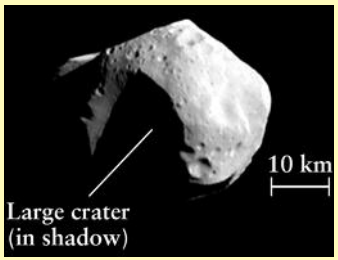
Solar System: Other Objects

Asteroids

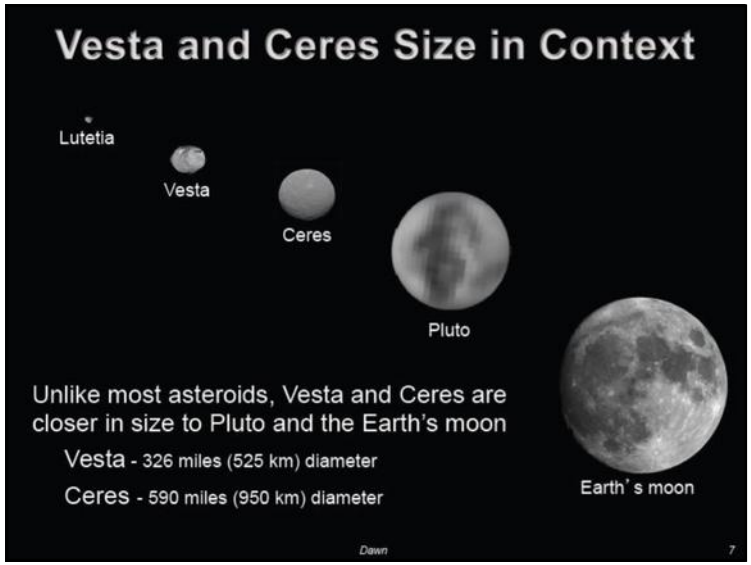
- rocky/metallic objects *in orbit around the Sun*
- ~ 75% *carbonaceous*, 17% *stony*, 8% *iron*
- typically *irregular* shapes
  (eg) 253 Matilde (*NEAR*)
- ***"minor planets"***
- ~ 10^6 asteroids
- ~ 10^5 have known orbits



- ***total*** mass equivalent ~*2000 km diameter* object

History

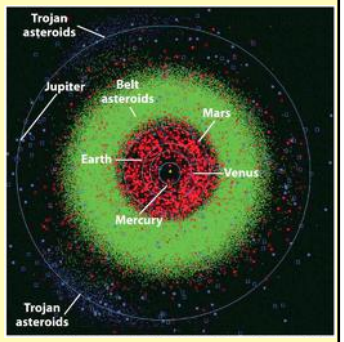
- *1700 & 1800's* - discovery of *Uranus*, *Neptune*
- *Bode's Law* predicted a planet: *Mars* ⇔ *Jupiter*
- *1 Ceres* discovered by *Giuseppe Piazzi (1801)*
- 2 *Pallas* discovered by *H. Olbers (1802)*
- *Ceres* is the largest asteroid; ~ *900 km* diameter
- ~ *200+* are greater than *100 km* diameter
- took *50 years* to find *first 10* asteroids
- discovery of *1000's* of asteroids: *photography*



Phobos (Mars EXPRESS)

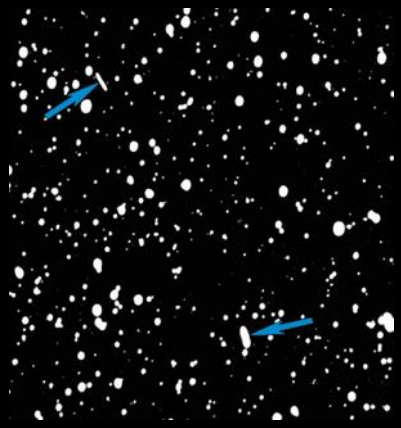
Location

- *most* in ***asteroid belt*** between *Mars & Jupiter*
- ***NOT*** like "*SW: ESB*"
- *~10^6 km* between asteroids (***2x*** Earth-Moon distance)
- *some* asteroid groups *cross* Earth's orbit: ***Apollos***, ***Amors***, ***Atens***
- *most* are *small & dark*



Q: How do we find them?

Finding asteroids



CLICKER: Asteroids in the asteroid belt…

(a) are typically beyond the Frost Line
(b) take hundreds of years to orbit the Sun
(c) orbit mostly between Jupiter & Saturn
(d) rarely intersect the orbits of the planets

Meteors & Meteorites

- ***meteoroids***: small rocks in space
- ***meteors***: material that enters Earth's atmosphere

- ***meteorites***: meteors which *hit the surface*

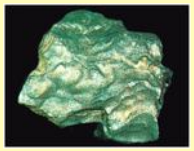
Meteor (*Australia: Oct 03*)

Meteor (*Russia: Feb13*)

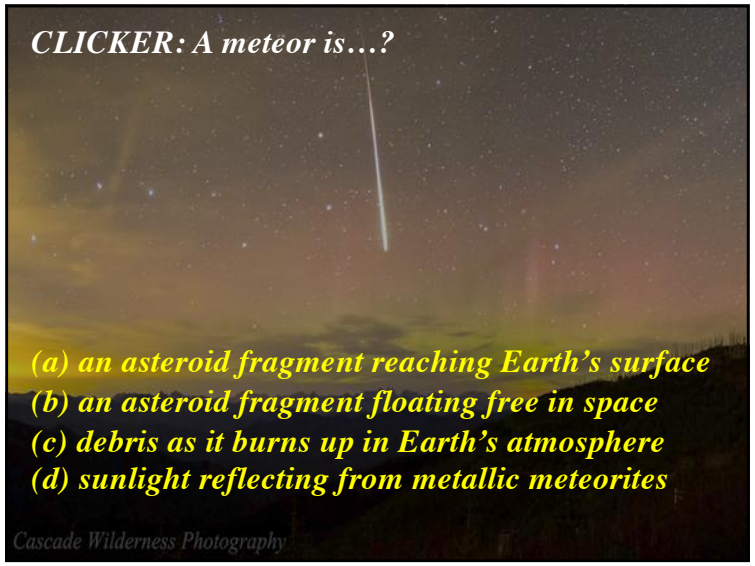
Composition

Q: Why are meteorites so interesting?

- *meteorites* are ***primitive solar system material***

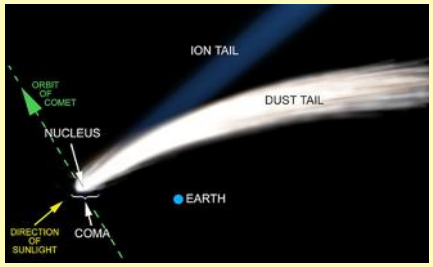


- *stony* (87%), *stony-iron* (2%), *iron* (6%)
- *carbonaceous chondrites* (5%)
- ***CC*** contain ***C***, *amino acids* (organic compounds)
- *undifferentiated* so *unmelted*; orig solar nebula?



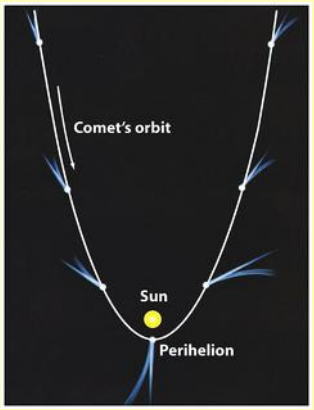
Comets

• *"dirty snowballs"* (***ice & dust***) *in orbit around Sun*



• 3 *main* parts:
- ***nucleus***
- ***coma*** *("halo")*
- ***tail(s)*** *(ion & dust)*

• comets *lose* mass (~ 0.1%) *near* the Sun ***Q:*** *why?*



• ***coma*** *grows & brightens*
• ~ size of ***Jupiter***!

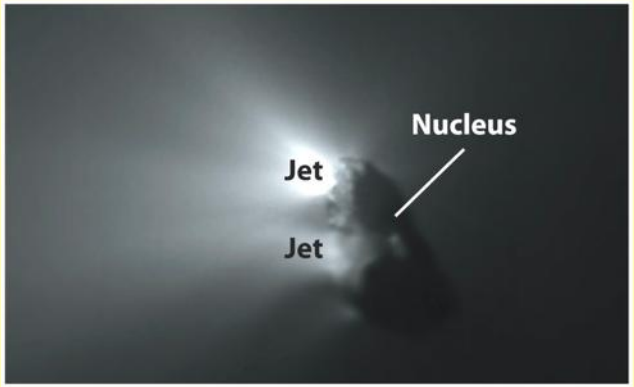
• ***tail*** can be *millions km* long
• ***ion tail*** points *directly away* from Sun (*solar wind*)
• ***dust tail*** has curved shape

• *comet debris* along orbit causes ***meteor showers***

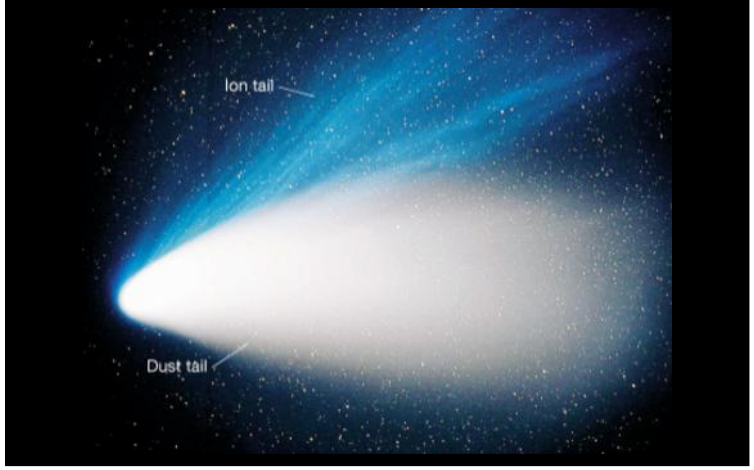
Q: *Do comets last forever?*

Nuclei

• *Giotto* flyby of *Halley (1986); 15x8 km* nucleus



Comets have two tails!



CLICKER:
What part of a comet is always present?
(a) nucleus
(b) coma
(c) (ion & dust) tail
(d) all of the above

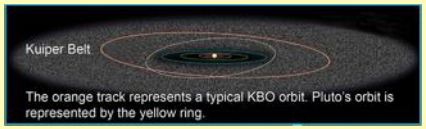
Meteor Showers

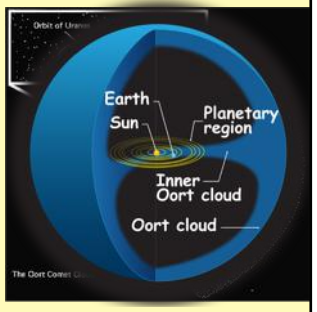
Prominent Yearly Meteor Showers

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

Cometary Origins

- ***Kuiper Belt*** beyond Neptune to ~ 50 AU
- ***Oort Cloud*** beyond that (*~spherical distribution*)



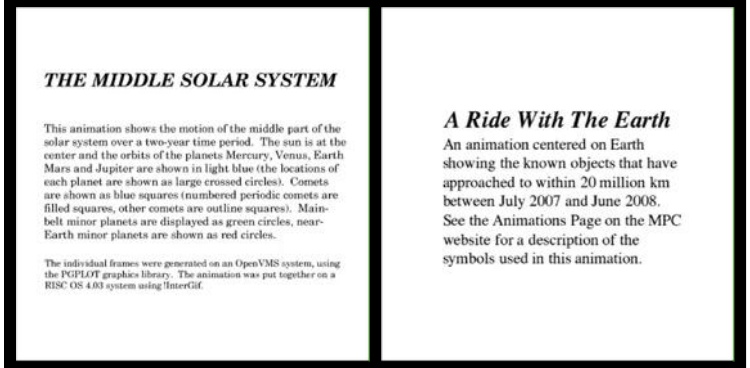


Q: *How did* ***Oort Cloud*** *form?*

Q: *Why are comets NOT from inner solar system?*

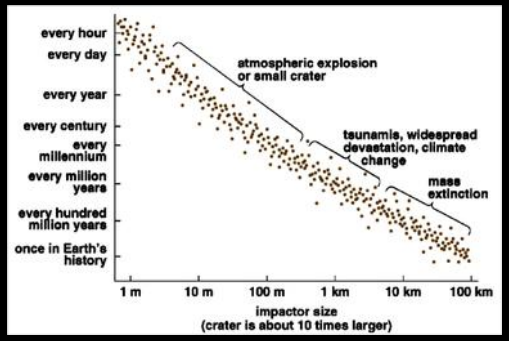
Barringer Crater

Earth crossing asteroids

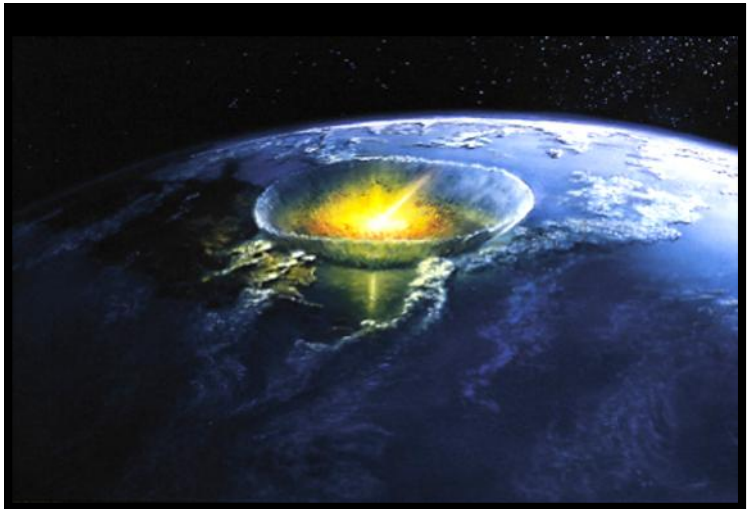


- objects within 20 million km of Earth in 2007-8
- red are < 6 million km; *a few* within Moon's orbit

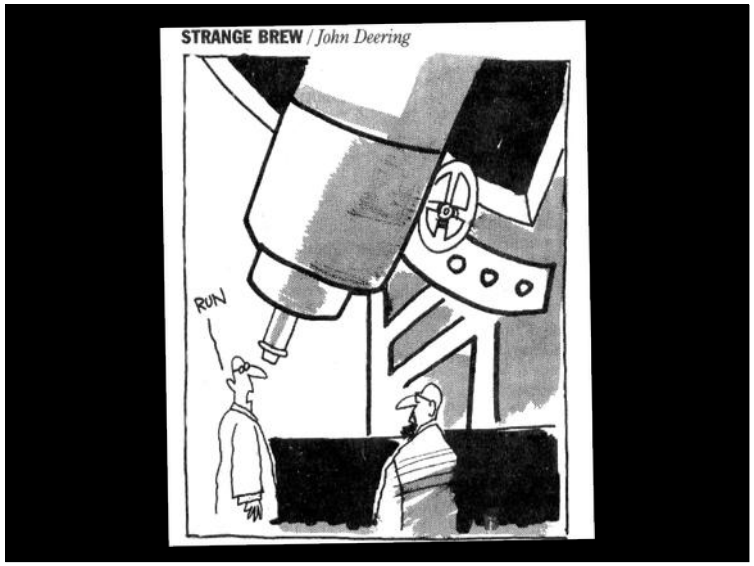
How likely are collisions?



- ***NEO****: within 1.3 AU of Sun*
- ***PHA*** *(Potentially Hazardous Asteroids): within $7x10^6$ km of Earth, 150+ m*



- *65 My ago* an object *10 km in diameter* hit Earth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