy/060819_new_proposal.html)

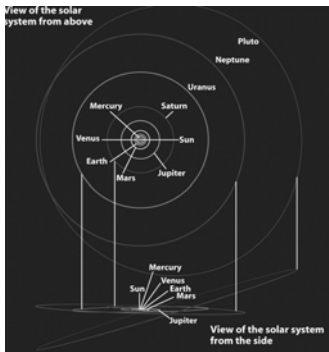
- This serves as a reminder that we are still learning about places nearby in the universe ... but ...

- My Very Educated Mother Just Served Us Nine Pizzas ... My Very Educated Mother Just Said Uh-oh No Pluto

• My Very Educated Mother Just Served Us Nine Pizzas ... My Very Educated Mother Just Said Uh-oh No Pluto

- My Very Educated Mother Just Served Us Ninjas?

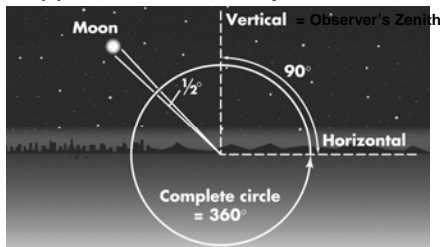
## Pluto: Problem “Planet”



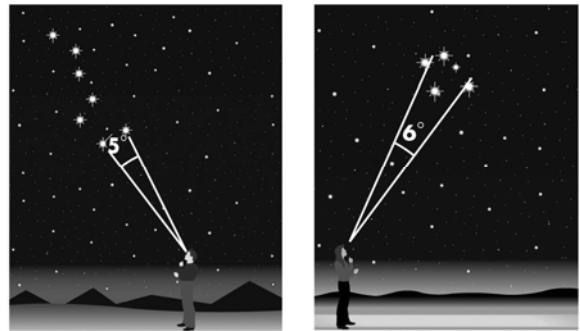
## Introduction to ASTR 111

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Astronomers use angles to denote the positions and apparent sizes of objects in the sky



- The basic unit of angular measure is the **degree** ( $^{\circ}$ ).
- Astronomers use angular measure to describe the apparent size of a celestial object—what fraction of the sky that object seems to cover
- The **angular diameter** (or **angular size**) of the Moon is  $\frac{1}{2}^{\circ}$  or the Moon **subtends** an angle of  $\frac{1}{2}^{\circ}$ .



If you draw lines from your eye to each of two stars, the angle between these lines is the **angular distance** between these two stars



## Answers

- 1.
- 2.
3. Next week you come sit in the same chair but weigh 30 pounds less. Will your (angular) measurements change? Yes. Increase. The length of your arm would not change, but the width of your hand would decrease. Instead of needing one hand width to obscure the dots you would need one plus, say, a finger to cover them.
- 4.

## Answers

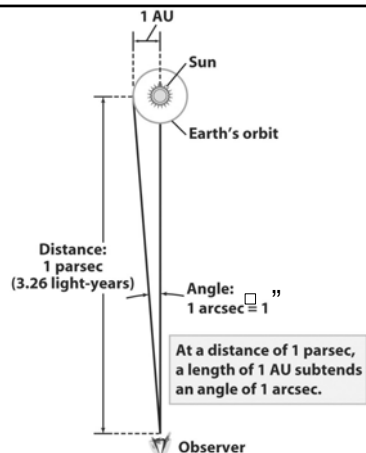
- 1.
- 2.
- 3.
4. What equation was used to determine the finger-length-to-degree relationship? The small angle formula (Chapter 1, page 8).  $d$  is the length of your arm and  $D$  is the length between points on your hand (for example, the width of your index finger or width of your hand).

## Introduction to ASTR 111

- What does an astronomer do?
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Astronomical distances are often measured in astronomical units, parsecs, or light-years

- **Astronomical Unit (AU)**
  - One AU is the average distance between Earth and the Sun
  - $1.496 \times 10^8$  km or 92.96 million miles
- **Light Year (ly)**
  - One ly is the distance light can travel in one year at a speed of about  $3 \times 10^5$  km/s or 186,000 miles/s
- **Parsec (pc)**
  - the distance at which 1 AU subtends an angle of 1 arcsec or the distance from which Earth would appear to be one arcsecond from the Sun



## Group Questions

1. How many meters are in a ly? (The speed of light is  $3 \times 10^8$  m/s)
  2. How long does it take light to reach Earth from the sun? (1 AU =  $1.5 \times 10^8$  km)
- Note:  $10^8$  means the same thing as 1E8 on your calculator or  $10^8$ . The ^ is used in text editors and email clients where you can't create subscripts.

### Group Questions

1. How many meters are in a ly? (The speed of light is  $3 \times 10^8$  m/s). 1 ly = 1 light-year, which is the distance that light travels in one year. Using the formula distance = rate x time, with rate =  $3 \times 10^8$  m/s and time = the number of seconds in a year = 365 days x (24 hr/day) x (60 min/hr) x (60 sec/min), gives distance =  $1.5 \times 10^{15}$  meters

### Group Questions

- 1.
2. How long does it take light to reach Earth from the sun? (1 AU =  $1.5 \times 10^8$  km) About 8 minutes.

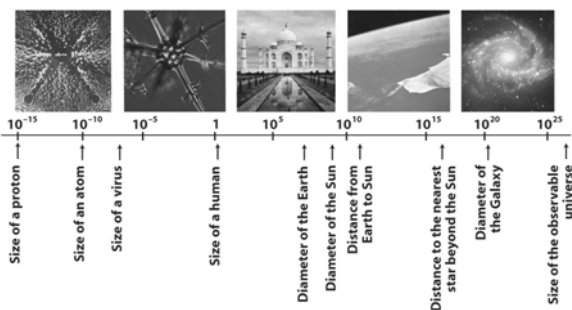
### Lecture Outline

- Course Outline and Syllabus (~15 minutes)
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- Review of Math that is used in Astronomy (~30 minutes)

### Review of Math that is used in Astronomy

- Powers of 10 notation ( $1E8 = 10^8 = 10^8$ )
- Powers of 10 words (from nano to peta)
- How to "derive" rules for manipulating numbers in scientific notation
- How to make an educated guess about a formula given only units

Powers-of-ten notation is a useful shorthand system for writing numbers



Google Web Images Video<sup>TM</sup> News Maps more »  
googol Search Search Advanced Search Preferences  
Web Results 1 - 10 of about 488,000 for googol

1 googol =  $1.0 \times 10^{100}$   
[More about calculator.](#)

Google is a play on the word **googol**, which was coined by Milton Sirota, nephew of American mathematician Edward Kasner, and was popularized in the book, *Mathematics and the Imagination* by Kasner and James Newman. It refers to the number represented by the numeral 1 followed by 100 zeros. Google's use of the term reflects the company's mission to organize the immense, seemingly infinite amount of information available on the web. [<http://www.google.com/corporate/history.html>]

### Review of Math that is used in Astronomy

- Powers of 10 notation
- Powers of 10 prefixes (from nano to peta)
- How to "derive" rules for manipulating numbers in scientific notation
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### Common prefixes you must know

Factor	Name	Symbol
(tera) $10^{12}$	Tera-	T
(billion) $10^9$	Giga-	G
(million) $10^6$	Mega-	M
(thousand) $10^3$	kilo-	k
(hundredth) $10^{-2}$	centi-	c
(thousandth) $10^{-3}$	milli-	m
(millionth) $10^{-6}$	micro-	$\mu$
(billionth) $10^{-9}$	nano-	n

### Review of Math that is used in Astronomy

- Powers of 10 notation
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### How to "derive" rules for manipulating numbers in scientific notation

- You should know that when you multiply numbers in powers of ten notation you need to do something with the exponents. So make up problems you know how to answer:

$$- 10^2 \times 10^1 = 100 \times 10 = 1000 = 10^3 = 10^{2+1}$$

$$- 10^2 \times 10^{-1} = 100 \times 0.1 = 10 = 10^{2+(-1)}$$

Looks like adding the exponents should work.

- You should always remember that if you forget something, you may still know enough to reason things out.

### Review of Math that is used in Astronomy

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### How to make an educated guess about a formula given only units

- Reason it out: If you are asked the circumference of a circle given a radius in meters a good guess is the circumference will have units of meters and will be proportional to the radius. Draw a circle; if it looks like it would take more string to cover the radius line than the circumference line, you should make a visual guess how much more string would be required and eliminate any multiple choice answers accordingly. (Answer: requires  $2\pi$  times more string since  $C = 2\pi \times \text{radius}$ .)
- Think about how you would get an approximation to the volume of a sphere given its radius. Think of volume formulas that you know and build on them.

### *You should already know:*

- The formulas for the volume of a sphere, the surface area of a sphere, and the circumference of a circle (see Appendix A-8)
- Powers of 10 notation (practice: Chapter 1, problems 10-12, 22-23)
- Powers of 10 words including nano, milli, micro, kilo, mega, giga, tera
- Unit conversion (Chapter 1, page 13-14)
- The planets

### *Questions*

- Why are there many units for distance in astronomy? What are three units of distance in astronomy? How to convert from one unit to another, Chapter 1, questions 10-18.
- Why Pluto is not considered a planet
- How to estimate angular distances (Chapter 1, page 6; question 9). Definition of an arcminute and arcsecond (Chapter 1, question 7-8). The meaning of “angular distance” and “subtends”. The difference between angular distance and actual distance. What happens to angular measure when things change (as covered in the group question, for example).
- Quiz yourself using questions 10-24 of the textbook Chapter 1 Quiz at <http://bcs.whfreeman.com/universe7e>.