

Astronomy 150: Killer Skies



This Class (Lecture 34):
Aliens!

Next Class:
Aliens: Where are They?

HW 11 due on Dec 10th

**Final: Dec 15th,
1:30pm-4:30pm in classroom**

Music: Supermassive Blackhole – Muse

Grades



- I will endeavor to post grades for each topic as soon as I can.
 - Already posted test of Participation Grades
 - Did not include this week though (discussion week is graded)
- Remember, I will drop 6 of the participation credits (plus 1 extra credit), AND 1 of the HWs.
- Running a little behind on the Night Labs and Asteroid Lab, 80% done.
- Nonetheless, medians of those are 100%, so most people doing quite well.

Final



- In this classroom Dec 15th, 1330-1630 (1:30pm-4:30pm).
- Will consist of
 - 18 question on Exam 1 material.
 - 18 question on Exam 2 material.
 - 35 questions from new material (Lect 23+).
 - +4 extra credit questions
- A total of 210 points graded out of 200 points, i.e. 5 points of extra credit.
- A normal-sized sheet of paper with notes on both sides is allowed.
- Exam 1 and 2 are posted on class website (not Compass).
- I will post a review sheet

Online ICES



- Anonymous ICES forms are available online, so far 145/244 (~60%!) students have completed it.
- I **appreciate** you filling them out!
- **Please** make sure to leave written comments. I find these comments the most useful, and typically that's where I make the most changes to the course.
- This is a new course, so comments are especially welcomed. Keep in mind constraints of a gen-ed though.

Question



Are you going to fill out an ICES form before the deadline?

- a) Yes, I did it already.
- b) Yes, sometime today
- c) Yes, this weekend
- d) Yes, I promise to do it before the deadline of Dec 10th!
- e) No, I don't want help you out (even after all you have done for me and my education) nor do I want to help out the large number of students who will come after me (I wish you a long life!). I prefer stagnation.

Question



What part of class did you like best?

- a) Lecture
- b) HW
- c) Exams
- d) Asteroid Lab
- e) Night Lab

Question



What part of class did you like least?

- a) Lecture
- b) HW
- c) Exams
- d) Asteroid Lab
- e) Night Lab

Outline

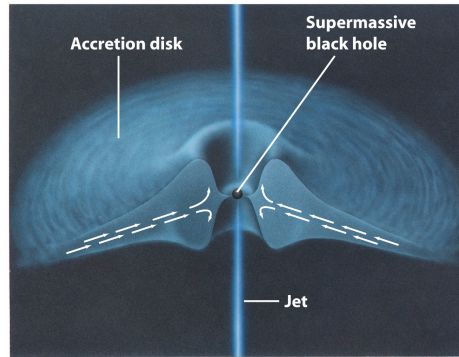


- Quasars
 - It feeds! Feeds.
- Why not aliens?
- Drake's Equation

Driving Active Galaxies: The Monster Within



- The energy source is a supermassive black hole
- Accretion disk emits tremendous amounts of energy as it falls onto the black hole
- Jet is a beam of death! But typical perpendicular to Galaxy.



Quasar Dangers



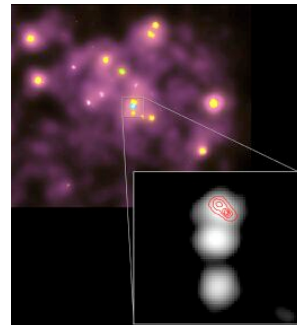
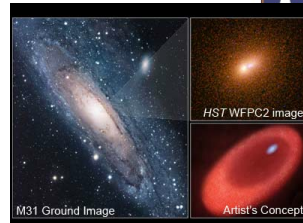
- The Milky Way has a supermassive black hole and so does Andromeda.
- They are not feeding right now, so no quasar energy.
- Can they every turn on?
- Yes, if material falls in (why?) and creates accretion disk.
 - We need about 0.1 solar mass of material accreted per year.



Quasar Dangers



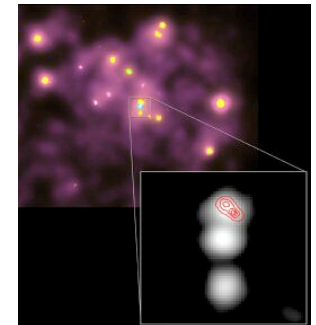
- Let's consider our near neighbor Andromeda (2 Mlyrs away).
- It has a 100 million solar mass black hole. (MW has 4 million).
- There are clusters nearby.
- Could it be about to feed?



Andromeda Dangers



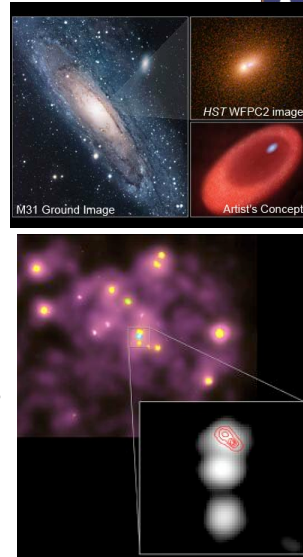
- Jet direction determined by spin of material that falls in.
- So, we don't know which way the jet would go.
- But, effects would be similar to those causes by GRB burst.
- But, Andromeda is very far away, so much less energy.



Andromeda Dangers



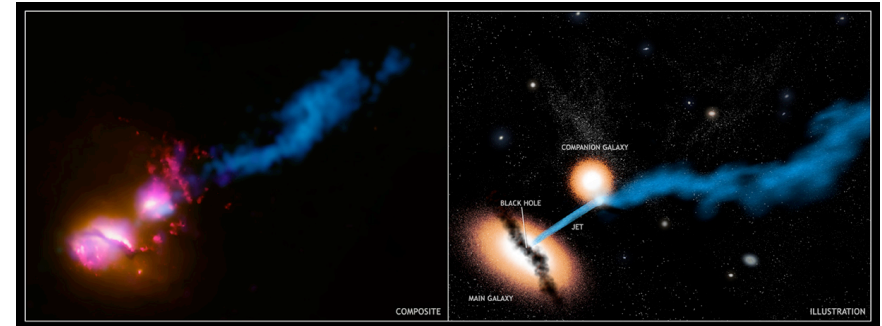
- But, this jet would stay on, not only last for ~20 seconds.
- Jet could cover large region of MW.
- Zero warning!
- Could be coming right at us right now!
- Could have started 2 million years ago!



The Death Star Galaxy



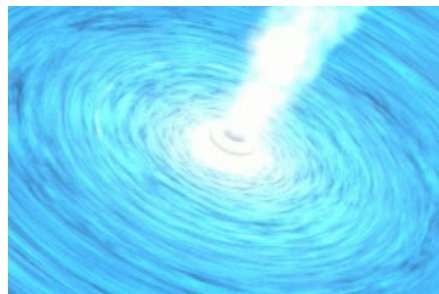
- Recent observations of a nearby galaxy (850 klyrs) show this is happening to two galaxies right now!
- Jet interacts with companion galaxy (20klyr separation)
- Any Earth-like planets getting fried?



The Death Star Galaxy



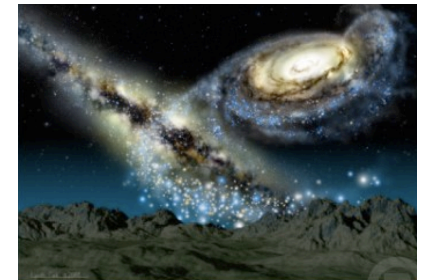
- The chances are low for Andromeda to kill us.
- Quasars are not feeding right now.
- Gas is not falling in– stable orbits?
- But it is possible.



Andromeda Future



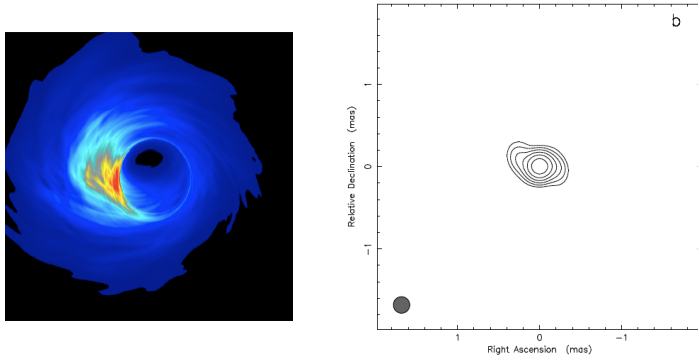
- During the creation of Milkomeda, however, all bets are off.
- Local quasar-like objects are mostly interacting galaxies.
- Gravity interaction can send material inward.
- Either black hole could feed or the new combined black hole.
- Earth location and jet direction is unknown though.



Local Danger?



- Our black hole has a very small accretion disk.
- Not really feeding, very very light snacks at best.
 - We do see occasional flares from the center, harmless.
- No jet, but it probably had one in the past!



Local Danger?



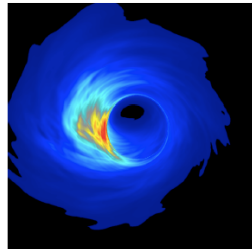
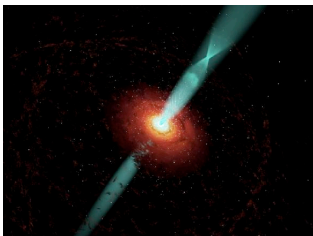
- There is a big molecular cloud nearby the center (390 lyrs), but currently in a stable orbit.
- If it fell in for some reason (cloud collisions?), we could easily create an accretion disk and jet.
- The direction of the jet will unlikely be pointed toward the Earth, but we don't know!



Mitigation



- Nope!
- Destruction on large scale of Galaxy. But beamed.
- No warning.
- Human race gone...



Imagine

- Astronomers notice that the center of Andromeda is getting brighter. Something interesting is going on.
- Astronomers suggest that Andromeda's supermassive black hole is feeding for some reason.
- It is exciting as astronomers watch the formation of a large accretion disk, which is somewhat unexpectedly oriented perpendicular to our line of sight.

Imagine

- Without warning, a beam of energy is unleashed from the center of Andromeda.
- The gamma-ray beam has less energy/time than a gamma-ray burst, but it doesn't turn off.
- As you are fried by gamma-rays, you wonder why you didn't pay more attention to Leslie during the last week of class or fill out your ICES form.

Top 10 Ways Astronomy Can Kill you or your Descendents



6. Rogue compact objects—White Dwarfs/Black Holes.
Black Holes don't suck, but if they hit you it sucks.
7. Galaxy Collisions.
Milky Way vs. Andromeda.
8. Cosmology!
This is the way the Universe ends..
9. Quasars. The Monster in the Milky Way?
It burnssss...
10. Aliens.
You're kidding right...

Top 10 Ways Astronomy Can Kill you or your Descendents



8. Aliens. Are you serious?

With 100-400 billion stars in our Galaxy, it seems likely that aliens exist. If they do exist, it takes longer to evolve than to colonize the Galaxy. Where are they? Our new alien overlords.

<http://www.youtube.com/watch?v=A8zsdIQe9UQ>

Imagine

- Astronomers notice something bright in gamma-rays moving into the Solar System.
- The object is changing course!
- Contact! But it isn't responding to our hails.
- The object passes by the asteroid belt, but then starts to move out of the Solar System.
- Excitement dies down, but a year later, an asteroid starts to change orbit and move toward Mars.
- The asteroid has factories and "lands" on Mars.
- Robotic spiders are building more and more factories, and with our orbiting spacecraft, we watch.

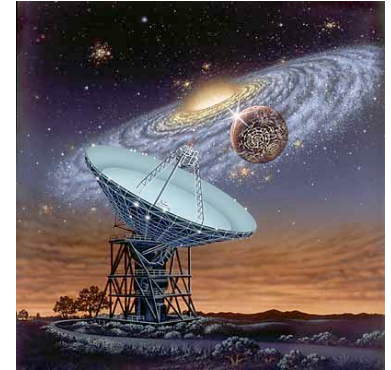
Imagine

- Within a few years, the surface of Mars is picked clean, as micro-factories replicate huge numbers of alien robot-like organisms and spacecraft.
- A year later, objects start to lift off from Mars, and they are coming toward Earth!
- As they land, there is nothing we can do.
- They begin to destroy the surface of the Earth, making more replicates of themselves.
- As you are ripped apart for your heavy elements, you wonder why you didn't pay attention during the last few days of Leslie's class.

Are We Alone?



- It's a great time to think about this question!
- In 1995, we knew of 9 planets. Now, in 2009, we know of 358 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.
- Can we answer arguably the biggest astronomical question of all time: *Are we alone?*



Questions



Do you think extraterrestrial life exists?

- a) Yes
- b) No
- c) Maybe

Questions



Do you believe that we have been visited by UFOs?

- a) Yes
- b) No
- c) Maybe

Questions



Are UFOs the same as ET life?

- a) Yes
- b) No
- c) Maybe

The Universe: Some Facts to Help you Live in it



Numerically Challenged



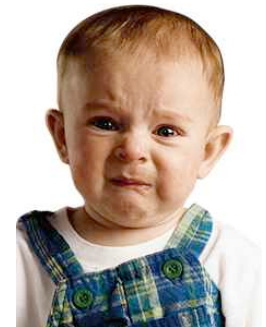
- In the Universe, the number of stars is greater than the number of grains of sand on all of the beaches of the Earth.
- Each of these stars may have planets.
- Or only 0.0001%?
- Is it sensible to think that life only exists on Earth?



Life?



- Astronomically, we are not special.
- So, we are probably typical in many ways to the other planets around other stars, in other galaxies.
- One aspect of the study of extraterrestrial intelligent life is to determine if *life* is a typical phenomenon.



Life?



- At the very worst, we expect that most galaxies have at least one planet with intelligent life on it
 - As the Milky Way has at least one planet with Intelligent Life.
- So, there ought to be at least 100 billion intelligent civilizations in the Universe!



Aliens?



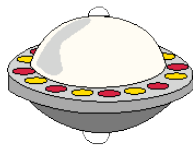
We have been bombarded by aliens in the media– all types.

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

Have we been visited by ETs?



“Extraordinary Claims Require Extraordinary Evidence”



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 communicate	Lifetime of advanced civilizations
stars/yr	systems/star	planets/system	life/planet	intel./life	comm./intel.	yrs/comm.	

R_*



- There are perhaps tens to hundreds of billions of galaxies
 - Each with hundreds of billions of stars
 - Age of Universe is 13.7 billion years
- Probably best known number.



f_p : Other Planets, Other Stars



47 Ursae Majoris System— 51 light years away (near the Big Dipper). 13 years of data has shown 2 planets— 1 Jupiter like and 1 Saturn like.

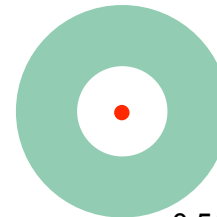


Wow! Among the most similar to our own system

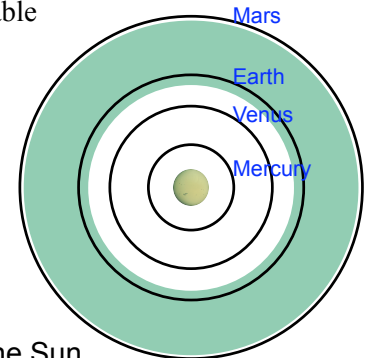
n_e : Habitable Zones— Are you in the Zone?



- Long living star
- Planets with stable orbits (thus stable temps)
- Liquid Water
- Protection from UV radiation



$0.5M_{\text{Sun}}$ star



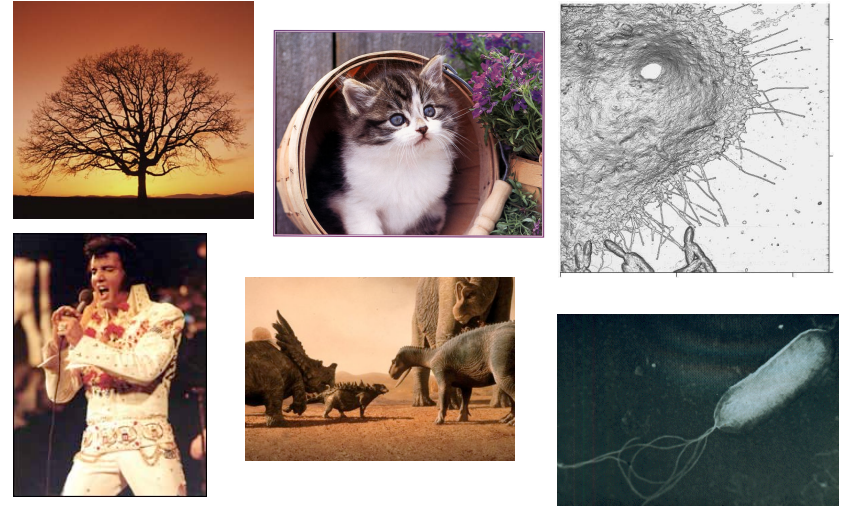
The Sun

f_i : Cosmic Imperative?



- Is life a cosmic imperative?
- Just like gas forms galaxies, and in galaxies stars and planets form, do chemicals on some planets form molecules that lead to life?

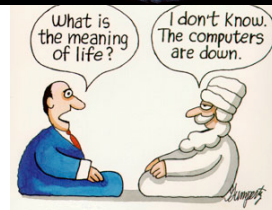
All Made from the Same Stuff



What is the Earth made of?



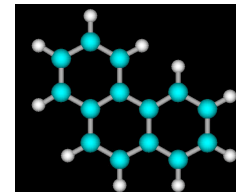
- The makeup of the Earth is very different than our makeup (all life).
- HONC are the elements of life.
 - Hydrogen– Big Bang
 - Oxygen– Fusion of 1st stars
 - Nitrogen– Fusion of 2nd stars
 - Carbon– Fusion of 1st stars
- **“We are star stuff!”**



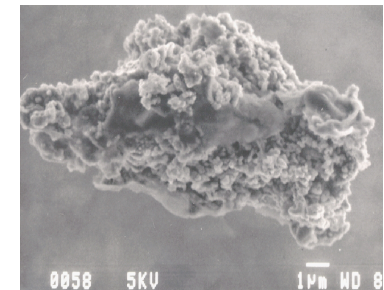
Molecules in Space!



- Molecules (e.g.)
 - Carbon monoxide (CO)
 - Water (H₂O)
 - Ammonia (NH₃)
 - Formaldehyde (H₂CO)
 - Glycine (NH₂CH₂COOH)?
 - Ethyl alcohol (CH₃CH₂OH)
 - Acetic Acid (CH₃COOH)
 - Urea [(NH₂)₂CO]
- Dust particles
 - Silicates, sometimes ice-coated
 - Soot molecules



Polycyclic aromatic hydrocarbons (PAH)



Dust particle (interplanetary)

Miller and Urey Experiment



- Testing chemistry on the early Earth— no oxygen.
- Can we make the important molecules of life easily?
- ALL 20 amino acids needed for life can form with water and an energy source under the right conditions.



http://physicalsciences.ucsd.edu/news_articles/miller-urey-resurrected051903.htm

Making Oxygen: The First Air Pollution



- The early Earth had no oxygen.
- Cyanobacteria changed the world!
- Created first environmental disaster!
- From 3.5 to 1.8 Byrs ago, allowing more complicated life.



Chain of Life



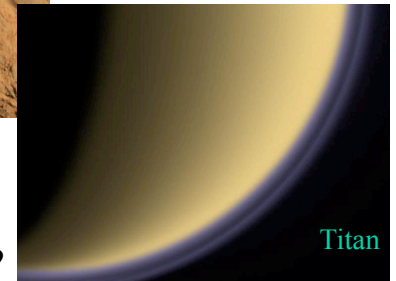
- 3.5 Byrs ago: **Bombardment of Earth stopped.**
- 3.8 Byrs ago: **First known fossils**
- 1 Byrs ago: **First multi-celled organisms.**
- 500 Myrs ago: **First boned creature— first fish.**
- 400 Myrs ago: **First amphibians.**
- 300 Myrs ago: **Many animals.**
- 200 Myrs ago: **Dinosaurs.**
- 100 Myrs ago: **Birds, mammals, flowering plants.**
- 65 Myrs ago: **Mass extinction— new chance for mammals.**
- 5 Myrs ago: **First humanoids.**

Is There Anyone Out There?



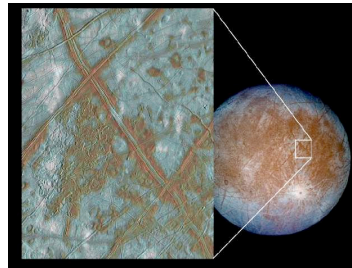
Could there be life in a place like this?

Or perhaps a place like this?

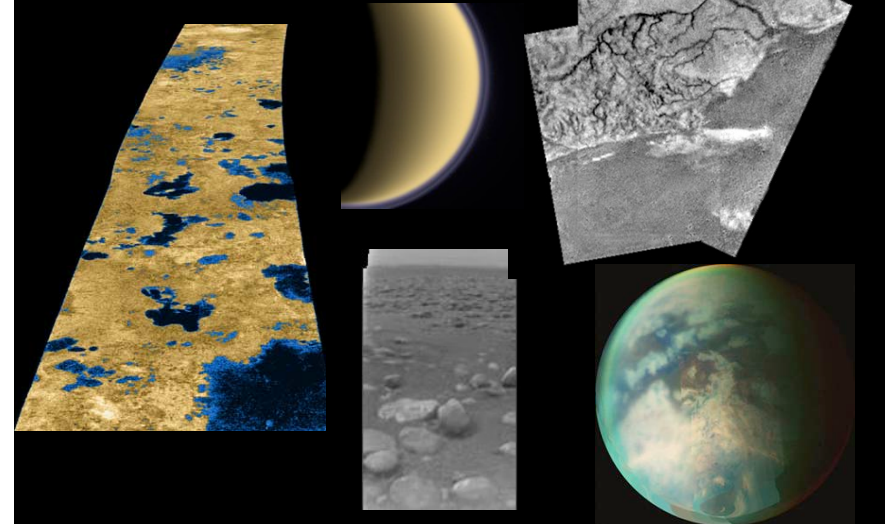


Europa: Moon of Jupiter

- Life would have to be below the surface, around hydrothermal vents.
- Similar to the first Earth life?
- We don't know how thick the ice is yet. To be continued.
- Future missions, will have to employ melting or smash and dive spacecraft.



Mapping Titan



Life in the Solar System

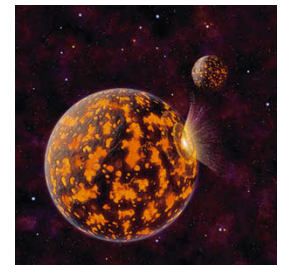
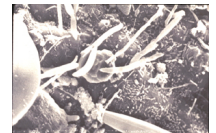


- **No conclusive evidence exists for life in our solar system besides on Earth**
- But, possibilities exist for life
 - Venus may have microbial life high in the atmosphere, fleeing the high temperature of the surface.
 - Mars may have some microbial history linked to water, and perhaps some subsurface life.
 - Maybe Martian life seeded Earth?
 - Europa's sub-crustal oceans may harbor life, even fish-like life.
 - Titan is very interesting
 - Thick atmosphere

How Old is Life?



- 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
- But, we do have evidence for very early microbial life on Earth (about 4 billion yrs old).
- The heavy bombardment ended at about that time.
- First multi-celled life about 1 billion years ago



Life



If we took all the biomass of all the animals, and all the biomass of all the viruses, bacteria, protozoa, and fungi— who weighs more?

- A) Animals
- B) Small stuff



Life



If we took all the biomass of all the animals, and all the biomass of all the viruses, bacteria, protozoa, and fungi— who weighs more?

Around 90% of all biomass on the Earth is in the smallest and simplest lifeforms.

