

ASTR 150

Mildew
By Roger Kettle
and
Andrew Christine



Homework 1 due Monday

- ▶ Office Hours after class today

Planetarium Shows begin next week

- ▶ Need to **register** to reserve a spot
- ▶ Registration, schedule, and report info on course website

▶ Register your iClicker!

▶ Last time: Gravity

▶ Today:

Astro Threat I: Impacts

Music: Kelly Watch the Stars – Air

Planetarium Session

Purpose:

- ▶ To help you understand the motions of the sky

Dates: 9/9, 9/10, 9/11, 9/16, 9/17, 9/18, 9/19

@ Staerkel Planetarium, Parkland College

- ▶ Show starts at 7pm, runs ~80 minutes
- ▶ \$3 door charge, please bring exact change

Report due Oct 4th at beginning of class

- ▶ Details on class website
- ▶ Attach **ticket** from the show to your report

Reserve a seat online

- ▶ Link to reservation site on class website

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 Descendants



1. Impacts!

Meteors

Meteoroids

Asteroids

Comets

Pieces of freakin' debris

Whatever....

Meteor Terminology

- ▶ **Meteoroid**
 - ▶ A bit of interplanetary debris that is **still in space**
- ▶ **Meteor**
 - ▶ A streak of light caused by a meteoroid **while it falls**
 - ▶ Commonly called a “*shooting star*”
- ▶ **Meteorite**
 - ▶ A space rock **on the ground**



Meteor literally means “a thing in the air”. Not a star at all.
On an average dark night, you can see a few meteors every hour
The vast majority of meteors are caused by particles are no larger than a pea and never survive to reach the ground
Only rarely is it big enough to survive and become a meteorite

Chelyabinsk Meteor

(Feb 15, 2013)



http://www.youtube.com/watch?v=90Omh7_I8vI

Feb 15, 2013 over Chelyabinsk Russia a huge fireball.

A 41,000 mph it was brighter than the Sun!

~20 meters in size and 10,000 tons, most of the energy absorbed in the atmosphere-- 20-30 times Hiroshima!

A 500 km Impact!



<http://www.ebaumsworld.com/video/watch/81489291/>

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

Meteor:

- ▶ fiery passage of space debris through the atmosphere, in the act of falling to Earth

What you see:

- ▶ a flash or streak of light

Sometimes called
“a shooting star”

Usually occurs ~50 miles up



<http://antwarp.gsfc.nasa.gov/apod/ap090501.html>

Meteors



<http://www.youtube.com/watch?v=Y8pPGxAyrY0>

Meteors

Typically from sand-grain sized particles falling into the atmosphere

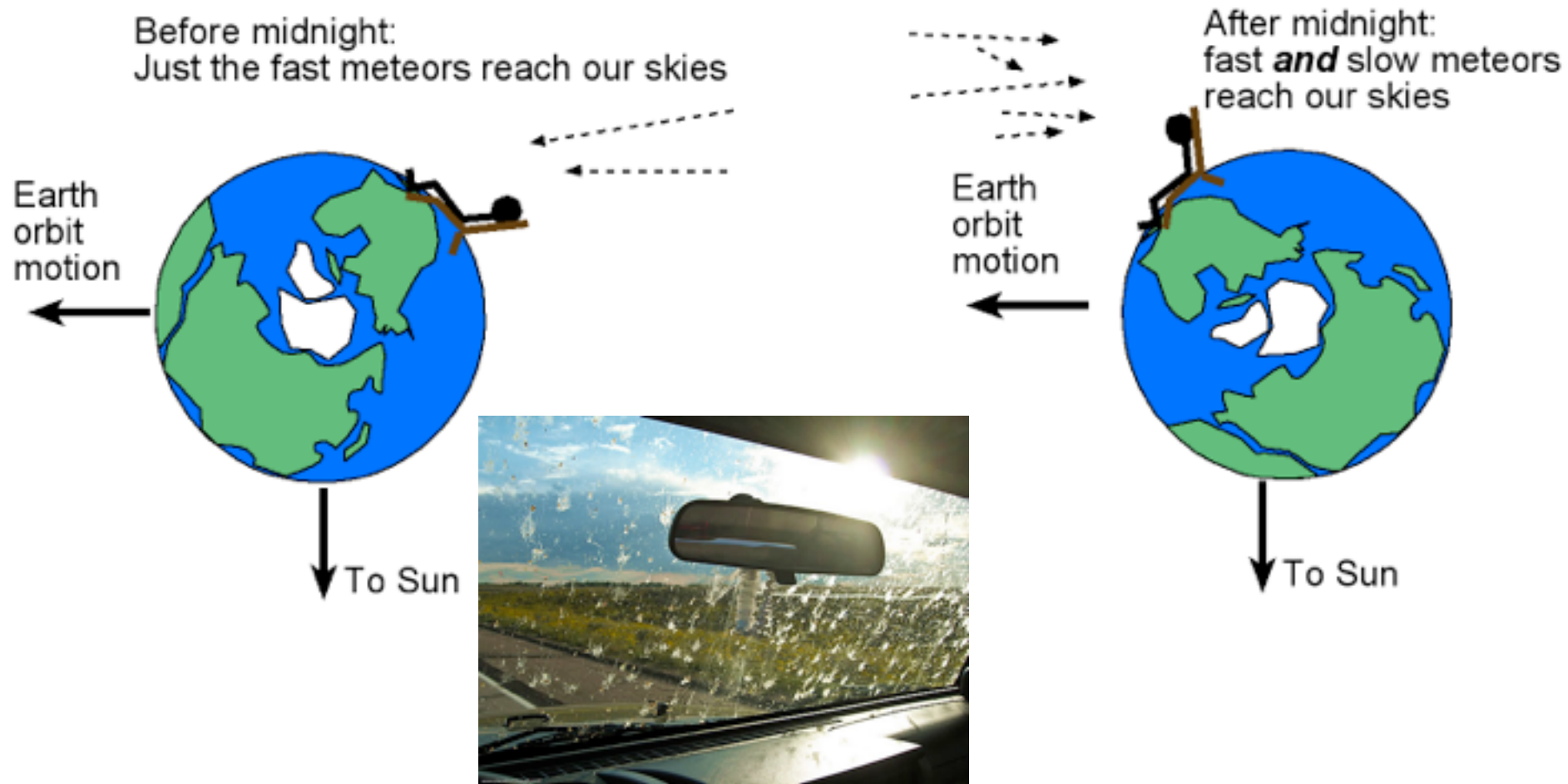
When they fall into the atmosphere, they heat up due to the atmosphere interaction (not friction!).

Creates a bright tail of hot gases and melted stuff



<http://antwarp.gsfc.nasa.gov/apod/ap080814.html>

Meteors: Best Viewed After Midnight



Earth's orbital speed is 30 km/s or 66,600 mph!

More meteors are seen after midnight because your local part of the Earth is facing the direction of its orbital motion around the Sun. Meteoroids moving at any speed can hit the atmosphere. Before midnight your local part of the Earth is facing away from the direction of orbital motion, so only the fastest moving meteoroids can catch up to the Earth and hit the atmosphere. The same sort of effect explains why an automobile's front windshield will get plastered with insects while the rear windshield stays clean.

Meteor Showers

Meteors can be seen all the time

One can typically see about 3 per hour

Several times a year, the rate increases

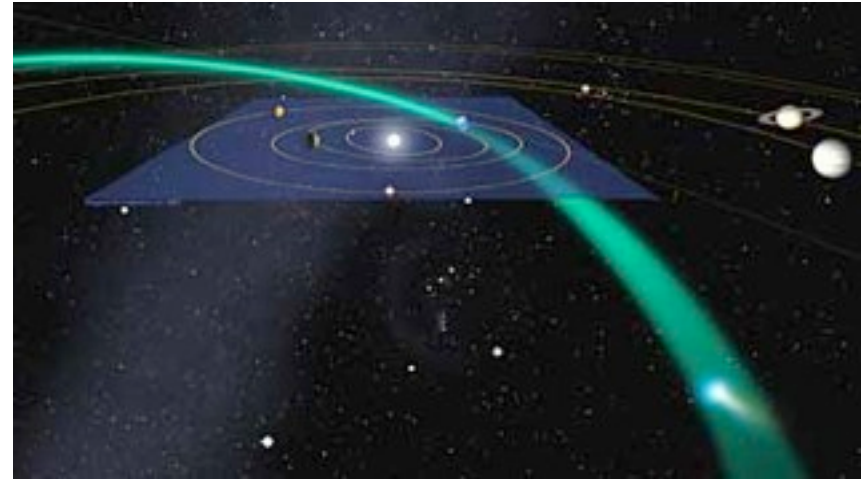
- ▶ Maybe more than a meteor per minute
- ▶ Called meteor showers

Seem to originate from a single point in the sky



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

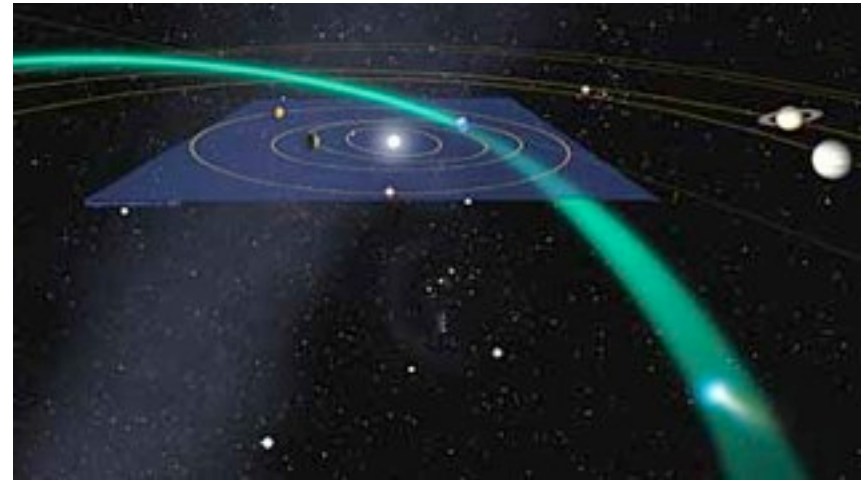


Prominent Yearly Meteor Showers

Showers	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



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Meteor Showers



<http://vimeo.com/14173983>

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

Fireballs



<http://www.youtube.com/watch?v=jUh7pYDmK08&NR=1>

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 (NY) (October 9, 1992)



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

Until the Russian meteor in Feb 2013, most videoed meteor.

Michele Knapp found the 26 pounds meteor and sold for \$69,000! Today, you can buy a piece for \$125/gram. The car she had just bought for \$300, and sold it for \$10,000.

Peekskill Fireball (October 9, 1992)

Location:
Johnstown, PA
©John Derr,
120 Wissinger Rd.,
Windber, PA
USA
15963
ph: 814-266-8088

<https://www.youtube.com/watch?v=AOU3r3Q4-eY>

Closer to Home

March 26th,
2003

Park Forest, IL

Many pieces
found.

One piece
went through
a roof, hit a
printer, hit a
wall



i>clicker 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 know what they look like. Follow me.**

Be Careful?

Actors in a fun “movie”

<http://www.youtube.com/watch?v=x0BifYPQQJE&feature=related>

Meteoroid to Meteor to Meteorite: 2008 TC3

Size of 2-5 meters

- ▶ 7-16 ft

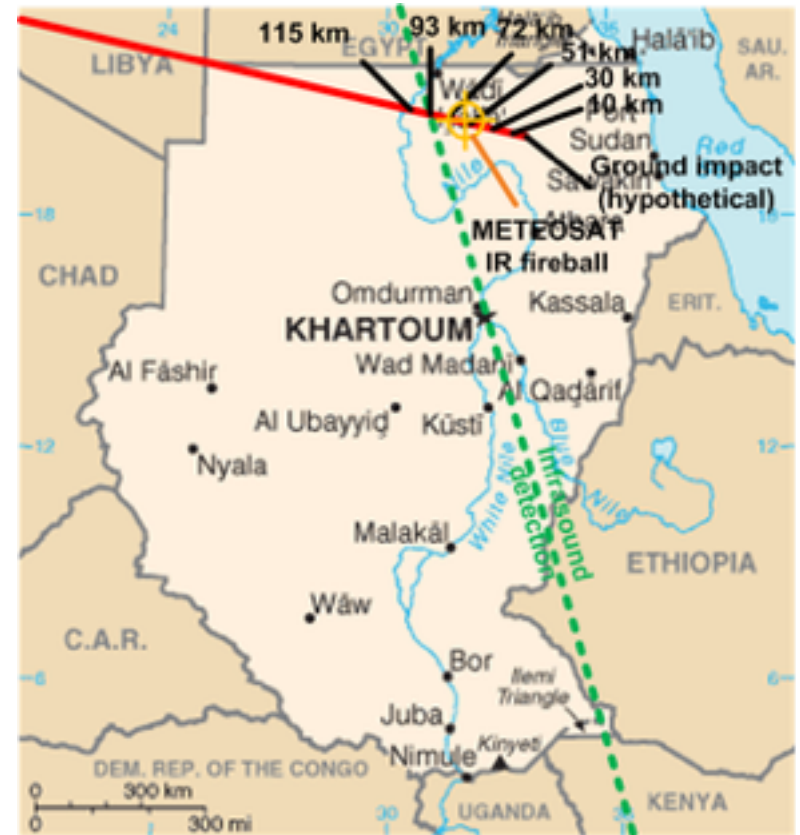
Exploded tens of km
above ground

Energy release:

- ▶ equivalent 0.9 to 2.1
kilotons of TNT!

Caused a large fireball

Meteoroids of this size hit
Earth about two or three
times a year



**2008 TC3 -- hit Earth October 2008, but
didn't make it to ground in one piece.**

Started at about 2 to 5 meters in size.

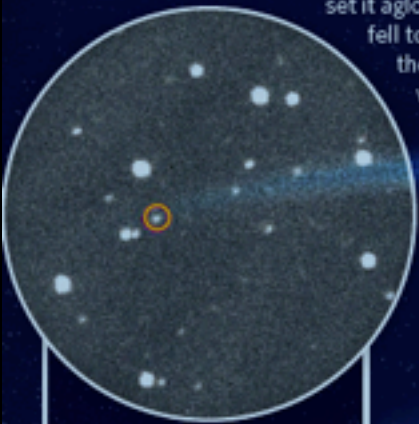


m8 IR3.9 temperature - 200810070245

Significance: First meteoroid detected before it was going to hit Earth. First meteorite recovered from such an object.

A 2008 TC₃ SPACE ODYSSEY

The little boulder 2008 TC₃ went through a series of name changes during its brief moment in the scientific spotlight. In space, the hunk of rock was called an asteroid or meteoroid. After it hit Earth's atmosphere, frictional heating set it aglow and it became a meteor. The pieces that fell to the ground are called meteorites. Here is the 2008 TC₃ biography, from the moment it was discovered.

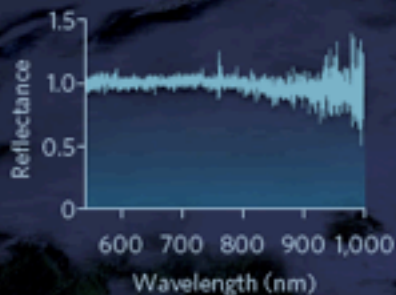


6 OCT 2008
06:39 UT

A fast-moving meteoroid close to Earth was spotted by the Catalina Sky Survey on Mount Lemmon in Arizona. Orbital calculations suggested it would hit the planet in 20 hours.

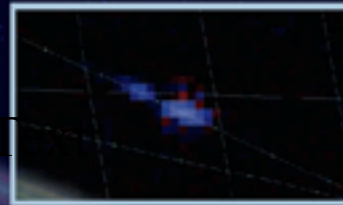
6 OCT 2008
22:22-22:28 UT

When the meteoroid was 121,100 kilometres from Earth, a telescope in the Canary Islands measured how much light the body reflected at different wavelengths.



7 OCT 2008
02:45:46 UT

When the meteoroid broke apart, it left behind clouds of hot dust, observed by the Meteosat-8 weather satellite.



7 OCT 2008
03:27 UT

A photograph captured clouds left behind after the fireball disappeared.



7 OCT 2008
02:45:40 UT

Ron de Poorter, a KLM pilot flying at an altitude of 10,700 metres over Chad, saw three or four short pulses of light beyond the horizon as the meteoroid flared through the sky.



DECEMBER
TO MARCH

A search team combed the desert multiple times and recovered some 280 meteorites.



What are Meteorites Made of?

Very useful to know what meteorites are made of

- ▶ Practical: better threat assessment if we know the properties of the impactors
- ▶ Meteorites are **extraterrestrial matter**! Unique insight into the ingredients of the rest of the solar system

Throughout the course, will want to know what things are made of--what is “**composition**”

- ▶ How to answer scientifically?

Consider a 1 kg stony meteorite--basically, a rock

- ▶ Cut in half--two smaller rocks, look and act similar
- ▶ Cut again--still smaller rocks, still similar properties
- ▶ But: process does not go on forever: after 75 cuts, something new--**atoms**

i>clicker question

A piece of space debris that burns up in the atmosphere is referred to as a _____, while a piece of debris that makes it to the ground is called a _____.

(A) meteor, meteorite

(B) meteorite, meteor