Astronomy 150:

Killer Skies

MWF 1300-1350
141 Wohlers Hall

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Office Hours:
W: 11:00-11:59 a.m.
or by appointment or email

This Class (Lecture 3):

Astro-Death is very unlikely

Next Class:
Asteroids/Comets

http://eeyore.astro.uiuc.edu/~lwl/classes/astro150/spring09/
(simpler to google-me, then click on 150 link)

Music: *I'm Your Moon* – Jonathan Coulton

You need to Register You Clicker

- Go to **link on syllabus** to register your clicker ASAP.
- **Bring it to class every day.**

https://online-s.physics.uiuc.edu/cgi/courses/shell/iclicker.pl

Outline

- Statistics of Death
- 1st way astronomy can kill you…. impacts

What is the most likely?

Which of the following do you think is the most likely cause of death in the world?

a) War
b) Poisoning
c) Melanoma (skin cancer)
d) STDs (not counting HIV/AIDS)
e) Astronomy related deaths

Note, wrong answers okay here.

What are you afraid of?

http://en.wikipedia.org/wiki/List_of_causes_of_death_by_rate

What are you afraid of?

CAUSES OF DEATH, USA, 2002

FORMAL NAME	INFORMAL NAME	% ALL DEATHS
(1) Diseases of the heart	heart attack (mainly)	28.5%
(2) Malignant neoplasms	cancer	22.8%
(3) Cerebrovascular disease	stroke	6.7%
(4) Chronic lower respiratory disease	emphysema, chronic bronchitis	5.1%
(5) Unintentional injuries	accidents	4.4%
(6) Diabetes mellitus	diabetes	3.0%
(7) Influenza and pneumonia	flu & pneumonia	2.7%
(8) Alzheimer's Disease	Alzheimer's senility	2.4%
(9) Nephritis and Nephrosis	kidney disease	1.7%
(10) Septicemia	systemic infection	1.4%
(11) Intentional self-harm	suicide	1.3%
(12) Chronic Liver/Cirrhosis	liver disease	1.1%
(13) Essential Hypertension	high blood pressure	0.8%
(14) Assault	homicide	0.7%
(15) All other causes	other	17.4%

http://www.benbest.com/lifeext/causes.html

What are you afraid of?

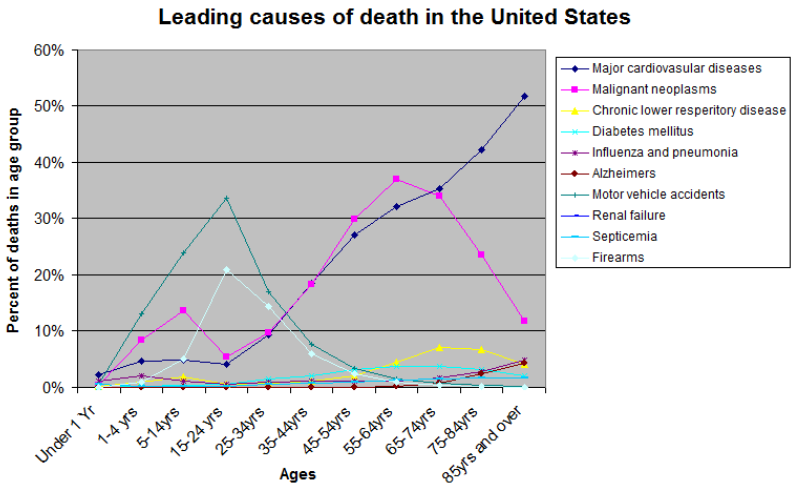
FIVE LEADING CAUSES OF DEATH, USA, AGES 15-24, 1998

CAUSE	PERCENT OF TOP 5	NUMBERS
(1) Accidents	51.8%	12,752
(2) Homicide	21.3%	5,233
(3) Suicide	16.3%	4,003
(4) Cancer	6.8%	1,670
(5) Heart Disease	3.9%	961

Seventy percent of all cancer deaths are the result of seven cancers:

http://www.benbest.com/lifeext/causes.html

What are you afraid of?

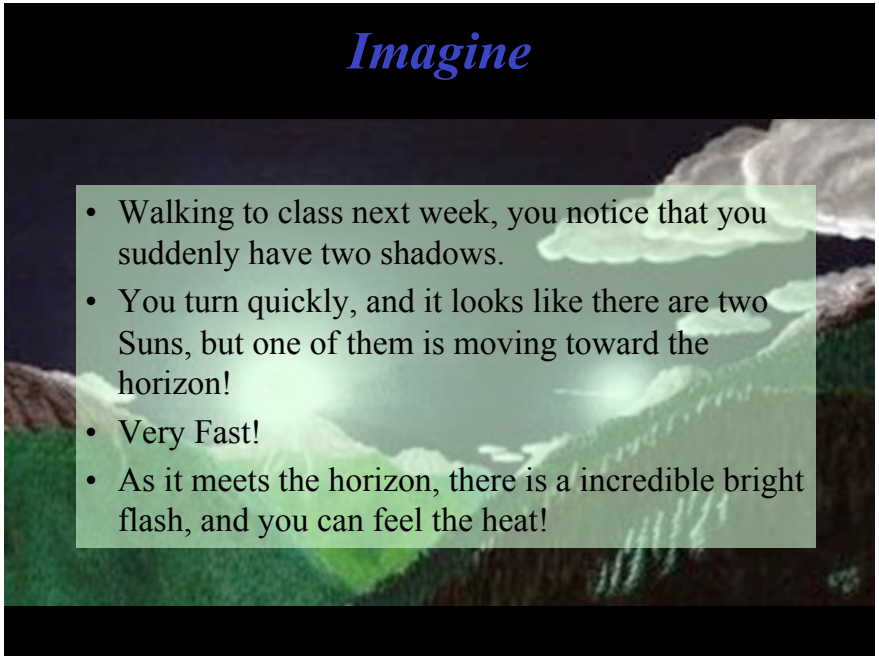


http://en.wikipedia.org/wiki/File:Causes_of_death_by_age_group_(percent).png

But Astronomy Can Cause Death on Global Scale

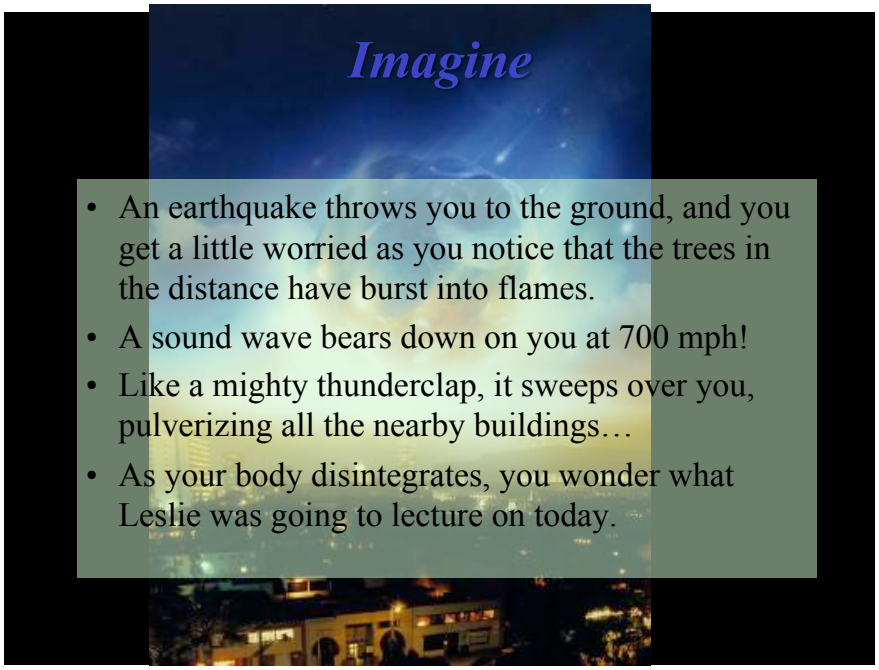
- Disaster, actually means “bad star”
- But real chance of astronomy killing you is tiny.
- But, astronomy can cause death on global scale, and will set the limit on the eventual lifetime of our civilization.

Imagine



- Walking to class next week, you notice that you suddenly have two shadows.
- You turn quickly, and it looks like there are two Suns, but one of them is moving toward the horizon!
- Very Fast!
- As it meets the horizon, there is a incredible bright flash, and you can feel the heat!

Imagine



- An earthquake throws you to the ground, and you get a little worried as you notice that the trees in the distance have burst into flames.
- A sound wave bears down on you at 700 mph!
- Like a mighty thunderclap, it sweeps over you, pulverizing all the nearby buildings…
- As your body disintegrates, you wonder what Leslie was going to lecture on today.

Top 10 Ways Astronomy Can Kill you or your Descendents

1. Impacts!

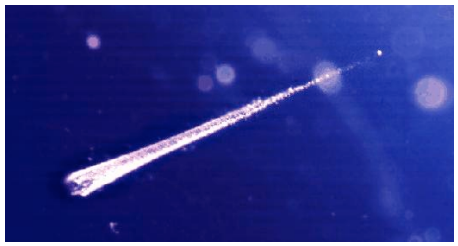
Meteors
Meteoroids
Asteroids
Comets
Pieces of freakin’ debris

Whatever…. http://www.youtube.com/watch?v=L70wJavN3vI
(start at :32/1:19)

Or http://www.youtube.com/watch?v=vZiZU42sn6w

What am I talking about?

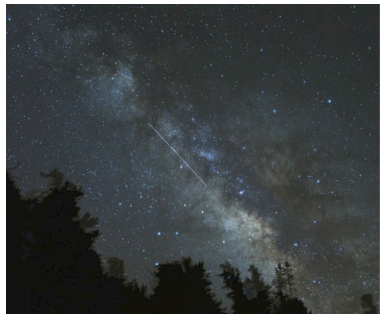
- Space debris.
- Space rocks.
- The leftovers of star and planet building.
- Can it happen? Has it happened before? Should I place my head between my knees?
- What are the terms?



http://www.faculty.uaf.edu/ffdjw/211/2007/meteors/Facts%20about%20Meteors%20entering%20Earth%20(page%202).htm

Meteors

- That flash of light you see…
- Sometimes called "a shooting star"
- Usually occurs ~50 miles up
- http://www.youtube.com/watch?v=Y8pPGxAyrY0



http://antwrp.gsfc.nasa.gov/apod/ap090501.html

Meteors

- Typically from sand-grain sized particles falling into the atmosphere
- When they fall into the atmosphere, they heat up due to the atmosphere interaction.
- Creates a bright tail of hot gases and melted stuff

http://antwrp.gsfc.nasa.gov/apod/ap080814.html

Meteor Showers

- Meteors can be seen all the time
- In the early morning, you can typically see about 3 per hour
- Several times a year, the rate increases
  - Maybe more than a meteor per minute
  - Called **meteor showers**
- Seem to originate from a single point in the sky

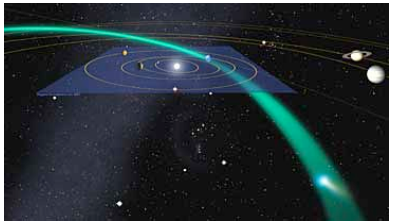
Meteors

- Best viewing time after midnight
- Don't use a telescope!

Jodrell Bank

Meteor Showers

- When a comet enters the inner Solar System, it leaves a trail of dust
- When Earth passes through this dust, we get a meteor shower
- Meteor showers don't typically produce meteorites
  - Its all dust, not rocks

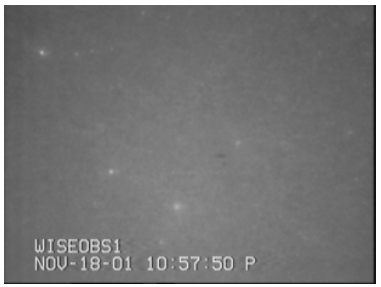


Prominent Yearly Meteor Showers

Shower	Date of maximum intensity	Typical hourly rate	Constellation
Quadrantids	January 3	40	Boötes
Lyrids	April 22	15	Lyra
Eta Aquarids	May 4	20	Aquarius
Delta Aquarids	July 30	20	Aquarius
Perseids	August 12	80	Perseus
Orionids	October 21	20	Orion
Taurids	November 4	15	Taurus
Leonids	November 16	15	Leo Major
Geminids	December 13	50	Gemini
Ursids	December 22	15	Ursa Minor

Fireballs

- A brighter than usual meteor.
- Sometimes called bolides by geologist.
- Sometimes explodes, larger than grains of sand.. about millimeter-size pieces of debris.
- http://www.youtube.com/watch?v=jUh7pYDmK08&NR=1



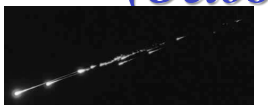
http://antwrp.gsfc.nasa.gov/apod/ap050812.html

Fireballs

- Since most meteors are from small objects, they burn up before they hit the ground.
- But some are from larger objects, which survive all the way to the ground.
- These are then called meteorites

http://antwrp.gsfc.nasa.gov/apod/ap081011.html

Peekskill Fireball (October 9, 1992)



Objects in space <50 meters in size are called **meteoroids**

Closer to Home

- March 26th, 2003
- Park Forest, IL
- Through the roof, hit the printer, hit the wall

Interesting Question

You and your friends watch a meteor shower together. Your friends want to go look for the meteorites. What do you say?

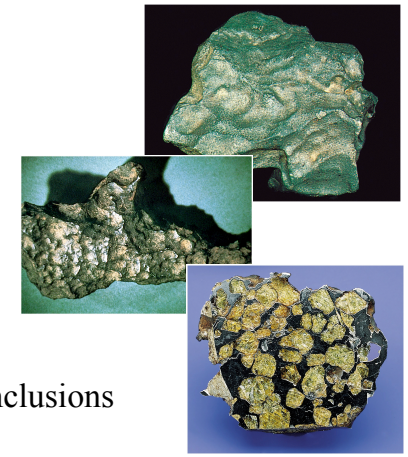
a) Cool, let's go!
b) Yes, all we need to do is look for the smoke.
c) No, it's too dangerous. We could be hit by one while looking.
d) No, they burned up in the atmosphere, nothing left.
e) Yes, I like cake.

Be Careful?

http://www.youtube.com/watch?v=x0BifYPQQJE&feature=related
(1:40)

Types of Meteorites

- 94% of meteorites are **stony**
  - Made of silicates, hard to distinguish from Earth rocks
- 5% are **irons**
  - Iron-nickel crystals
- 1% **stony-irons**
  - Silicates with iron inclusions

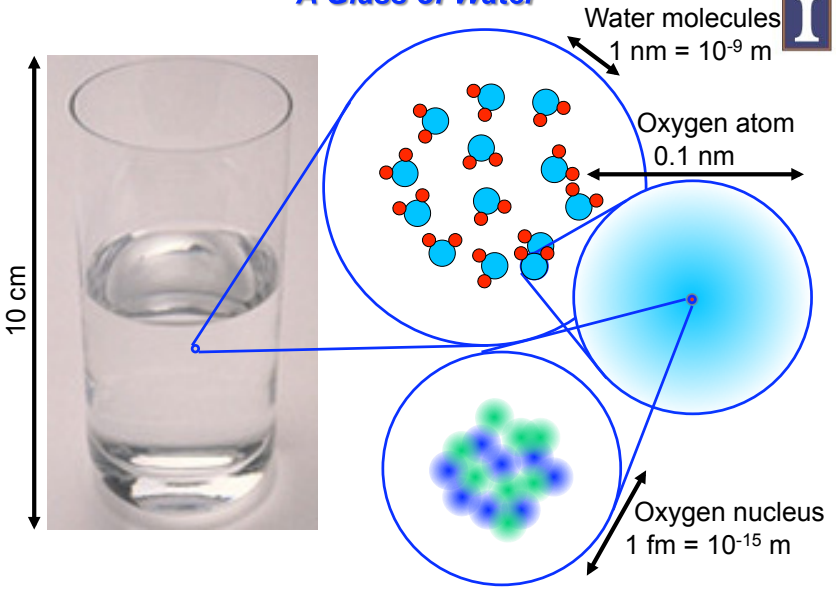


Meteorites are Ancient

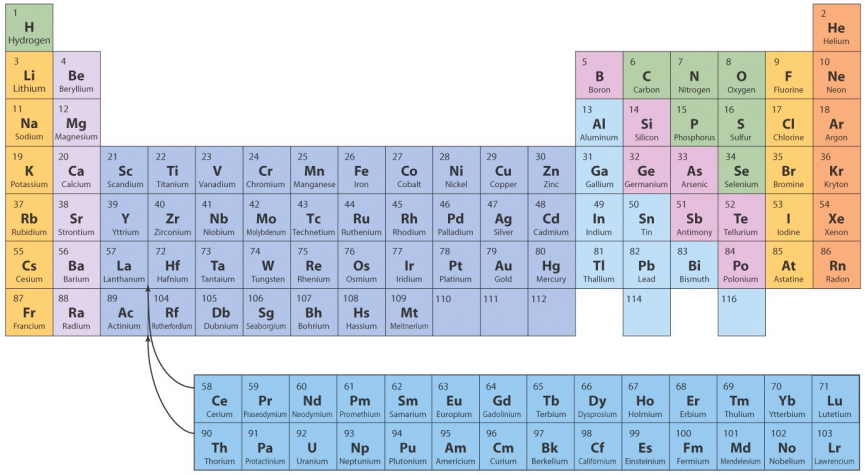
We have found that meteorites are the oldest objects in the Solar System

How do we know?

A Glass of Water



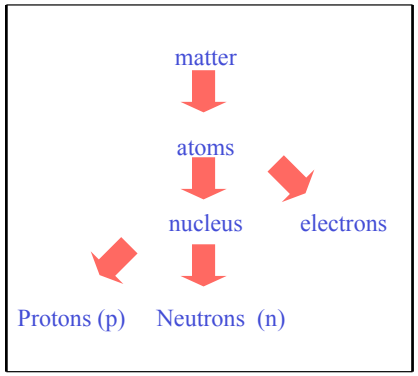
The Periodic Table of the Elements



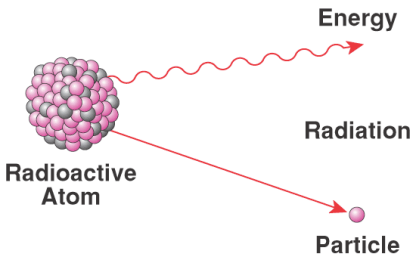
The number of protons in an atom determines the type of element, and the number of protons and neutrons determine the atomic weight.

Radioactive Dating

Recall:



- Most atomic nuclei stable
- But some nuclei are *unstable*.
  ⇒ *decay* to new nucleus
  "radioactive"



The Law of Radioactive Decay

As radioactive "parent" decays, the number of decay product or "daughters" increases

Decay is a good "clock"

- Each radioactive species has different "tick"
- Rate= "half-life"
- Exponential decay from original population of N

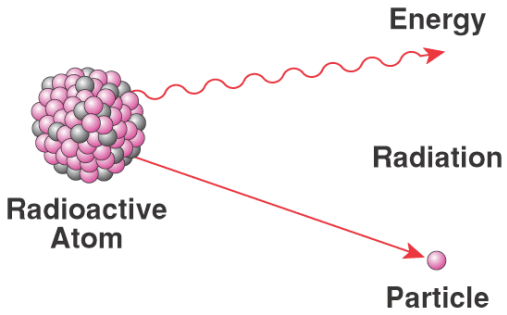
Decay Rule

Start out with N parents, 0 daughters

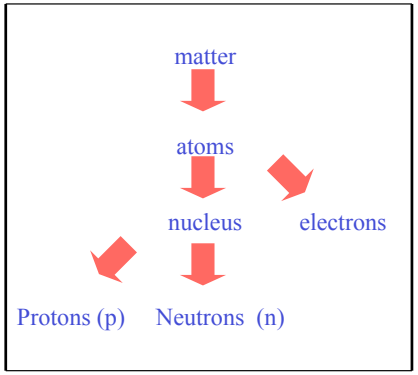
Time t since start	# parents	# daughters
0	N	0
$t_{1/2}$	½ N = half as much	½ N have appeared
$2t_{1/2}$	¼ N = half again as much	¾ N
$3t_{1/2}$	1/8 N	7/8 N
$30t_{1/2}$	About $N/10^9$	99.9999999% N

Radioactive Decay Examples

http://www.colorado.edu/physics/2000/isotopes/radioactive_decay3.html



Radioactive Dating



Example 1: Carbon C=6p

- Carbon-12: 6p+6n, stable
- Carbon-14: 6p + 8n, unstable (1/2 life of 5730 years)
- **$^{14}C \rightarrow {}^{14}N$ (nitrogen)**
- Nitrogen-14: 7p + 7n, stable

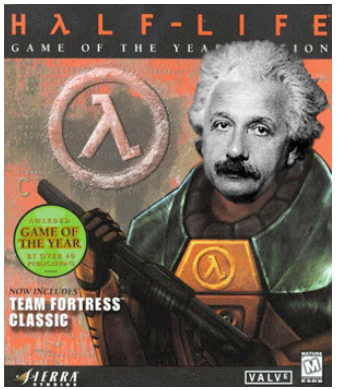
Example 2: Uranium U=92p

- Uranium-238: 92 p + 146 n (1/2 life of 4.5 billion years)

$^{238}U \rightarrow$ chain of decays $\rightarrow {}^{206}Pb$ (lead)

Carbon-14

- Cosmic rays from space are constantly hitting the Earth.
- React with ^{14}N in atmosphere to create ^{14}C.
- Decays back to ^{14}N with half life of 5730 years.
- But, there is an equilibrium in abundance
- In atmosphere, the ^{14}C is mostly in $^{14}CO^2$.



http://bbspot.com/Images/News_Features/2003/12/half-life.jpg

Carbon-14

- Plants take in $^{14}CO^2$ with the $^{12}CO^2$ and other animals eat the plants.
- So, every living creature has a equilibrium ratio of $^{14}CO^2/^{12}CO^2$.
- When the organism dies, the ^{14}C decays to ^{14}N. By measuring how much ^{14}C remains, you can date the fossil.
- This works well to about 60,000 years.
  - Viking remains in Newfoundland– 500 yrs before Columbus.
  - Shroud of Turin to 1330 AD

http://web.mit.edu/smcguire/www/newfoundland/newf16.html

Interesting Question

Half-life of a radioactive element is

a) The time it takes for half a radioactive sample to decay.
b) The time it takes for half the human population to die.
c) The time it takes for half of the class to get the idea of radioactivity,
d) The time it takes for rocks to turn into amorphous solids.
e) The time it takes to eat cake.