Astronomy 330:

Extraterrestrial Life

TR 1100-1220
Astronomy 134

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by appointment or email

This Class (Lecture 1):

Introductions/Pluto

Next Class:

Size Scales

http://eeyore.astro.illinois.edu/~lwl/classes/astro330h/spring12/

Music: *Pets* – Porno for Pyros

Class Web Page

http://eeyore.astro.illinois.edu/~lwl/classes/astro330h/spring12/

Outline

- Class Introductions
- Introduction of Extraterrestrial Life
- Class Goals
- Syllabus
- The Pluto thing (it's old but still many students want to talk about it)
- Let's take some time to get our bearings around the Universe.

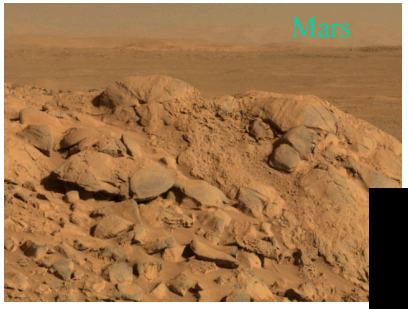
Welcome to Astro 330

- It's a great time to take this course!
- In 1995, we knew of 9 planets around 1 sun. Now, Jan. 2012, we know of over 700 planets around numerous suns (1000s of candidates) and the first Earth-sized exoplanets!
- In the near future, NASA missions may find life on Titan or Europa, evidence of life of Mars, or image Earth-like planets around nearby stars.
- In this course, you will get an understanding of arguably the biggest astronomical question of all time:
  Are we alone?
- We will address this question with scientific methods, but also perhaps with some philosophy, science fiction, and fun thrown in too.

Which is Mars? Which is Earth?

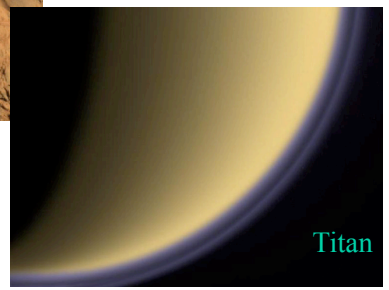
A B

Is There Anyone Out There?



Could there be life in a place like this?

Or perhaps a place like this?



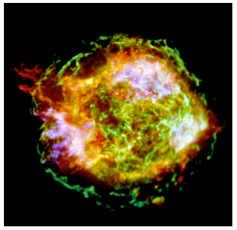
Where Do We Come From?

- How can clouds of gas and dust form stars, worlds - and us?
- … and where are we going?

Should we be *AFRAID*?

- Will giant asteroids doom the earth?
- Will gamma-rays from an exploding star irradiate us?

- Will we be swallowed by a black hole?



The Universe: Some Facts to Help you Live in it

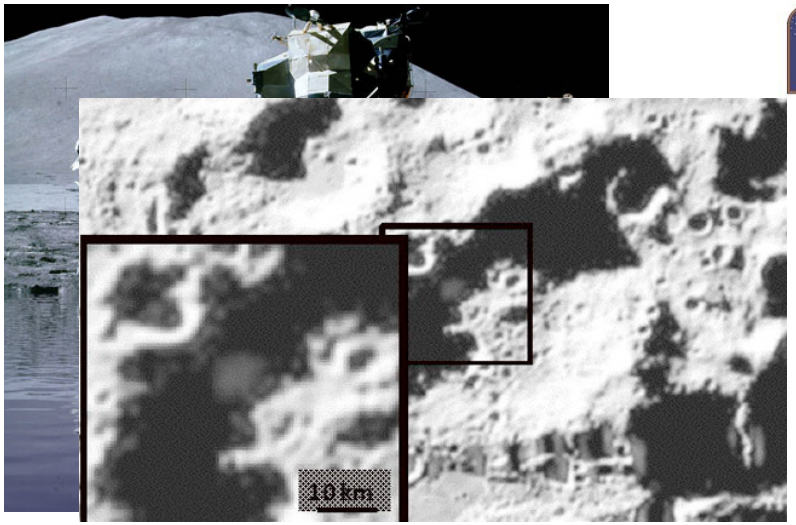
Tell someone that there are 100 billion stars in our Galaxy and they will believe you. Tell someone a bench has wet paint and they will have to touch it.

Roving on Mars:

Spirit and Opportunity find evidence of water

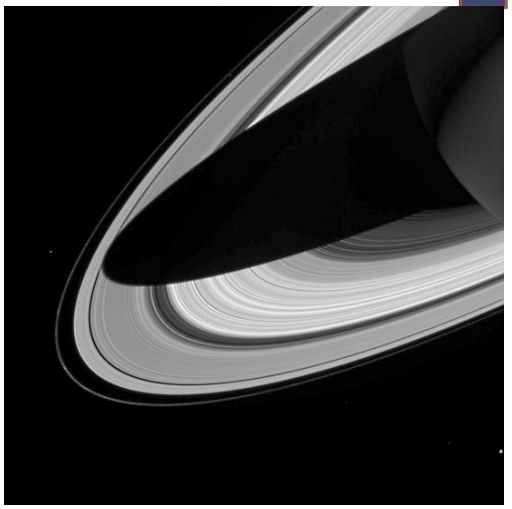
http://antwrp.gsfc.nasa.gov/apod/image/0403/emptynest_opportunity_big.jpg

Roving on Mars



Water on the Moon!

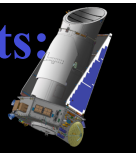
Cassini Explores the Ring World

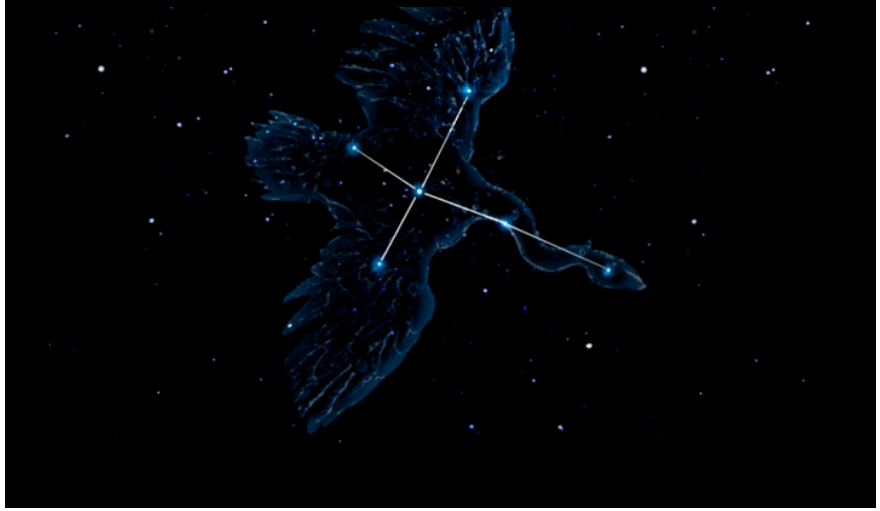


http://saturn.jpl.nasa.gov/cgi-bin/gs2.cgi?path=../multimedia/images/rings/images/PIA05417.jpg&type=image

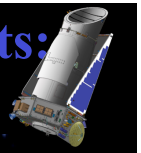
Mapping Titan

Looking for Earth-Like Planets: Kepler





Looking for Earth-Like Planets: Kepler



Earth-sized planets are common!

Planets in the habitable-zone!

Many more to come!

Astro 330: Sex in Space?

One of the neat aspects of this course is that we can address this cool subject with an open mind and scientific rigor.

Don't be scared of science. It is really just common sense and logic. Although not all scientist have those in any larger amounts than non-scientists.

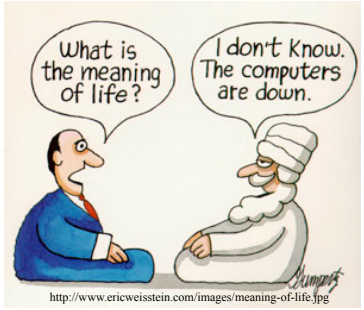
Astro 330

In this class, we shall confront some of the ideas concerning the formation of life on this planet (origination of life), so we can apply it to extraterrestrial life. Remember, we only have a sample of one in the entire Universe!

BUT, we will not condemn anyone's beliefs (God, Gods, UFOs, etc.). So, we will examine life in the scientific sense.

Life

- This examination may bring us to some very depressing conclusions
- What is life?
  - Just sunlight plus geochemistry?
- If we decide that intelligent life is common in the Universe, how will that make us feel?



http://www.ericweisstein.com/images/meaning-of-life.jpg

Class Facts

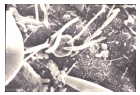
- Today, there is **no** evidence for ET life.
- And we don't even know how life happened on Earth.
- Earth's early geologic record (first 1/2 billion years) is **GONE**
  - Clues to early life formation are gone
  - Earth is about 5 billion years old

Class Facts

- But, we do have evidence for very early microbial life on Earth (about 3.5-4 billion yrs old).
- Oxygen atmosphere 2 billion years ago!
- First multi-celled life only 1 billion years ago.

Class Facts

- Humans are NEW on Earth (about 5 Myrs ago)
- Keep in mind that faith is not science. Faith is fine, but we have to keep in mind that in this class, "I just KNOW it!" is not an acceptable answer.



- **We are investigating big questions scientifically.**

Be Careful of Science

- Sometimes people make big claims in the name of science.
  - Ancient world thought that the Earth was the center of the Universe.
  - Percival Lowell (~1913) thought he saw canals on Mars (optical illusion).
  - Eddington (~1940) tried to make the fine structure constant (α=1/137.036) a rational number.
- We need to learn from these mistakes.

But Learn to Speculate

- The French Academy of Sciences once pronounced that meteorites were nonsense
  - EVIDENCE and REASON can produce just as many thrills as dogmatic faith-based belief
  - They were eventually just shown a meteorite!
- The professors of Astronomy in the early 1600s, were teaching a geocentric solar system.
  - The Catholic church only forgave Galileo about his heliocentric solar system ideas in 1992!

Life on Earth

- A miracle?
- An accident?
- More-or-less inevitable given the laws of nature and chemistry with suitable conditions?
- **Principle of Mediocrity**: There's nothing terribly special about the astronomical, geological, physical and chemical circumstances on Earth; most likely nothing special about biology either

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!

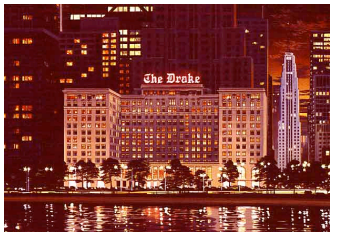
Course Goals

After this course one should be able to:

- Understand our current scientific view of life in the universe.
- Conceptualize the factors involved with the ultimate question.
- Propose what the future may hold for the field.
- Make informed decisions about science policies.
- Hold any "discovery" of extraterrestrial life to a personal scientific standard of proof.

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

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

N	R_*	f_p	n_e	f_l	f_i	f_c	L
# of advanced civilizations we can contact in our Galaxy	Rate of star formation	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations

Aliens?

We have been bombarded by aliens in the media– all types.

No surprise that **close to half** of all Americans believe in aliens.

Course Outline

Topics:

- We will review some basic astronomy
- Planetary and solar system astronomy
- Biology and biochemistry
- Geology
- Paleontology
- Evolution
- History and the future of mankind on Earth
- Interstellar communication and travel, including UFO's.
- Take part of the journey, and let's enjoy the ride.

Grades

Requirement		Percentage of Grade
Class Participation (will drop some)		10%
Presentation Synopsis		2%
Homework Assignments	10 out of 11	15%
Presentation		15%
Research Paper Draft		2%
Research Paper		10%
Midterm		20%
Final		26%
Total		**100%**

Class Participation

Class Participation

- You should attend lectures and discussions.
- We will have random opportunities for your feedback, in the form of asking questions, "voting" on the possible outcomes of observations or demonstrations, or brainstorming answers to open-ended questions. To reward your participation in these activities, you will often be asked to turn in your response **(worth 10% of your grade!)**.
- Although the number of these are not set, often they come upon me on a whim, we probably have these for every class, so some of these will be dropped.

Interesting Question #1

Although there is no proof of ET life, it can be said that

a) everyone feels a deep connection with the night sky, suggesting that we are from space.

b) about ½ of the US population believes in aliens.

c) aliens walk amongst us.

d) only a very small number of people think that aliens are a possibility.

e) cows are scared.

Questions

1. Why did ***you*** take this course?

2. What are ***you*** interested in learning in this course?

3. Do ***you*** think extraterrestrial life exists?

Oral Presentation

- Most students in this class come with a topic that is of interest to them.
- Student will build this interest into a research project. Logically, if one student is interested then other students will likely be interested in the topic too.
- This forum provides the opportunity to investigate issues that may not be explored or not explored in depth during class.

Oral Presentation Questions

1. How relevant is the topic to the search for extraterrestrial life or this class?
2. How interesting is the topic for the general class audience?
3. Rate the extent of the speakers knowledge on the topic?
4. Rate the quality of the overall presentation?
5. Does the research use enough solid scientific basis?

These questions are rated 1-10 out of 10 scale.

Presentation Examples

- Life without a planet
- Faces and pyramids on Mars
- Aliens in South Park: Satire, Silly, or Scientific
- Supernovae: Adding Heavy Elements to the Mix
- Panspermia: Life from the Stars
- Human Colonization of other Planets/Asteroids
- Terraforming Mars
- How to get to Mars
- Self-Replicating Space Probes: Explore the Galaxy on the Cheap.

Presentation Synopsis

Due on Feb 2nd, the presentation synopsis (after 1st HWs is due– more on that later).

- 2-3 paragraphs: describing the main idea behind the presentation
- 1-2 paragraphs: addressing the 5 questions directly
- A list of 5 or more references for the presentation / research paper. This is necessary to help you avoid some of the more *questionable* sources. URLs are fine refs for this class.

Research Paper

- Each student will be writing a research paper on their presentation topic.
- This paper must be 8 to 10 pages double-spaced 12-point font, not including references. A draft of the paper is due April 12th.
- The final paper is due May 1st. Most points are usually lost for bad referencing (expect a couple refs per page on average) or missing bibliography.

For examples on WWW reference, see the syllabus or contact me. Remember that I have access to google as much as you do. Academic honesty is vital!

Homework Assignments

- There will be 11 homework assignments given throughout the course (1 is dropped).
- These will be MC, simple answer or short essay, and are meant to sharpen your thinking on the material covered in lecture, and to help prepare you for the exams.

http://lrrc3.sas.upenn.edu/popcult/cartoons/anthropo/homework/homework.JPG

Homework Assignments

- Homeworks are due on Compass on Thursday nights at 11:59pm.
- For MC, will have multiple attempts, without penalty
- First one is due next week!
  - Easy-peasy
- **Late homework may not be accepted.**

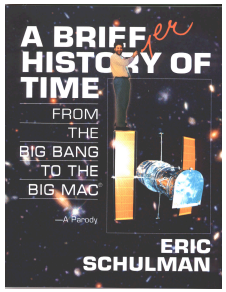
http://lrrc3.sas.upenn.edu/popcult/cartoons/anthropo/homework/homework.JPG

Yuck-- Exams

- There will be one midterm exam and one comprehensive final exam for this course. The exams will be take-home essay exams.
- Nonetheless, they are not open book or lectures.

Book 'em Danno

TEXTBOOK: *None*

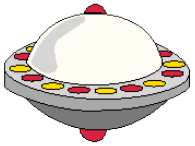


RECOMMENDED READING:
A Briefer History of Time by Eric Schulman

http://members.bellatlantic.net/~vze3fs8i/bhtes/index.html

Have we been visited by ETs?

"Extraordinary Claims Require Extraordinary Evidence"

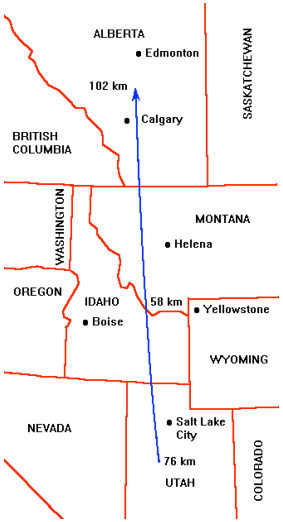


An Example: Meteor 1972

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…

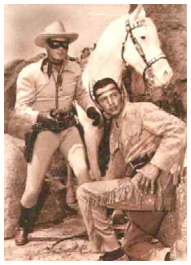
- Event was completely unexpected
- Crossed relatively sparsely-inhabited region
- Only visible for a *total* of 101 seconds
- Visible for no more than 30 seconds at any one spot

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?

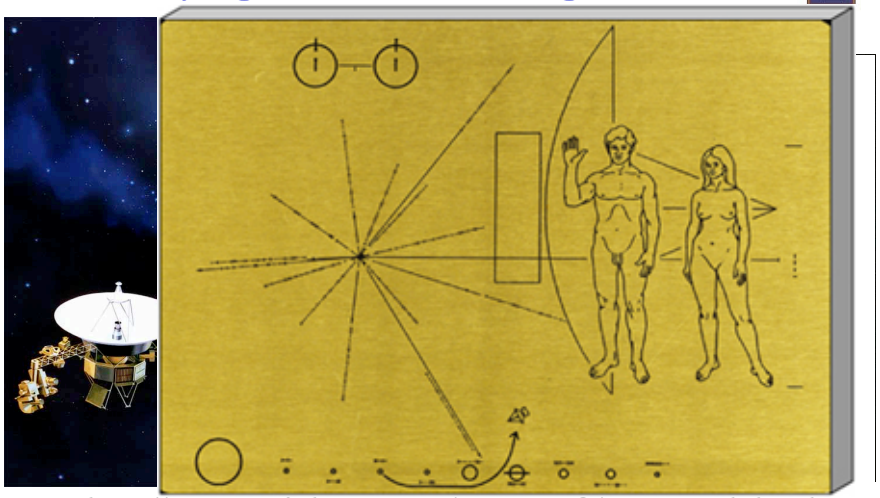
- But we've been broadcasting our presence on Earth for the last 65 years now!
- At the present time, the Earth is brighter in radio than the Sun.
- Is anyone out there watching TV right now?
- Also there have been a few intentional messages…



SETI: Listening for ET

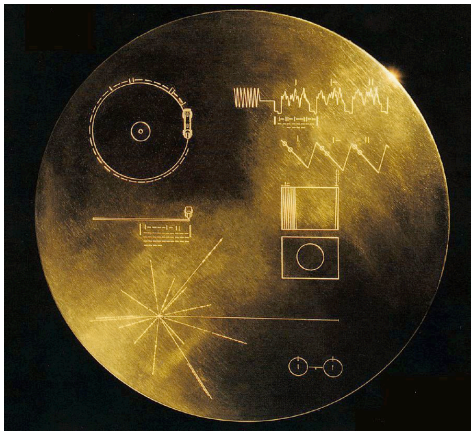
- Communications via radio signal
  - 18–21 cm wavelength range good for interstellar communication
- SETI search is ongoing
  - SETI
  - **http://www.seti.org**
- If they exist, should we contact them?

Voyager– the message is out.



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

Voyager– the message is out.



http://www.youtube.com/watch?v=Axj1CVG6udE

Basic Astronomy Highlights

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

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

Astronomy is not Astrology!

Check out how the new zodiac configuration affects the various signs.

Sign	Old Dates	New Dates
Capricorn	Dec. 23-Jan. 20	**Jan. 9- Feb. 15**
Aquarius	Jan. 21-Feb. 19	**Feb. 16-Mar. 11**
Pisces	Feb. 20-Mar. 20	**Mar. 12-Apr. 18**
Aries	Mar. 21-Apr. 20	**Apr. 19-May 13**
Taurus	Apr. 21-May 21	**May 14-June 19**
Gemini	May 22-June 21	**June 20-July 20**
Cancer	June 22-July 22	**July 21-Aug. 9**
Leo	July 23-Aug. 21	**Aug. 10-Sept. 15**
Virgo	Aug. 22-Sept. 23	**Sept. 16-Oct. 30**
Libra	Sept. 24-Oct. 23	**Oct. 31-Nov. 22**
Scorpio	Oct. 24-Nov. 22	**Nov. 23-Nov. 29**
Ophiuchus	Not a Part of the Zodiac	**Nov. 30-Dec. 17**
Sagittarius	Nov. 23-Dec. 22	**Dec. 18-Jan. 8**

- And the zodiac signs were picked 2000 years ago.
- Since then the Earth has precessed, and someone born "in" Virgo is actually a Libra.
  - cf. Tropical Astrology
- And now there are 13 signs too.

Basic Astronomy

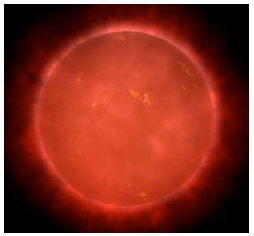
- Earth rotates on its axis, takes about 1 day.
- Sky rises in the East, sets in the West, due to our rotation motion.
- Earth orbits the Sun, takes 1 year.
- Reason for the seasons is the 23 degree tilt of the Earth. It's Summer in Australia now!
  - Because of this, the Sun also moves in the Sky during the year, i.e. reaches higher in the sky in the summer (so longer days) than winter in the northern hemisphere

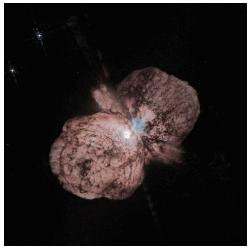
Basic Astronomy

- 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 hydrogen gas (much of it ionized)
- 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

Nearby Stars and What is a Galaxy?

- Stars are “freaky 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.

Drake Equation

Frank Drake

$$N =$$

# of advanced civilizations we can contact in our Galaxy today

Drake Equation

Frank Drake

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

# 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.

What happened to Pluto?

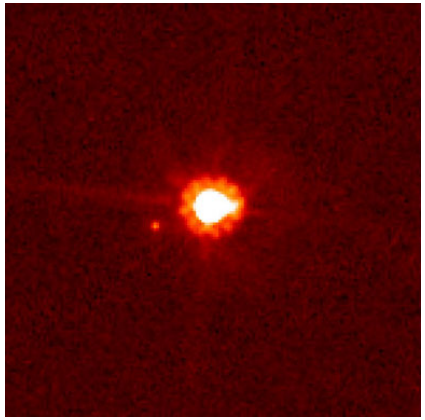
http://orbitingfrog.com/blog/wp-content/uploads/2008/07/poor_pluto_mathias_pedersen.jpg

The War of "What is a planet?"

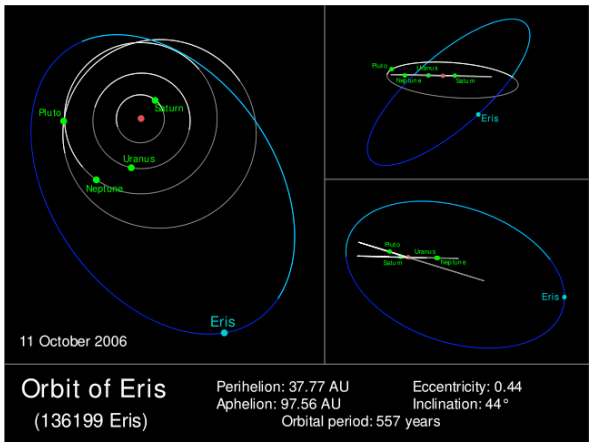
The War of "What is a planet?"

What's Changed?

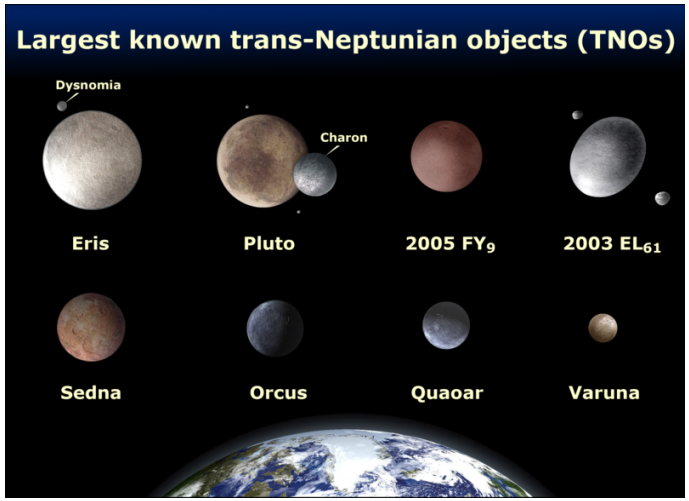
- The object Eris discovered in 2005
  - ~20% larger than Pluto (maybe)
  - ~30% more massive than Pluto
  - Has a moon (Dysnomia)
  - Weird orbit
- Planet?
- Why shines?



The Planet Eris?



Planet or Plan-not?



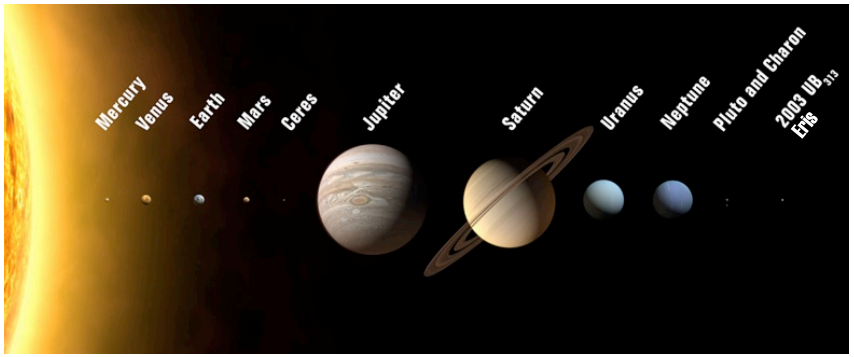
What is a Planet?

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?



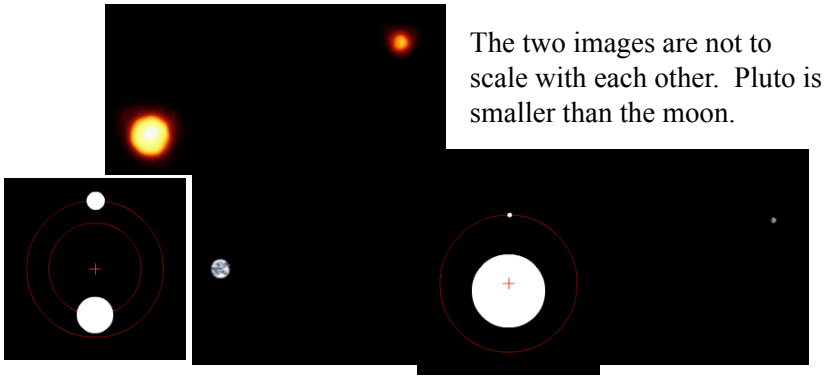
My Very Eccentric Mother Curiously Just Showed Us Nine Pianists Conducting Encores

My Very Excellent Mother Just Served Us Nine Pizzas

Why Charon and not our Moon?

Pluto-Charon

Earth-Moon

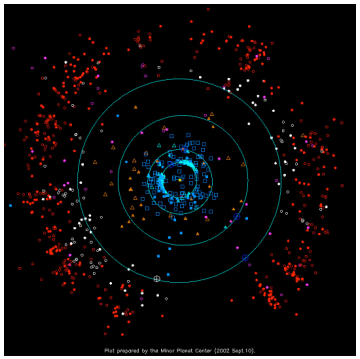


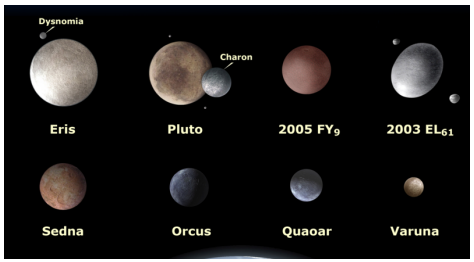
The two images are not to scale with each other. Pluto is smaller than the moon.

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???

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 Alternate Proposal

A planet is a celestial body that

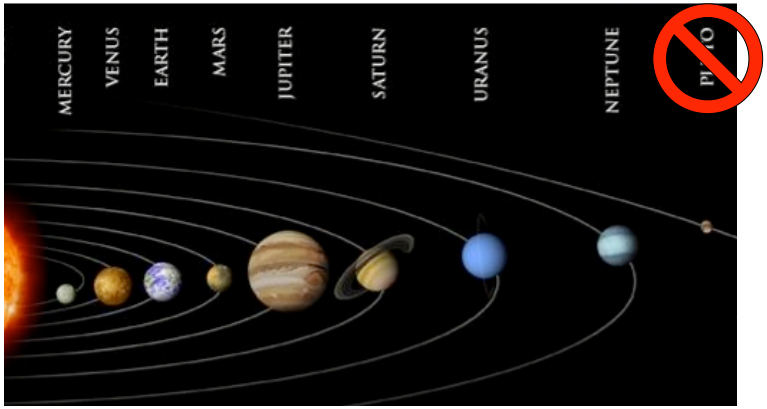
(a) has sufficient mass for its self-gravity assumes a nearly round shape, and

(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

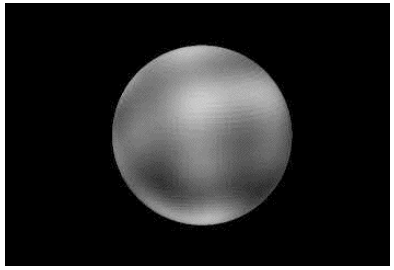
The Results...

~~Nine~~ 8 Planets



My Very Excellent Mother Just Served Us Noodles!

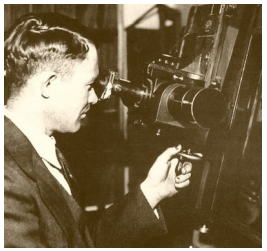
So what do we call Pluto now?



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 in Illinois!

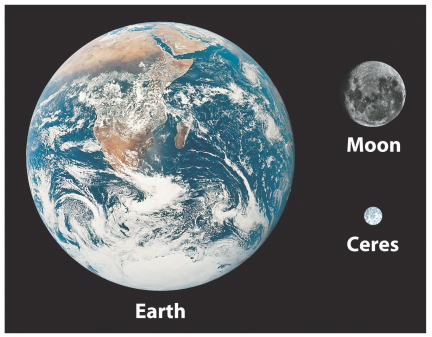
- Clyde Tombaugh, who discovered Pluto, was from Illinois, so the Illinois State Senate made a resolution
  - RESOLVED, BY THE SENATE OF THE NINETY-SIXTH GENERAL ASSEMBLY OF THE STATE OF ILLINOIS, that as Pluto passes overhead through Illinois' night skies, that it be reestablished with full planetary 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

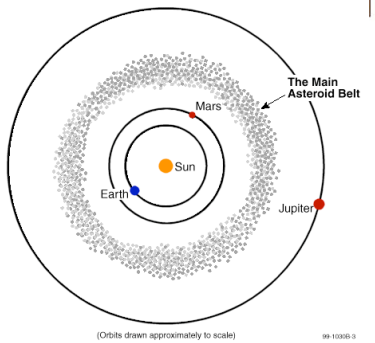


  - Luckily for me, it never passes overhead in Illinois!

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.