

*Astronomy 150:*  
***Killer Skies***  
*MWF 1300-1350*  
*141 Wohlers Hall*



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**Office: Astro Building #218**

**Office Hours:**

**R: 10:00-11:00 a.m.**

**or by appointment or email**

This Class (Lecture 3):

Astro-Death is very unlikely,  
but rocks beware

Next Class:

Asteroids/Comets

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

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

## *HW 1*



- HW 1 is due Monday night.
- But, can still submit for another week on compass.
- HW 2 will be available soon.

## *You need to Register Your Clicker*



- Go to **[link on syllabus](#)** to register your clicker by September 13<sup>th</sup>.
  - Register with first part of your illinois email (NetID)
- Grade points lost if not registered by that date.
- If you can't read your iclicker ID, you can go the Illini bookstore (at the bag-check counter), "vote" with your clicker, and your clicker ID will be displayed on the base unit.



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

## *Outline*



- Statistics of Death
- 1<sup>st</sup> way astronomy can kill you.... impacts

## Summing up Scales: It still won't fit in your head!



<http://www.youtube.com/watch?v=HEeh1BH34Q&feature=related>

- And now that I have convinced you how big the Universe is and how small we (and the Earth!) are, is it any wonder that you don't know anyone that has been killed by astronomy?
- What are the current top reasons for human deaths?

## What is the most likely?



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

- a) War 0.3%
- b) Poisoning 0.61%
- c) Melanoma (skin cancer) 0.12%
- d) STDs (not counting HIV/AIDS) 0.32
- e) Astronomy related deaths None known yet

## What are you afraid of?



[http://en.wikipedia.org/wiki/List\\_of\\_causes\\_of\\_death\\_by\\_rate](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%

## 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

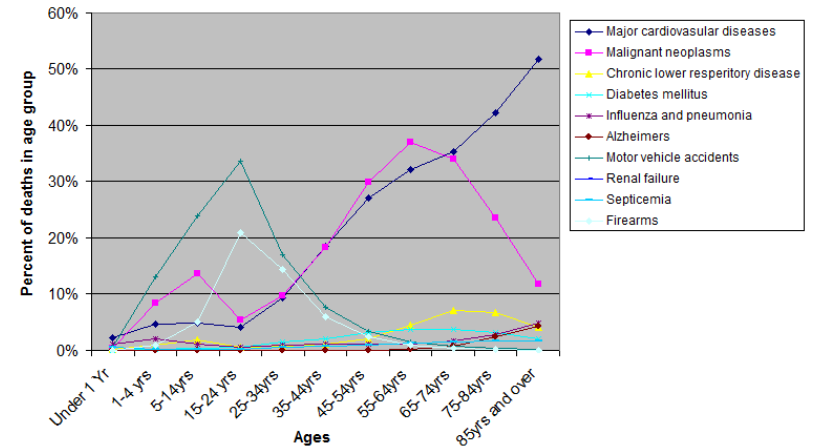
Seventy percent of all cancer deaths are the result of seven cancers:

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

## What are you afraid of?



Leading causes of death in the United States



[http://en.wikipedia.org/wiki/File:Causes\\_of\\_death\\_by\\_age\\_group\\_\(percent\).png](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=f1JeK8AK7y8>

Or <http://www.youtube.com/watch?v=-zvCUmeoHpw>

## What am I talking about?



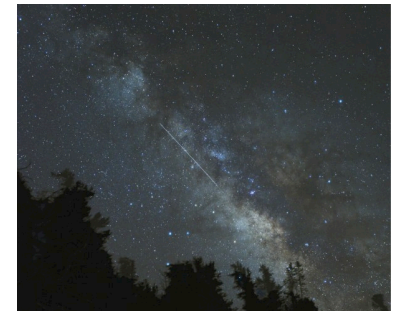
- Space debris.
- Space rocks.
- The leftovers from building the Sun and planets.
- Can it happen? Has it happened before? Should I place my head between my knees?
- What are the terms I should know?



## Meteors



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



## 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



S. Numazawa

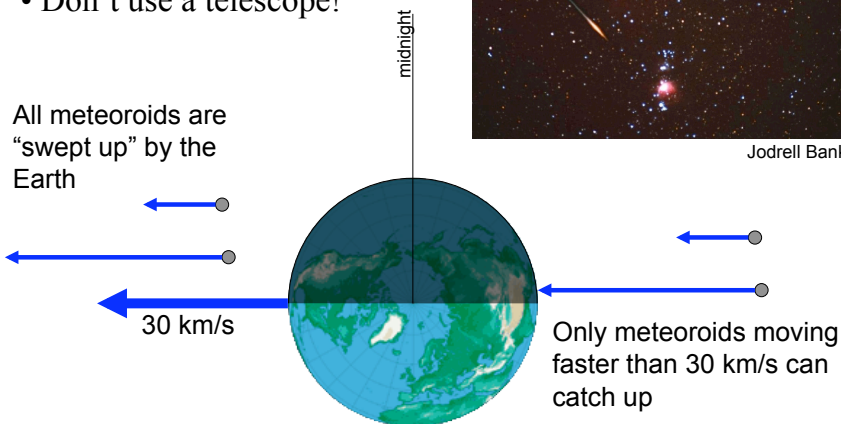
## Meteors



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



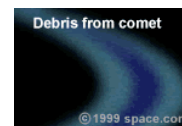
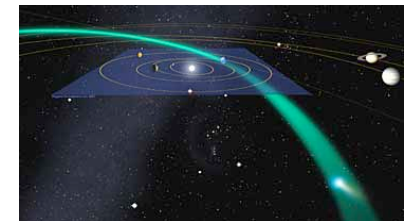
Jodrell Bank



## 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



© 1999 space.com

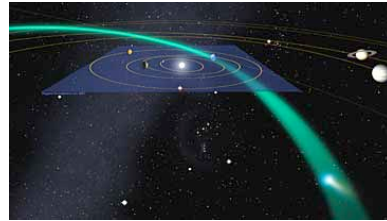
Prominent Yearly Meteor Showers

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
Persids	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

## Meteor Showers



- Meteor showers don't typically produce meteorites
  - It's all dust, not rocks
- <http://vimeo.com/14173983>



Prominent Yearly Meteor Showers

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## 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 leftover objects 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=x0BifYPOQJE&feature=related>  
(1:40)

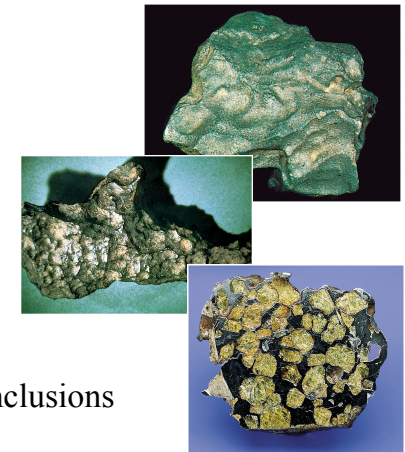
Do you have to ask if it was true?

[http://wiki.answers.com/Q/Is\\_Scott\\_Pendleton\\_and\\_Jen\\_Fox's\\_story\\_really\\_TRUE](http://wiki.answers.com/Q/Is_Scott_Pendleton_and_Jen_Fox's_story_really_TRUE)

## 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



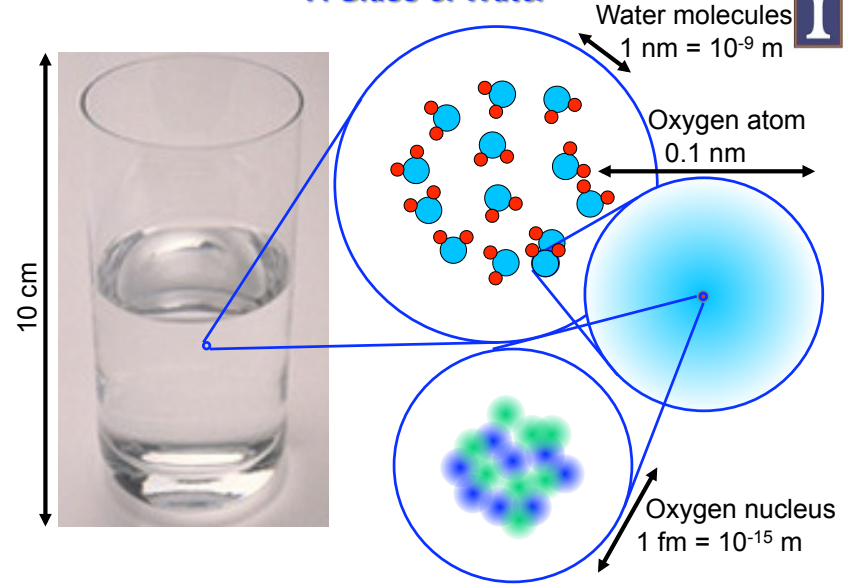
# Meteorites are Ancient



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



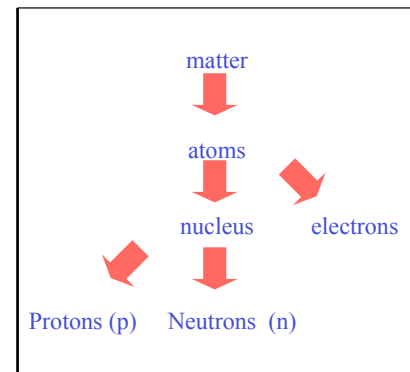
1 H Hydrogen																	2 He Helium																												
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon																												
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon																												
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton																												
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon																												
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon																												
87 Fr Francium	88 Ra Radium	89 Ac Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110	111	112	114	116																																
<table border="1"> <tr> <td>58 Ce Cerium</td> <td>59 Pr Praseodymium</td> <td>60 Nd Neodymium</td> <td>61 Pm Promethium</td> <td>62 Sm Samarium</td> <td>63 Eu Europium</td> <td>64 Gd Gadolinium</td> <td>65 Tb Terbium</td> <td>66 Dy Dysprosium</td> <td>67 Ho Holmium</td> <td>68 Er Erbium</td> <td>69 Tm Thulium</td> <td>70 Yb Ytterbium</td> <td>71 Lu Lutetium</td> </tr> <tr> <td>90 Th Thorium</td> <td>91 Pa Protactinium</td> <td>92 U Uranium</td> <td>93 Np Neptunium</td> <td>94 Pu Plutonium</td> <td>95 Am Americium</td> <td>96 Cm Curium</td> <td>97 Bk Berkelium</td> <td>98 Cf Californium</td> <td>99 Es Einsteinium</td> <td>100 Fm Fermium</td> <td>101 Md Mendelevium</td> <td>102 No Nobelium</td> <td>103 Lr Lawrencium</td> </tr> </table>																		58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium
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The number of protons in an atom determines the type of element, and the number of protons and neutrons determine the atomic weight.

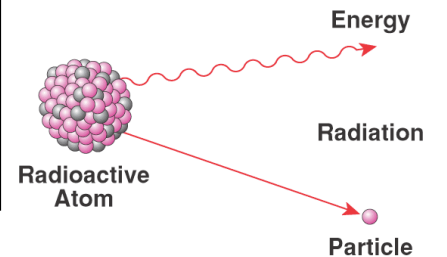
## Radioactive Dating



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 Rule  
Start out with N parents, 0 daughters

Time t since start	# parents	# daughters
0	N	0
$t_{1/2}$	$\frac{1}{2} N = \text{half as much}$	$\frac{1}{2} N$ have appeared
$2t_{1/2}$	$\frac{1}{4} N = \text{half again as much}$	$\frac{3}{4} N$
$3t_{1/2}$	$\frac{1}{8} N$	$\frac{7}{8} N$
$30t_{1/2}$	About $N/10^9$	99.9999999% N

Decay is a good “clock”

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