Sex in Space: Astronomy 330

TR 1000-1050
Noyes Laboratory 217

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Office Hours:
W: 11:00 a.m. – noon
or by appointment

This class (Lecture 2):

Pluto & Size Scales

Next Class:

Cosmology

HW1 due on Tuesday!
(grace period until Feb 3rd)
Make sure to follow directions!

Music: *Astronomy*– Metallica

Outline

- Some basic astronomy
- ETs?
- The Drake equation
- The Pluto thing (it's old but still many students want to talk about it)

Basic Astronomy Highlights

The following are some astronomy facts for those who have not had any astronomy before.

Astronomy is not Astrology!

- In the ancient world, astronomy and astrology went hand-in-hand
- Many ancient astronomers were also astrologers
- Today, they are not connected.

Astronomy is not Astrology!

- Scientific tests of astrology show it's predictions are no more accurate than random chance
- Nevertheless, more people earn income casting horoscopes than doing astronomical research
- Pseudo-science, not science

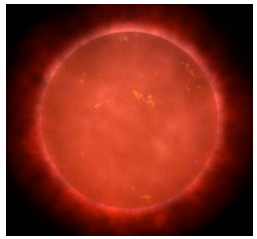
- And the zodiac signs were picked 2000 years ago.
- Since then the Earth has precessed, and someone born "in" Virgo is actually a Libra.

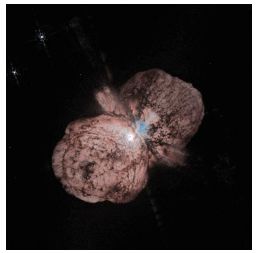
Basic Astronomy

- Earth rotates on its axis, takes about 1 day.
- Sky rises in the East, sets in the West, due to our rotation motion.
- Earth orbits the Sun, takes 1 year.
- Reason for the seasons is the 23 degree tilt of the Earth. It's Summer in Australia now!
- Moon orbits the Earth, takes about 1 month.
- No such thing as the "Dark Side" of the Moon, but there is a "Far Side" of the Moon.
- Moon phases are from relative position of Earth, Moon, and Sun.

What is a Star?

- A huge ball of mostly ionized hydrogen gas
- Mostly turning hydrogen into helium, which makes energy.
- Some stars can burn (thermonuclear speaking) for 10's of billions of years (<0.5 solar masses), and some only burn for a few million years (>25 solar masses)
- Our Sun is the closest star.





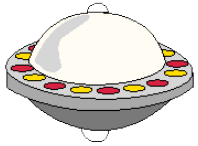
http://www.daviddarling.info/images/red_dwarf_art.jpg
HST of Eta Carinae

Basic Astronomy

- Stars are "freaky far" far away from us!
- All the stars you can see with your naked eye (about 6000), are "nearby".
- A bunch of stars + gas + dust + stuff together make up a galaxy.
- Galaxies are usually separated by "freaky far" distances.

Have we been visited by ETs?

"Extraordinary Claims Require Extraordinary Evidence"

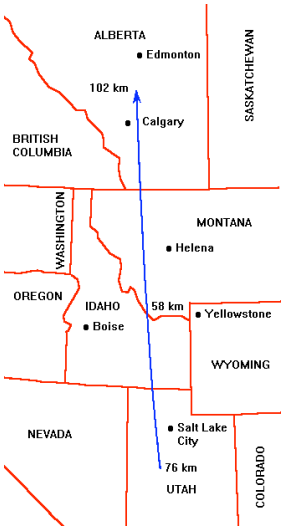


An Example: Meteor 1972

http://www.uwgb.edu/dutchs/

Yikes, a Near Miss

- A bus sized object entered atmosphere over Utah and exited over Canada
- Velocity of 15 km/ sec
- Missed Earth by 58 km



But…

- Event was completely unexpected
- Crossed relatively sparsely-inhabited region
- Only visible for a *total* of 101 seconds
- Visible for no more than 30 seconds at any one spot

But…

- Nonetheless, we have dozens of clear photographs of this event
- Still, we have no comparable images of UFOs.
- And today digital cameras and camera phones should make unusual events even more seen.

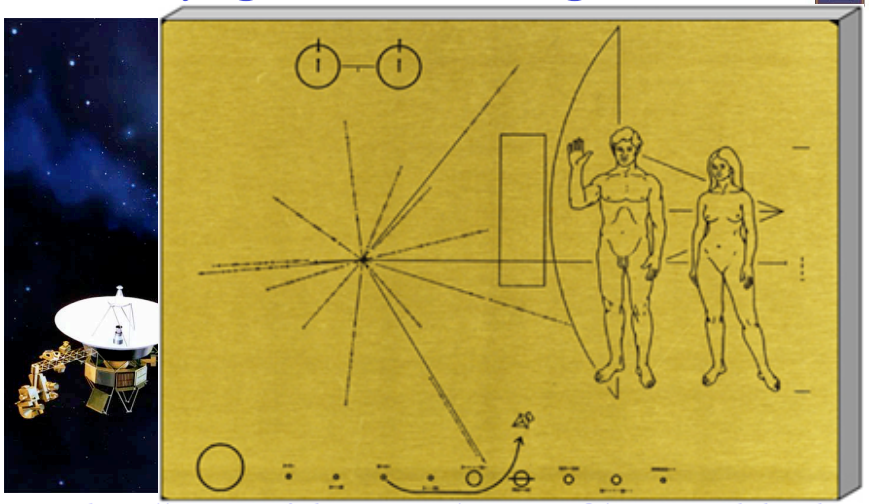
Perhaps we shouldn't look for Aliens?

- But we've been broadcasting our presence on Earth for the last 65 years now!
- At the present time, the Earth is brighter in radio than the Sun.
- Is anyone out there watching TV right now?
- Also there have been a few intentional messages…

SETI: Listening for ET

- Communications via radio signal
  - 18–21 cm wavelength range good for interstellar communication
- SETI search is ongoing
  - SETI
  - **`http://www.seti.org`**
- If they exist, should we contact them?

Voyager– the message is out.



http://voyager.jpl.nasa.gov/spacecraft/sceneearth.html

Major Premise of Course

The Universe is ***homogenous*** and ***isotropic***.

- The laws of nature are the same everywhere.
- So we can apply the lessons learned from life on Earth to extrapolate about life in space.
- Life probably should have repeated elsewhere, given the same circumstances.
- The Universe is freaky big!

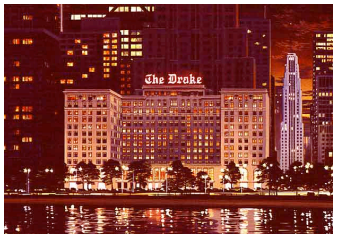
Question

In this class we will assume that the Universe is ***homogenous*** and ***isotropic*** because

a) It gives the best chance for finding extraterrestrial life.
b) It allows us to apply our understanding of astronomy and biology (and all science in general) to other stars, planets, and life.
c) It assumes that the rules for life on our planet will be very different from other planets.
d) It assumes that the laws of nature are different everywhere.
e) It will probably be assumed by aliens too.

Course Goals

- This class is designed to be fun.
- This course will revolve around the "Drake Equation".
- The Drake Equation ***looks*** like an attempt to calculate how many intelligent extraterrestrial civilizations exist with whom we *might* be able to communicate in our Galaxy.



- However, the equation actually helps us understand our ignorance about the subject and illuminates the various topics and issues worth thinking about when we ask the question, *"Are we alone?"*, with an open mind.

Drake Equation

Frank Drake

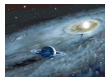
N =

# of advanced civilizations we can contact in our Galaxy today

Drake Equation

Frank Drake








$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

N	R_*	f_p	n_e	f_l	f_i	f_c	L
# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that commun-icate	Lifetime of advanced civilizations
	stars/ yr	systems/ star	planets/ system	life/ planet	intel./ life	comm./ intel.	yrs/ comm.

Question

What does the Drake equation really tell us?

a) It calculates the exact number of advanced civilizations in the Universe.
b) It means nothing, a fake equation. It is only meant to guide our thinking about the relevant questions.
c) It gives us an exact number of alien lifeforms (intelligent or not) in the Galaxy.
d) It calculates the number of advanced civilizations in our Galaxy.
e) It allows us to estimate the age of the Universe.

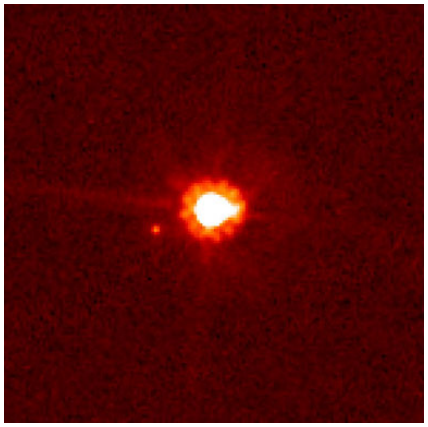
What happened to Pluto?

http://orbitingfrog.com/blog/wp-content/uploads/2008/07/poor_pluto_mathias_pedersen.jpg

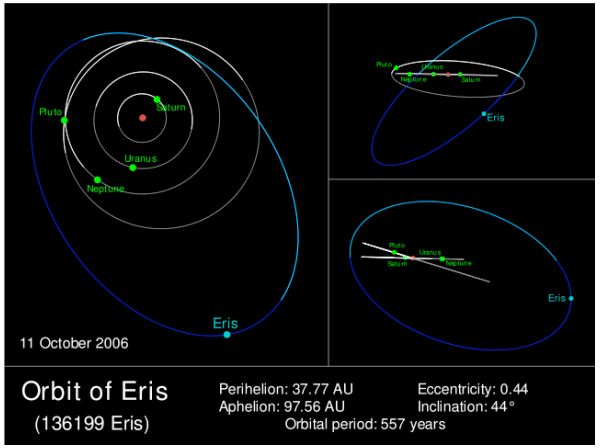
The War of "What is a planet?"

What's Changed?

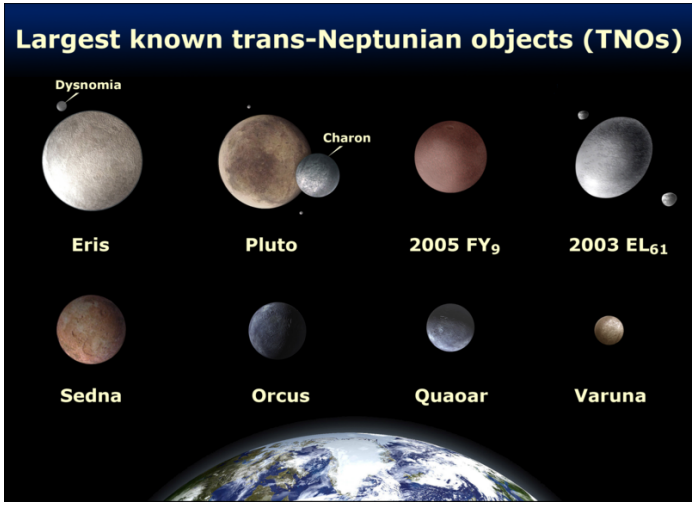
- The object Eris discovered in 2005
- ~20% larger than Pluto
- ~30% more massive than Pluto
- Has a moon (Dysnomia)
- Weird orbit
- Planet?



The Planet Eris?



Planet or Plan-not?



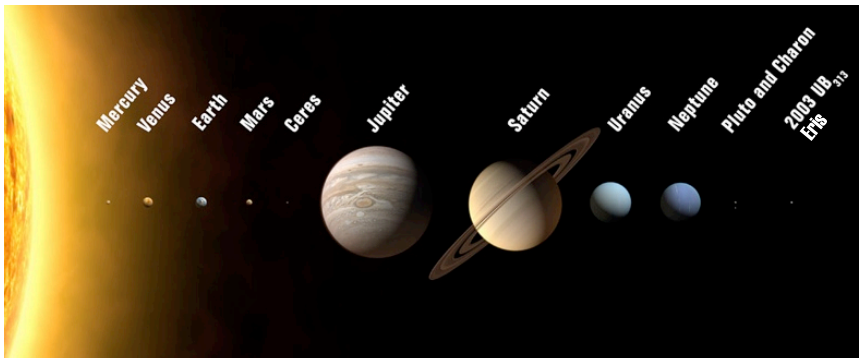
What is a Planet?

A planet is a celestial body that

(a) has sufficient mass for its self-gravity assumes a nearly round shape, and

(b) is in orbit around a star, and is neither a star nor a satellite of a planet

12 Planets?



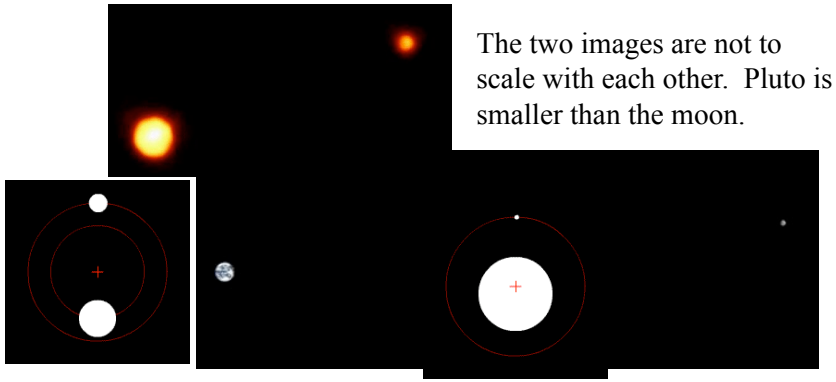
My Very Eccentric Mother Curiously Just Showed Us Nine Pianists Conducting Encores

My Very Excellent Mother Just Served Us Nine Pizzas

Why Charon and not our Moon?

Pluto-Charon

Earth-Moon



The two images are not to scale with each other. Pluto is smaller than the moon.

When a moon orbits a planet, or a planet orbits a star, both bodies are actually orbiting around their *center of mass*

Two Dozen Planets???

The Alternate Proposal

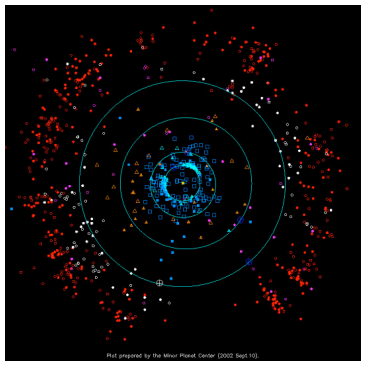
A planet is a celestial body that

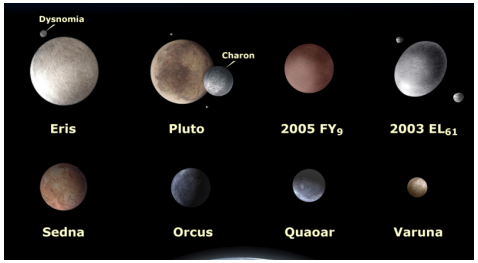
(a) has sufficient mass for its self-gravity assumes a nearly round shape, and

(b) is in orbit around a star, and is neither a star nor a satellite of a planet, ***and***

(c) has cleared the neighborhood around its orbit

This definition would exclude Pluto (and others) because it's one of many...

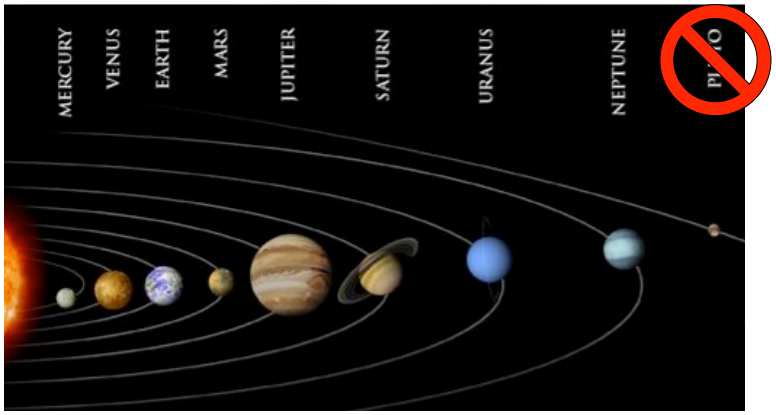




Red & white dots show other Pluto-like objects discovered around & beyond Neptune's orbit

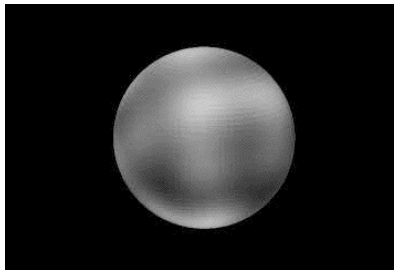
The Results...

~~Nine~~ 8 Planets



My Very Excellent Mother Just Served Us Noodles!

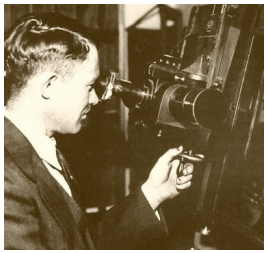
So what do we call Pluto now?



Planet-ish objects that meet the earlier definition, but fail to make the grade because of the new criterion would be called *dwarf planets*

Not Here in Illinois!

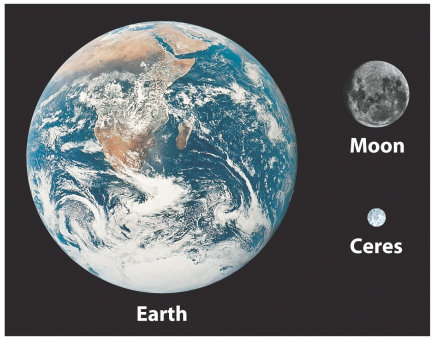
- Clyde Tombaugh, discovered Pluto, was from Illinois, so the Illinois State Senate made a resolution
  - RESOLVED, BY THE SENATE OF THE NINETY-SIXTH GENERAL ASSEMBLY OF THE STATE OF ILLINOIS, that as Pluto passes overhead through Illinois' night skies, that it be reestablished with full planetary status, and that March 13, 2009 be declared "Pluto Day" in the State of Illinois in honor of the date its discovery was announced in 1930

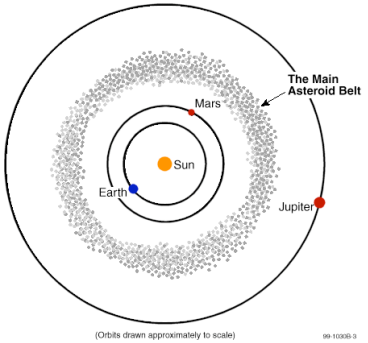


  - Luckily for me, it never passes overhead in Illinois!

http://ilga.gov/legislation/fulltext.asp?DocName=&SessionId=76&GA=96&DocTypeId=SR&DocNum=46&GAID=10&LegID=40752&SpecSess=&Session=

Ceres, Another Former Planet





- Ceres was considered a planet for 50 years after its discovery in 1801
- Demoted after similar bodies were found
- Now, called an **asteroid**

Question

What the hell happened to Pluto?

a) It's rotational energy decreased, which pushed it out of planetary orbits.
b) We found out that Pluto was never a planet.
c) The definition of Planet was modified.
d) Other objects that may be bigger than Pluto were found.
e) It just plain ran out of luck.