Sex in Space: Astronomy 330
TR 1100-1120
134 Astronomy Building

Leslie Looney

Phone: 244-3615

Email: lwl@uiuc.edu

Office: Astro Building #218

Office Hours:

  W: 11:00 a.m. – noon

  or by appointment

This class (Lecture 2):

  Size scales and
    Cosmology

Next Class:

  Cosmology and the
   origins of elements

HW1 due next Thursday.

Music: *Million Miles Away from Home* – Dune

Outline

- This Pluto thing (it's old but still many students want to talk about it)
- The Drake equation
- Let's take some time to get our bearings around the Universe.
- We live in the Milky Way.

What is a planet?

THERE CAN BE NO PEACE UNTIL THEY ACCEPT THAT PLUTO **IS** A PLANET!

© The Rocky Mountain News. Dist. by NEA, Inc.

The Planet Eris?

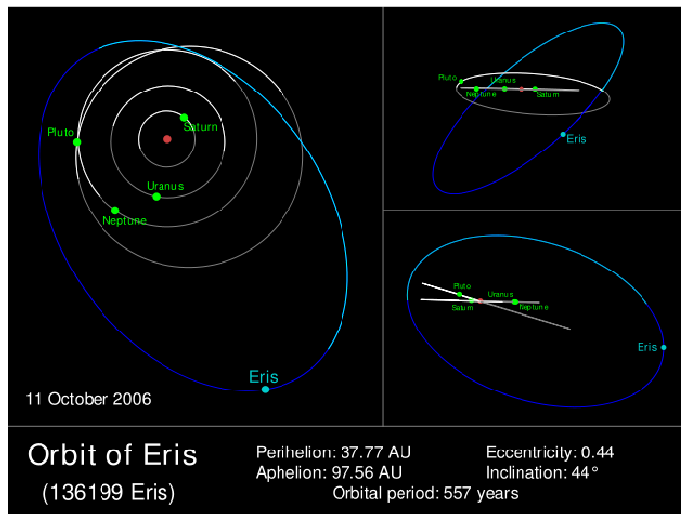- ~20% larger than Pluto
- ~30% more massive than Pluto
- Has a moon (Dysnomia)
- Weird orbit
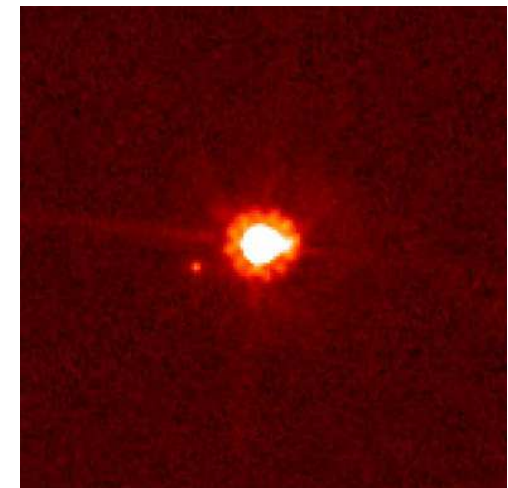
The Planet Eris?

Orbit of Eris
(136199 Eris)

11 October 2006

Perihelion: 37.77 AU Eccentricity: 0.44
Aphelion: 97.56 AU   Inclination: 44°
Orbital period: 557 years

Planet or Plan-not?

Largest known trans-Neptunian objects (TNOs)

Dysnomia

Charon

Eris   Pluto   2005 FY$_9$ 2003 EL$_{61}$

Sedna   Orcus   Quaoar   Varuna

The Initial 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

12 Planets?

Mercury Venus Earth Mars Ceres Jupiter Saturn Uranus Neptune Pluto and Charon 2003 UB$_{313}$ Eris

My Very Eccentric Mother Curiously Just Showed Us Nine Planters Conducting Encores
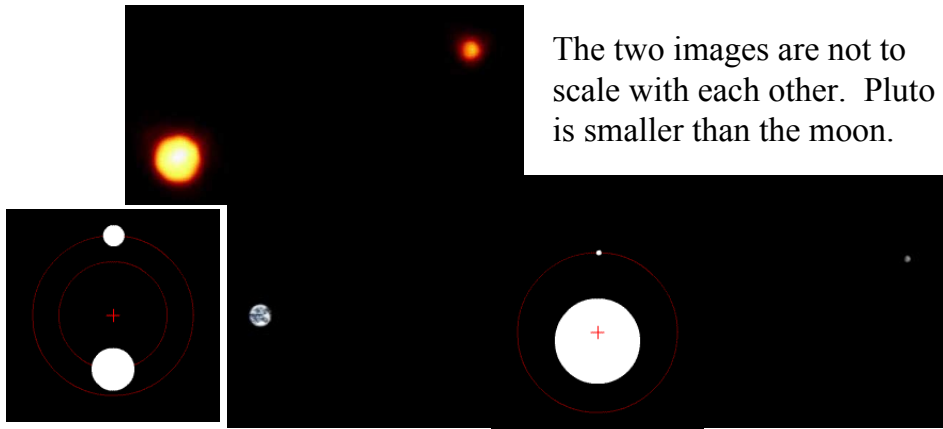
My Very Excellent Mother Just Served Us Nine Pizzas

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???

2003 EL₆₁ 2005 FY₉ Sedna Orcus Quaoar 2002 TX₃₀₀

2002 AW₁₉₇ Varuna Ixion Vesta Pallas Hygiea

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...

Dysnomia

Charon

Eris   Pluto   2005 FY₉   2003 EL₆₁

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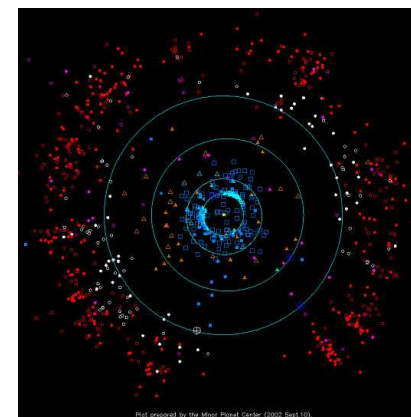
Red & white dots show other Pluto-like objects discovered around & beyond Neptune's orbit

The Results...

~~8~~ ~~Nine~~ Planets
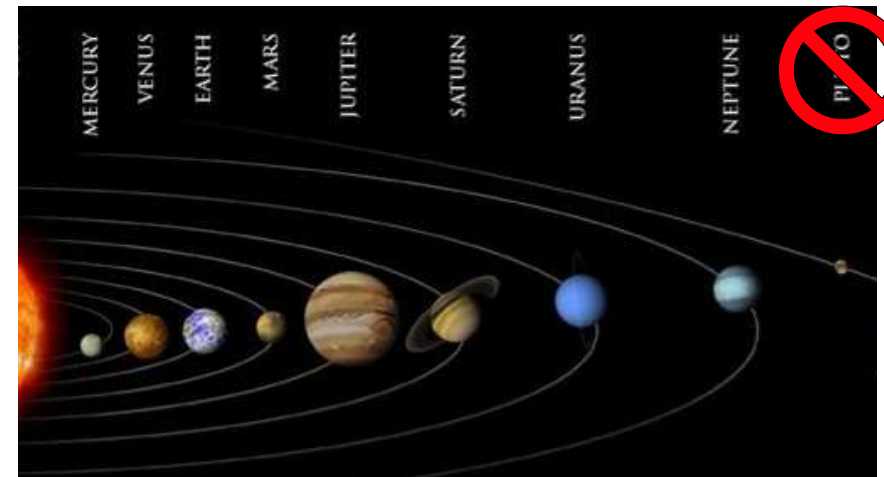
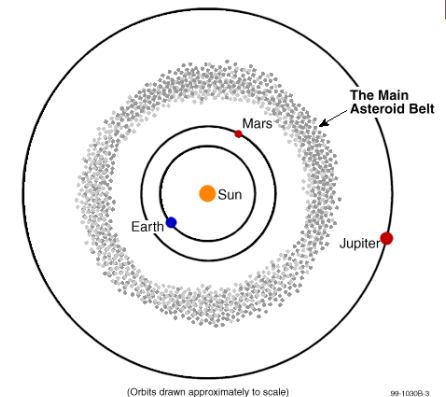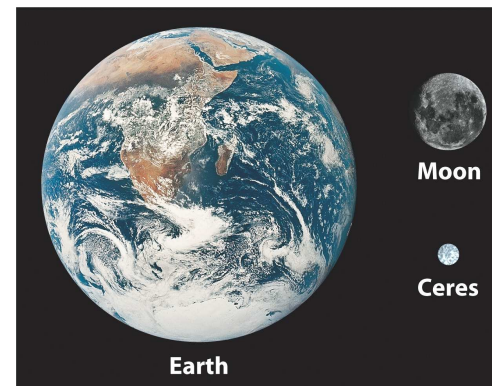**My Very Excellent Mother Just Served Us Noodles!**

So what do we call Pluto now?
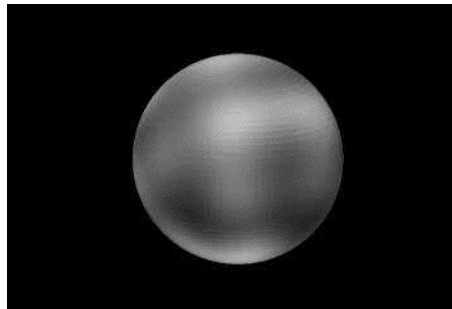
Planet-ish objects that meet the earlier definition, but fail to make the grade because of the new criterion would be called *dwarf planets*

Ceres, Another Former Planet

Earth   Moon   Ceres

The Main Asteroid Belt

Mars   Sun   Earth   Jupiter

(Orbits drawn approximately to scale)   99-1030B-3

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

Drake Equation

Frank Drake

$$N =$$

# of advanced civilizations we can contact in our Galaxy today

---

Drake Equation

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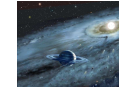
$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# of advanced civilizations we can contact in our Galaxy today	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
	stars/ yr	systems/ star	planets/ system	life/ planet	intel./ life	comm./ intel.	yrs/ comm.
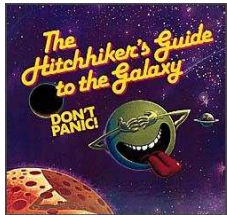
Space is Big!

"Space is big. Really big. You just won't believe how vastly hugely mind-bogglingly big it is. I mean, you may think it's a long way down the road to the chemist, but that's just peanuts to space…

To be fair though, when confronted by the sheer enormity of the distances between the stars, better minds than the one responsible for the Guide's introduction have faltered.

The simple truth is that interstellar distances will not fit into the human imagination."
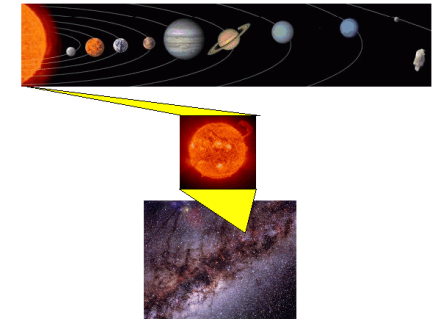
--Douglas Adams
The Hitchhiker's Guide to the Galaxy

One of

We are:

- 1 planet out of 8 (9) in our solar system.
- 1 stellar system of 100 billion stars in our Milky Way
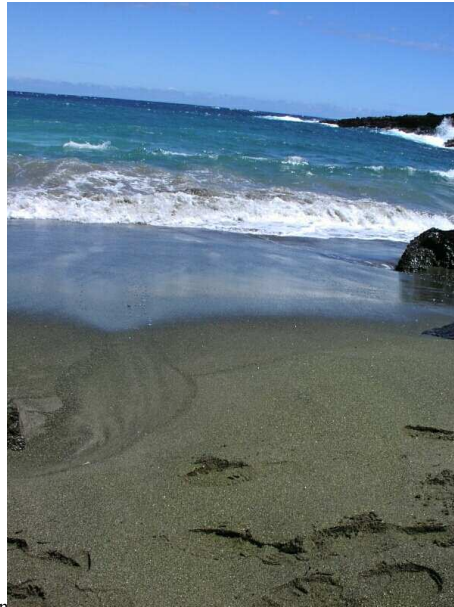
So?

- In the Universe, the number of stars is greater than the number of grains of sand on all of the beaches of the Earth. (Paraphrasing Carl Sagan.)

- Each of these stars may have planets.

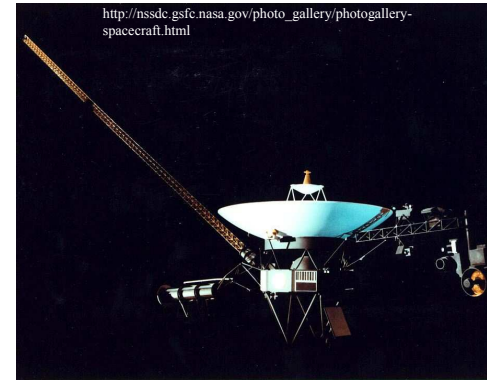- Is it sensible to think that life only exists on Earth?

Interstellar Travel

Don't forget that the Voyager spacecraft are about the fastest vehicles made by mankind. Even so, Voyager would take over 100,000 years to reach some of the closest star systems.
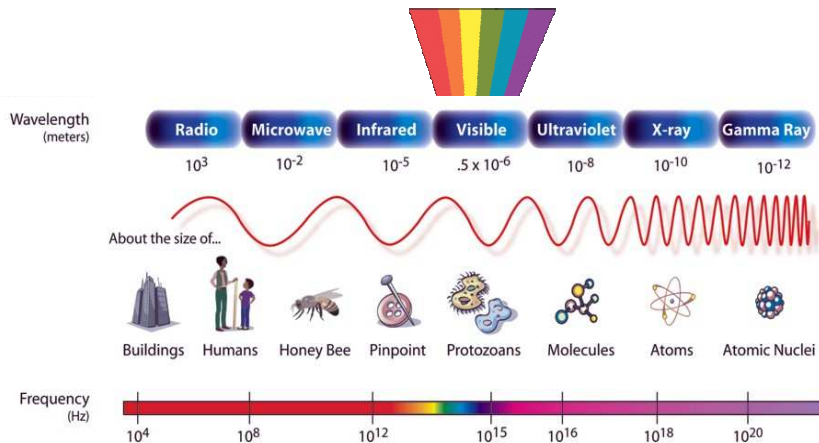

http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-spacecraft.html

---

The electromagnetic spectrum

- Visible light is only a tiny portion of the full electromagnetic spectrum
- Light comes in many colors that you can not see! The color x-ray or color radio or color microwave.
- Divisions between regions are really only from biology or technologies.

The atmosphere absorbs
some wavelengths and not others
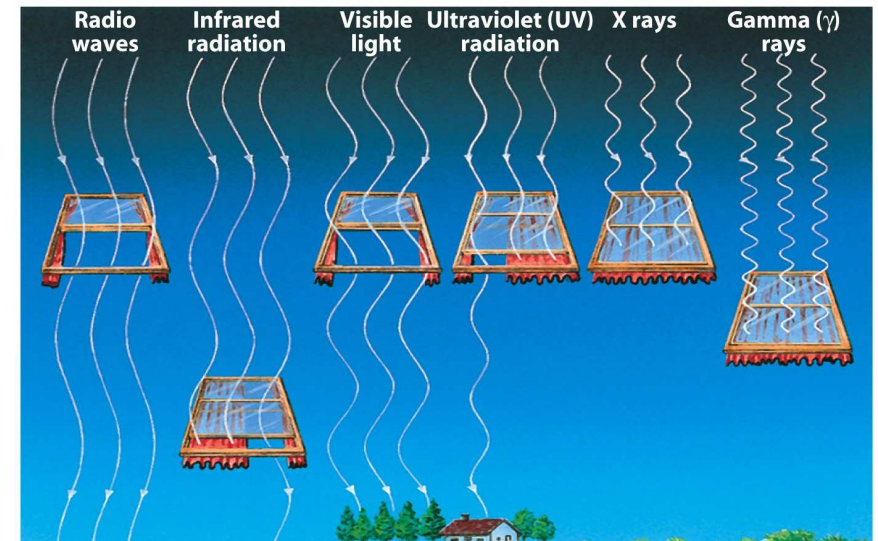
Speed of Light

- Light has a finite speed that is the same for all observers. Regardless of the observer's speed. (Special relativity—later).
- Nowadays we **define** the speed of light to be

  2.998×10^8 m/s

Distances

How far is it to Chicago?

Around 135 miles

Or 217 km

Or 712800 feet

Or 8.7×10^{10} microns

Or 285120 paces

Or 2 hours at car speed

Or 1 The Matrix DVD units at car speed

Or 0.7 ms at light speed

A Light Year

The **light-year**
- Distance that light travels in one year
- Speed of light: roughly 3.00×10^5 km/sec
- 3.16×10^{17} seconds in one year

so 1 light year = $(3.00 \times 10^5$ km/sec$) \times (3.16 \times 10^7$ sec$) = 9.42 \times 10^{12}$ km

- Nearest star (Proxima Centauri) is about 4.2 light years away.
- Analogous to saying: Chicago is about 2 hours away.

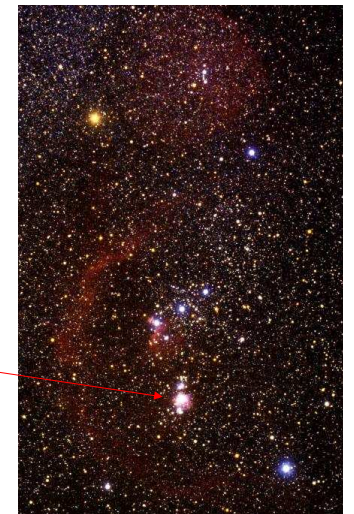# First Contact?

- Let's assume that there is life in the Alpha Centauri stellar system.
- It will take 100,000 years to travel on a Voyager-like spacecraft.
- It will take 8.4 years to send out a radio message and get a response.
- For stars in the sword of Orion, it would take 3000 years.

Other Distances

- 1 light year is 9.42×10^{12} km
- AU: the distance from the Sun to the Earth = 149,570,000 km = 1.58×10^{-5} light years
- pc: the distance away that a star would have a parallax of 1 arcsec = 3.086×10^{13} km = 3.26 light years