Stars, Galaxies, and the Universe

Instructor: Prof. Kaaret

702 Van Allen Hall

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Lectures: MWF 12:30 pm – 1:20 pm

Lecture Room 1 Van Allen Hall

Textbook: Cosmic Perspective: Stars, Galaxies, and Cosmology, Fifth Edition, by Bennett, Donahue, Schneider, Voit

Why study Astronomy?

From modern astronomy, we have our best answers, so far, to questions such as:

- How and where are the atoms in our bodies formed?

- Is there life anywhere else than on Earth?

- What is the history of the Universe and what will eventually happen to the Universe?

Why study Astronomy?

- Astronomy allows us to understand our place in the cosmos.

- Astronomy also reveals objects that stretch the imagination such as black holes, exploding stars, and giant jets of matter larger than a galaxy but moving at the speed of light.

- Astronomy shows us that the Universe is comprehensible.

How empty is the solar system?

- What fraction of the volume in the solar system (which we will take to be a sphere enclosing the orbit of Neptune) is taken up with solid stuff (the Sun, planets, asteroids, …)?

- Any guesses?

Scale model solar system

- To try to address this question, we are going to build a scale model of the solar system.

- So, what is a scale model?

A scale model …

A) is made out of plastic?
B) corresponds to a real object?
C) is a World War II airplane?
D) has the same proportions as a real object?
E) has the same colors as a real object?

Scale models

- A scale model is a representation of a real object or set of objects in which all of the different parts of the model have sizes in the correct proportions to the real thing.

Scale models

- For scale factor *s*, real dimension *D*
 then model dimension $d = sD$

For example, with a scale factor
s = 1:160 = 1/160 = 0.00625, an airplane with
length *D* = 12 meters becomes a model with
length *d* = 0.00625*12 meters = 0.075 m
                                                    = 7.5 cm.

Scale model solar system

- We need the measurements of the real solar system. For our purposes, we will limit this to the diameter and distance from the Sun for each planet.

Planets

Gas giants

Rocky
planets
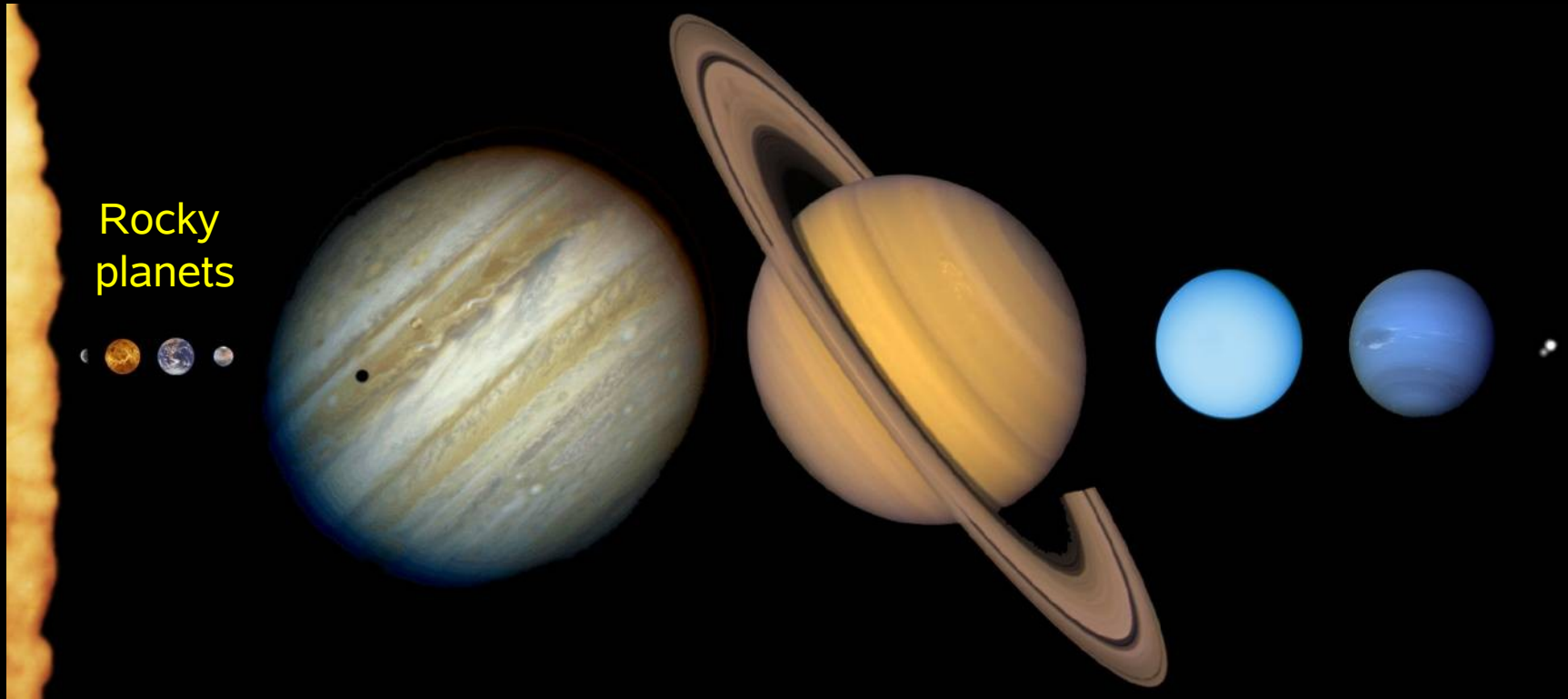
Is Pluto a Planet?

- During the 1990s more than 1000 objects orbiting beyond Neptune, theTrans-Neptunian Objects (TNO), were discovered.

- In 2003, Eris, a TNO was found that is larger than Pluto and has its own moon.

- So, add Eris as a planet or dump Pluto?

- The International Astronomical Union (IAU) made a new definition of a planet:

  – A celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighborhood around its orbit.

- So Pluto and Eris are not real planets (they are dwarf planets).

Eris
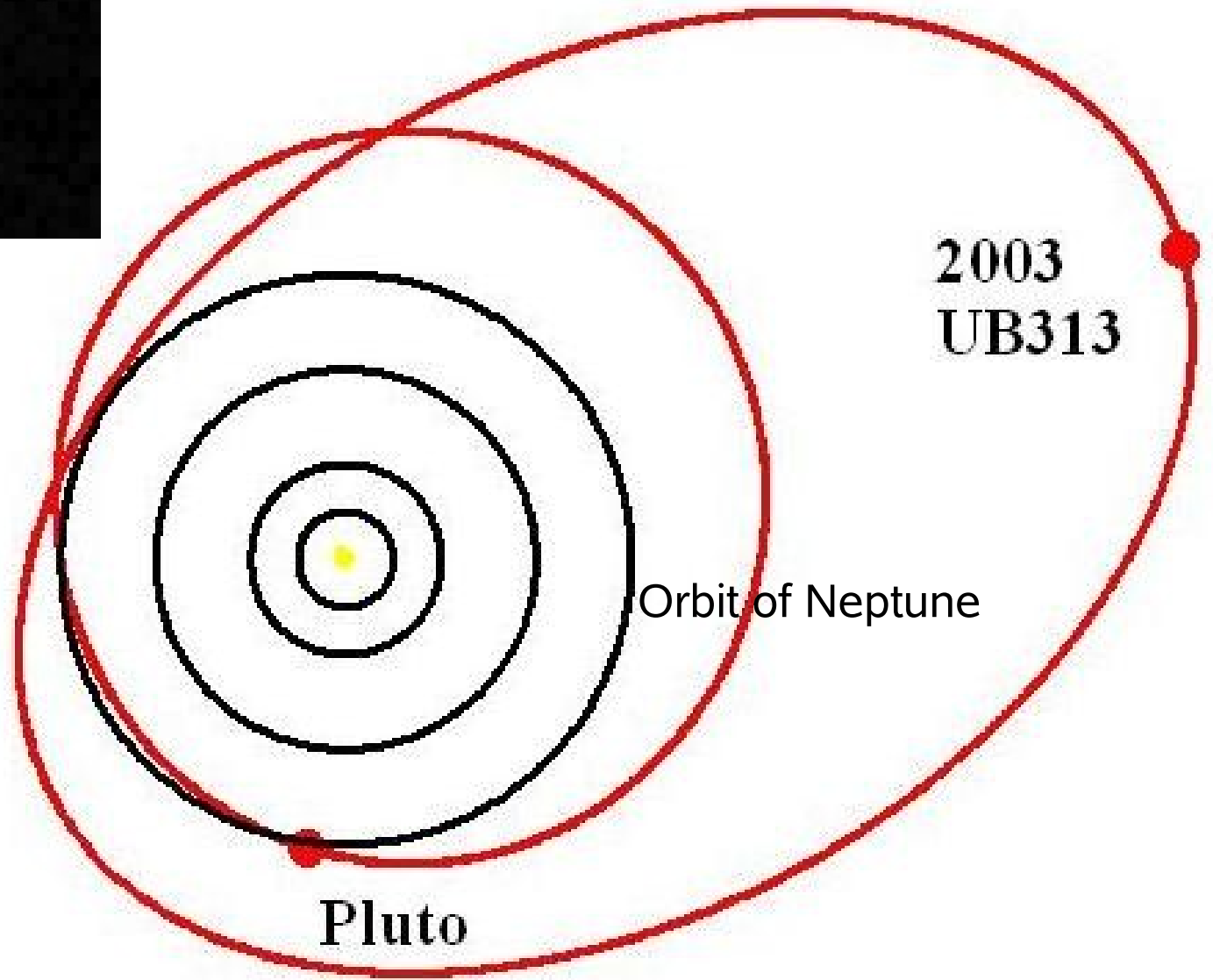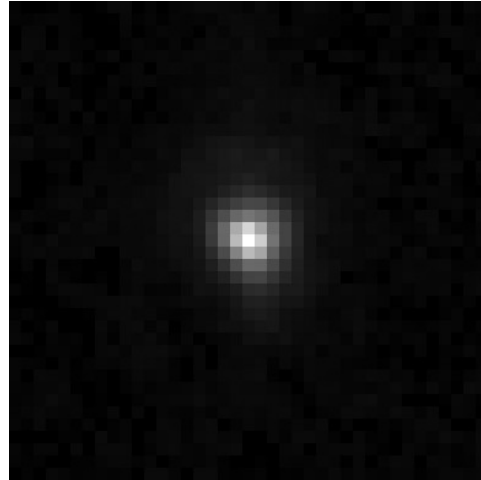
2003
UB313

Orbit of Neptune

Pluto

Solar system data

	Diameter [meters]	Distance from Sun [meters]
Sun	1,392,700,000	0
Mercury	4,878,000	57,900,000,000
Venus	12,104,000	108,200,000,000
Earth	12,756,000	149,600,000,000
Mars	6,787,000	227,900,000,000
Jupiter	142,980,000	778,300,000,000
Saturn	120,540,000	1,427,000,000,000
Uranus	51,120,000	2,870,000,000,000
Neptune	49,530,000	4,497,000,000,000

Scale model of solar system

Scale factor s = 3:1,000,000,000,000 = 0.000000000003

	Distance from Sun meters	Scaled distance meters
Sun	0	0.00
Mercury	57,900,000,000	0.17
Venus	108,200,000,000	0.32
Earth	149,600,000,000	0.45
Mars	227,900,000,000	0.68
Jupiter	778,300,000,000	2.33
Saturn	1,427,000,000,000	4.28
Uranus	2,870,000,000,000	8.61
Neptune	4,497,000,000,000	13.49

Scale model of solar system

Scale factor s = 3:1,000,000,000,000 = 0.000000000003

	Diameter meters	Scaled diameter meters
Sun	1,392,700,000	0.004178
Mercury	4,878,000	0.000015
Venus	12,104,000	0.000036
Earth	12,756,000	0.000038
Mars	6,787,000	0.000020
Jupiter	142,980,000	0.000429
Saturn	120,540,000	0.000362
Uranus	51,120,000	0.000153
Neptune	49,530,000	0.000149

Scale model of solar system

- To fit the solar system into the classroom, we scaled the radius of the orbit of Neptune to be 13.5 meters

- Sun is the size of a match head

- Jupiter is smaller than a grain of salt

- Earth has the diameter of a strand of hair (thin hair)

How far is the Moon from the Earth in our Model?

Moon is 384,400,000 m from Earth.

A) Strand of hair

B) Thickness of finger nail

C) Two grains of salt

D) Width of pinky

How far is the closest star in our Model?

Proxima Centauri is
39,900,000,000,000,000 m from Earth.

A) Old Capitol Building

B) Field House

C) Des Moines

D) New York

Course information

- Website: http://astro.physics.uiowa.edu/~kaaret/s09
- Survey of modern astronomy, conceptual approach
- Course covers
  - Night sky, moon, eclipses
  - Search for extra-solar planets, intelligence
  - Sun, stars
  - Black holes, neutron stars
  - Galaxies
  - Cosmology
- Does not cover solar system, extraterrestrial life in detail. Other classes are available for these topics.

i>Clicker

- We will be using a iClicker to take attendance and to get student feedback during lectures.

- Every student must have an iClicker and bring it to class.

- Every student must register their iClicker.

Course information

- Some math will be needed
  - Simple algebraic equations
  - Plugging numbers into equations
  - Understanding powers of ten
  - Simple geometry
- Students will be expected to observe the sky
  - Average of about one hour per week
  - The only way to get extra credit is via supervised observing on the roof of Van Allen Hall during *clear* week nights

Course information

- Laboratory
  - If you are registered for 4 s.h., you are already assigned to a weekly laboratory section.
  - Laboratory sessions start next week.
  - Observing with a research-grade optical telescope in Arizona (Rigel telescope). You will be using this facility for a research project in the second half of the semester.

Grading

The course grade (letter grade will include +/- grading) will be determined by the sum of points accumulated during the semester. The total possible points are given in the table below. The only way to get extra credit (up to 20 points) is by supervised observing on the roof of Van Allen Hall.

Attendance	20
Homework and 4 one-hour exams, 80 points each with lowest dropped	320
Final exam	160
Total	500

Administration

- E-mail philip-kaaret@uiowa.edu to suggest times for Astronomy tutorial
- Will do i-Clicker registration now and before/after next few classes