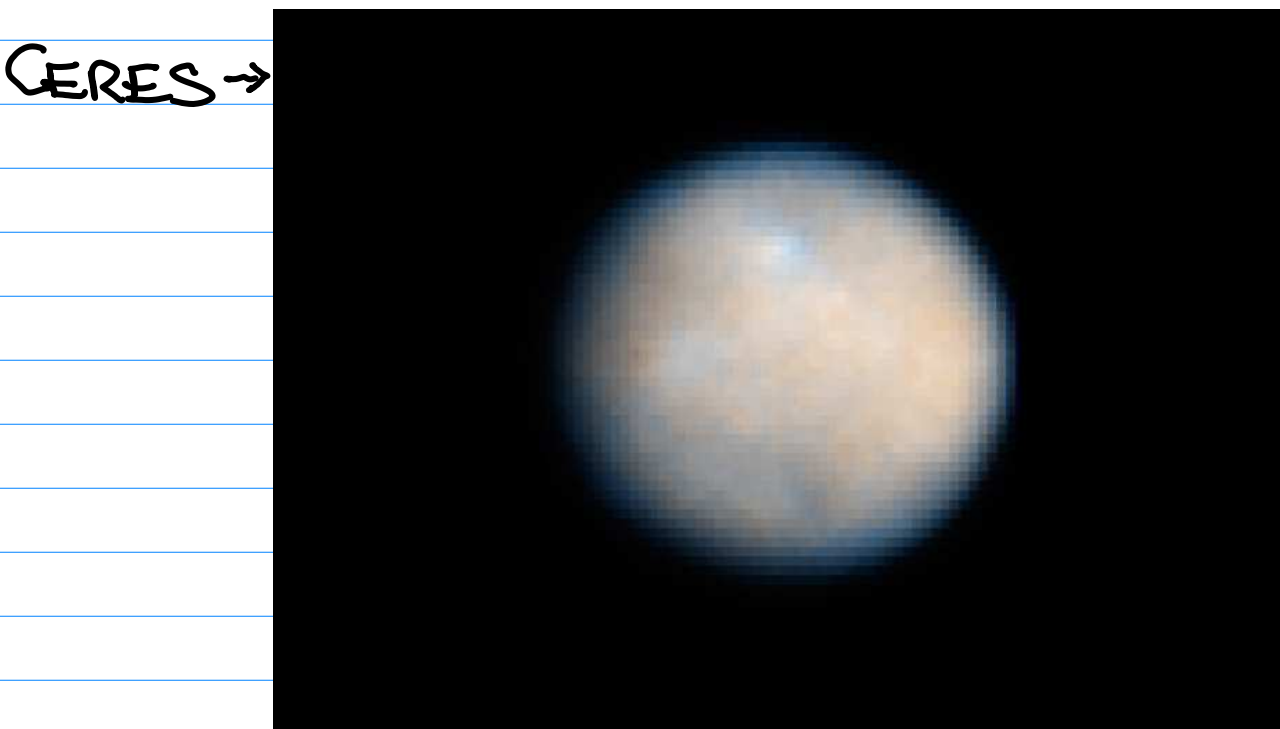


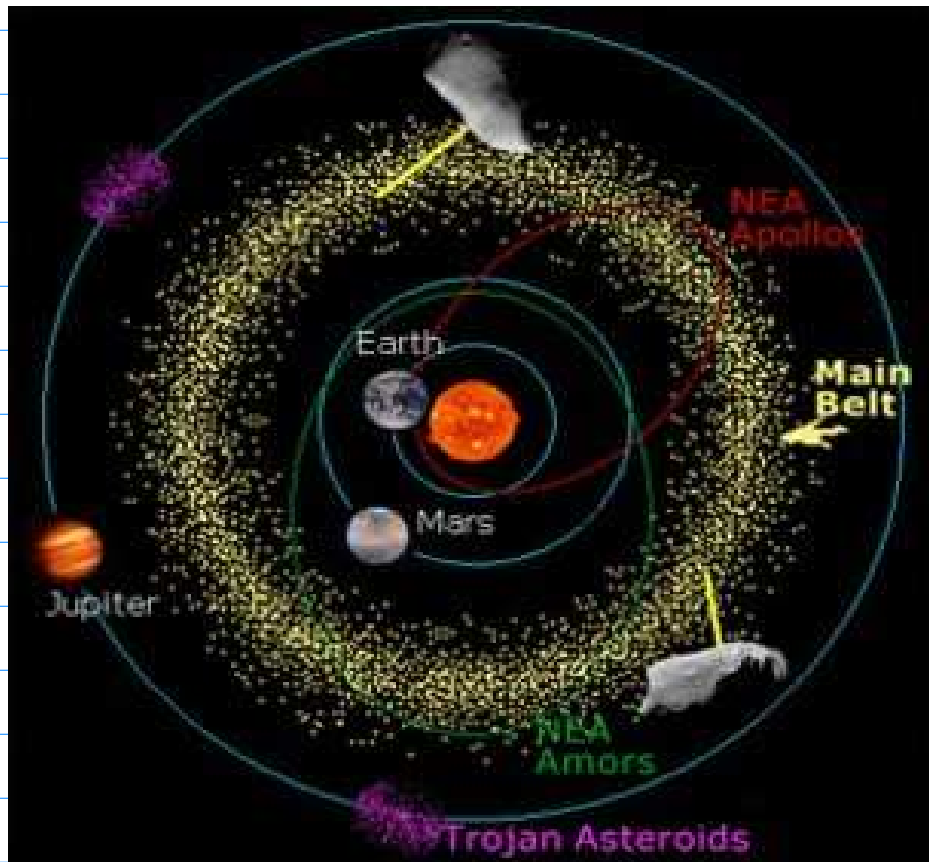
# SOLAR SYSTEM DEBRIS

## ASTEROIDS

THE LARGEST ASTEROID CERES (IT HAS DIAMETER OF ABOUT 1,000 km) WAS DISCOVERED IN 1801 BY G. PIAZZI



MOST ASTEROIDS (INCLUDING CERES) ARE LOCATED IN ASTEROID BELT -  
- A REGION BETWEEN MARS AND JUPITER  
FROM 2.2 AU TO 3.3 AU



ALL ASTEROIDS HAVE PROGRADE (COUNTERCLOCKWISE) MOTION.

MOST ASTEROIDS HAVE ORBITAL PLANES NEAR THE ECLIPTIC.

THE ASTEROIDS IN THE ASTEROID BELT HAVE NEARLY CIRCULAR ORBITS.

APOLLO ASTEROIDS HAVE HIGHLY ELLIPTICAL ORBITS WHICH CROSS THE

EARTH'S ORBIT.

TROJAN ASTEROIDS ARE ALONG THE ORBIT OF JUPITER,  $60^\circ$  AHEAD OF JUPITER AND  $60^\circ$  BEHIND IT.

ASTEROIDS RANGE IN SIZE FROM 1000 km (1) TO 100 m (25 MILLION) IN DIAMETER.

LARGE ASTEROIDS (LIKE CERES) ARE SPHERICAL IN SHAPE, WHILE THE SMALLER ONES HAVE IRREGULAR SHAPE



DIMENSIONS :

18.2 km  $\times$  10.5 km  $\times$  8.9 km

ASTEROID GASpra

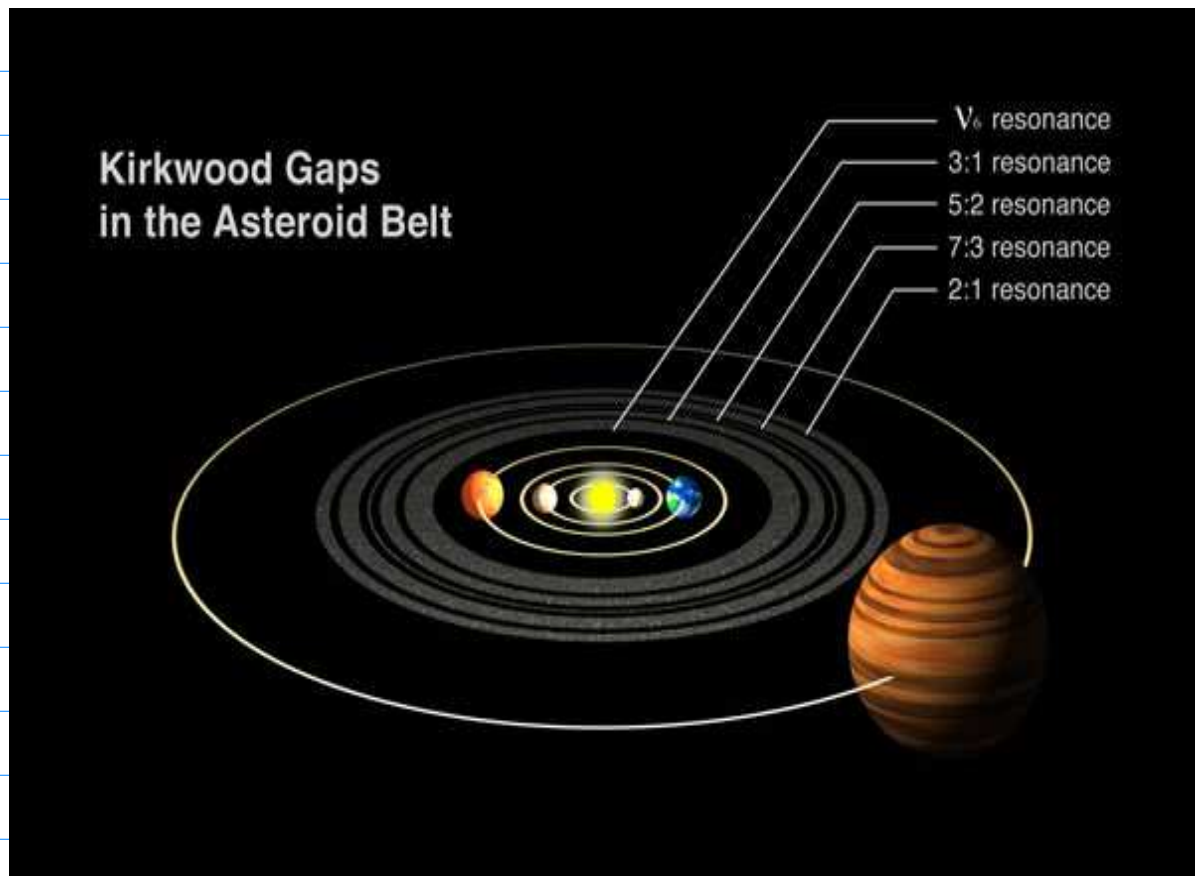
30% OF THE TOTAL MASS OF ALL ASTEROIDS IS IN CERES; HOWEVER IF ALL ASTEROIDS WERE PUT TOGETHER THEY WOULD PRODUCE AN OBJECT BARELY 1500 km IN DIAMETER WITH A MASS WHICH IS  $\frac{1}{25,000} = 0.04\%$  OF THE EARTH'S MASS.

THE AVERAGE SPACING BETWEEN THE BELT ASTEROIDS IS ABOUT MILLION km.

WHY DIDN'T THE MATERIAL IN THE BELT FORM A PLANET? THE PERTURBATIONS CAUSED BY GRAVITY OF ENORMOUS PLANET JUPITER PREVENTED PLANET FORMATION.

ALSO, JUPITER IS RESPONSIBLE FOR THE GAPS — THE KIRKWOOD GAPS —

IN THE BELT:



THE REASON FOR THE KIRKWOOD GAPS IS THE SAME AS THE REASON FOR THE CASSINI DIVISION IN THE RINGS OF SATURN - THE ORBITAL RESONANCE WITH PLANET JUPITER (MIMAS IN THE CASE OF CASSINI DIVISION).

## COMPOSITION AND CLASSIFICATION OF ASTEROIDS

THERE ARE THREE BASIC GROUPS:

C-ASTEROIDS, S-ASTEROIDS, M-ASTEROIDS

C-ASTEROIDS: THE MAJORITY (75%)  
OF ASTEROIDS ARE IN THIS GROUP.

THEY ARE VERY DARK WITH ALBEDO OF  
3% - 4% (LIKE A LUMP OF COAL).



THEY ARE COMPOSED OF SILICATES  
MIXED WITH DARK CARBON COMPOUNDS -  
- HENCE THE NAME C-ASTEROIDS.

MOST OF THE C-ASTEROIDS ARE LOCATED AT THE OUTER EDGE OF THE ASTEROID BELT

S-ASTEROIDS: THEY FORM THE SECOND LARGEST GROUP (17%) OF ASTEROIDS.

EXAMPLE: ASTEROID GASPA

THEY ARE BRIGHTER THAN C-ASTEROIDS WITH ALBEDO OF 10% - 22%.

THEY HAVE THE STONY APPEARANCE AS THEIR SURFACE CONSISTS OF SILICATE MATERIAL (THE DARK CARBON COMPOUNDS ARE MISSING). HENCE THE NAME S-ASTEROIDS.

MOST OF THEM ARE LOCATED NEAR THE INNER EDGE OF THE ASTEROID BELT (NEAR THE ORBIT OF MARS).

M-ASTEROIDS: THEY ARE THE  
SMALLEST ASTEROID GROUP.



THEY ARE MODERATELY BRIGHT  
WITH ALBEDO OF 10%-20%.

SOME, BUT NOT ALL, ARE MADE OF  
NICKEL AND IRON - HENCE, THEIR  
NAME (M FOR METAL).

THEY ARE LOCATED IN THE MIDDLE  
OF ASTEROID BELT.

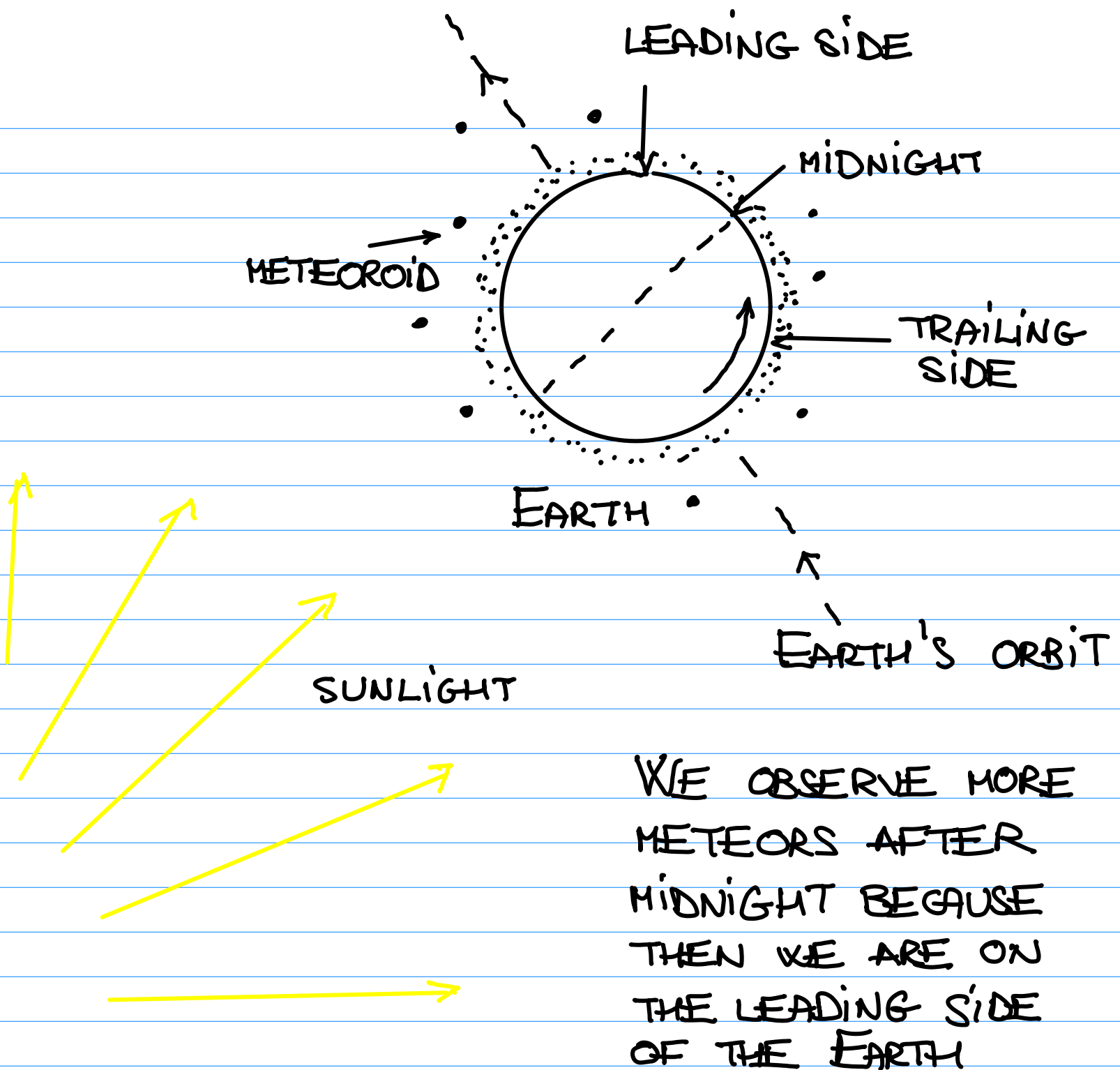


# METEORIDS, METEORS & METEORITES

METEORIDS ARE SOLID OBJECTS, SMALLER THAN ASTEROIDS, THAT ORBIT THE SUN. THEY RANGE IN SIZE FROM SMALL GRAIN UP TO 1m.

WHEN A METEOROID ENTERS THE EARTH'S ATMOSPHERE AND STARTS BURNING BECAUSE OF FRICTION WITH THE AIR IT PRODUCES A METEOR - A "SHOOTING STAR"





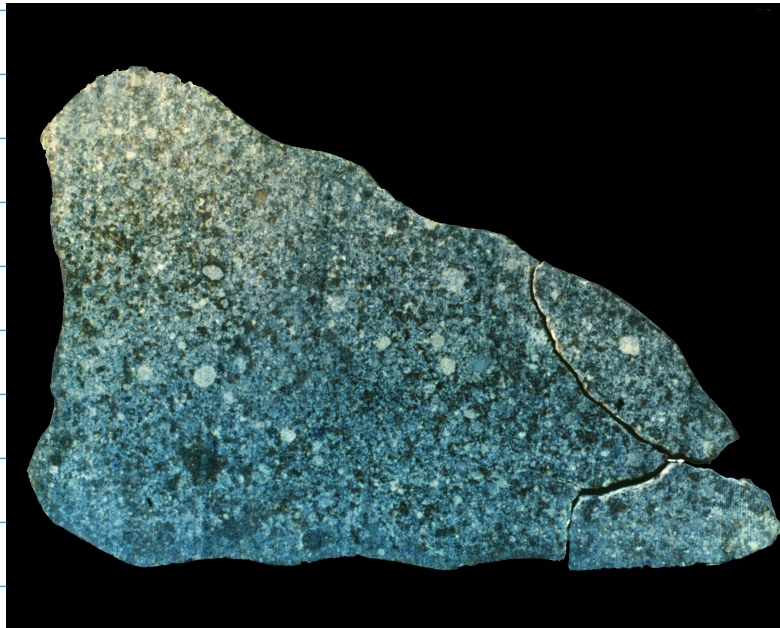
WE OBSERVE MORE METEORS AFTER MIDNIGHT BECAUSE THEN WE ARE ON THE LEADING SIDE OF THE EARTH

METEOROIDS BEGIN TO GLOW AT AN ALTITUDE OF 130 km AND MOST BURN OUT BY THE TIME THEY ARE 80 km ABOVE THE GROUND. THEIR NUMBER IS SO LARGE THAT ABOUT 100 TONS OF MATERIAL STRIKES THE EARTH EVERY DAY.

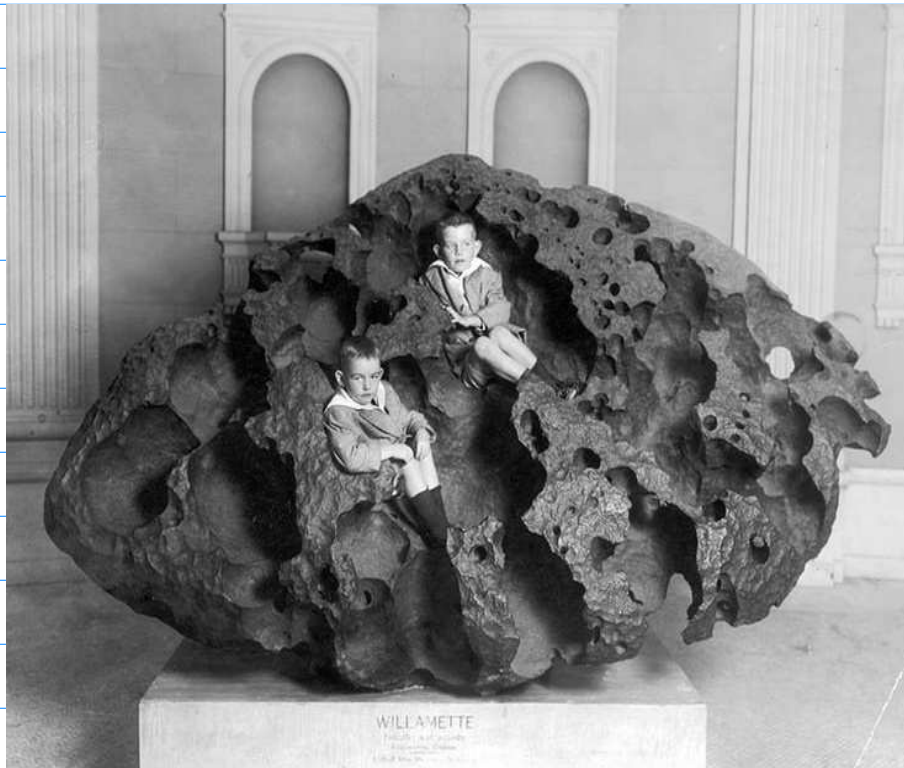
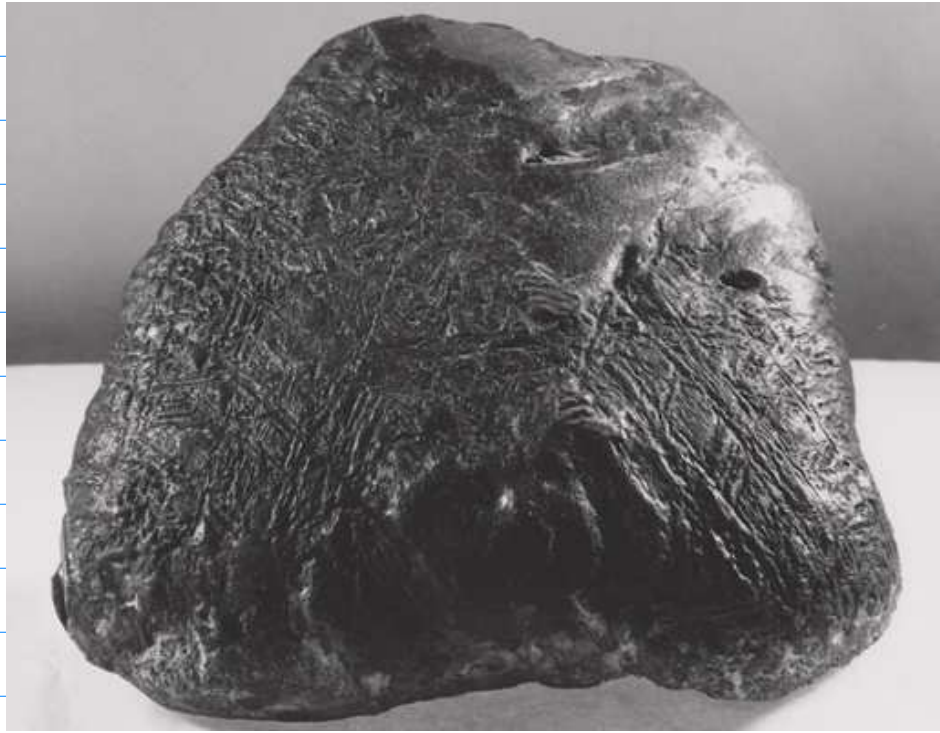
THOSE METEOROIDS THAT DON'T BURN OUT AND LAND ON THE GROUND ARE CALLED METEORITES.

THERE ARE THREE MAJOR GROUPS OF METEORITES:

STONES : 95% OF ALL METEORITES ARE IN THIS GROUP. THEY ARE COMPOSED OF SILICATE ROCK.

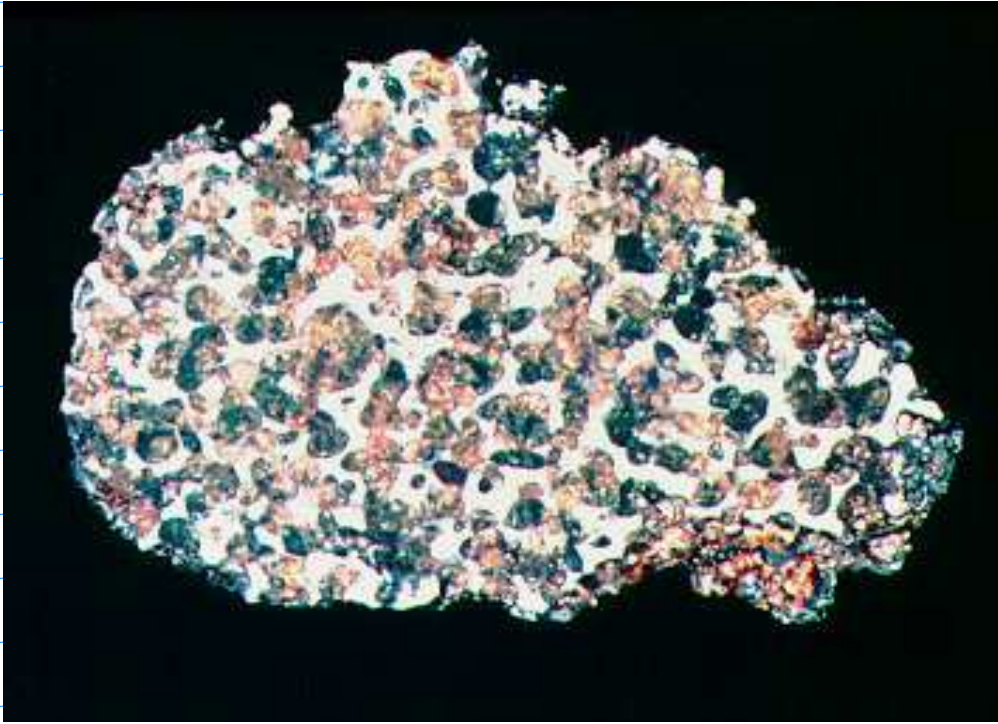


IRONS: ABOUT 3% OF METEORITES ARE  
IN THIS GROUP.





STONY-IRONS : ABOUT 1% OF METEORITES  
BELONG TO THIS GROUP



THERE ARE ALSO A FEW CARBONACEOUS  
(CARBON RICH) METEORITES

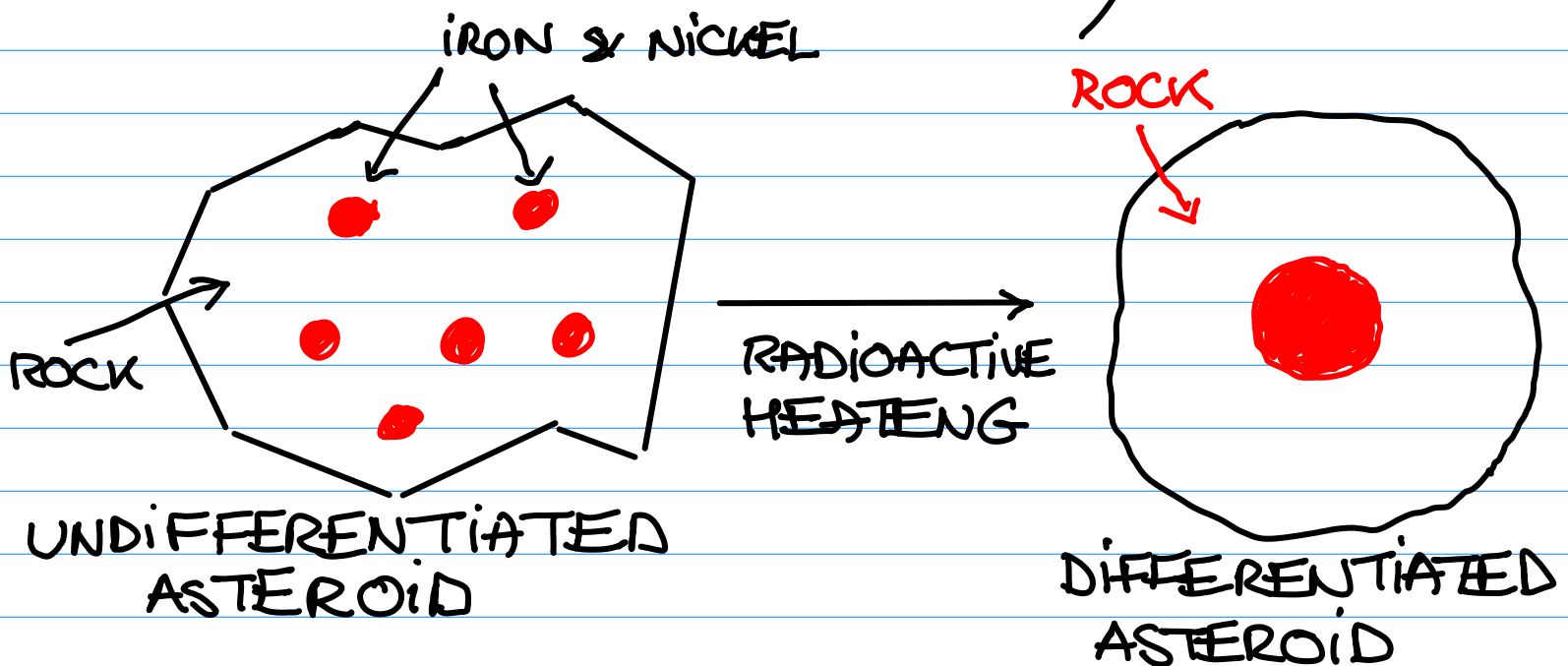


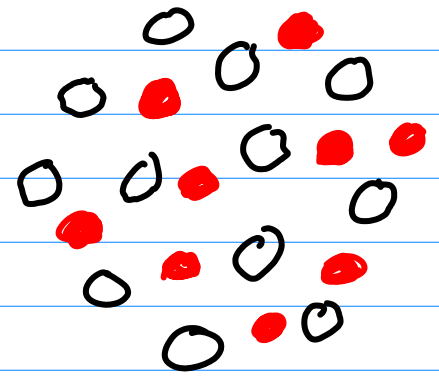
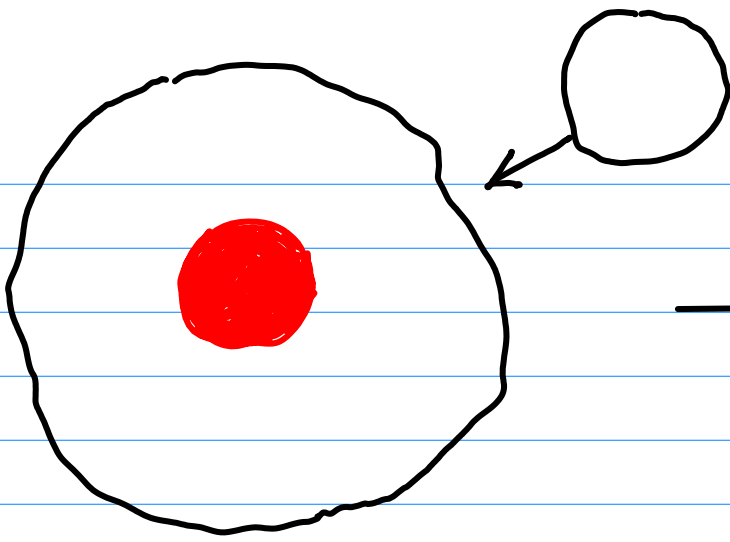
MURCHISON - FOUND  
IN CANADA IN 1969

THERE ARE TWO GROUPS OF METEORITES BASED ON THEIR FORMATION/ORIGIN:

PRIMITIVE (NOT DIFFERENTIATED) METEORITES WERE FORMED IN THE EARLIEST HISTORY OF THE SOLAR SYSTEM. THEY HAVE NEVER BEEN SUBJECTED TO GREAT HEAT OR PRESSURE SINCE THEIR FORMATION. CARBONACEOUS AND SOME (BUT NOT ALL) STONES BELONG TO THIS GROUP.

DIFFERENTIATED METEORITES ARE PIECES OF ASTEROIDS OR ROCKS FROM MOON OR MARS EJECTED BY IMPACTS.



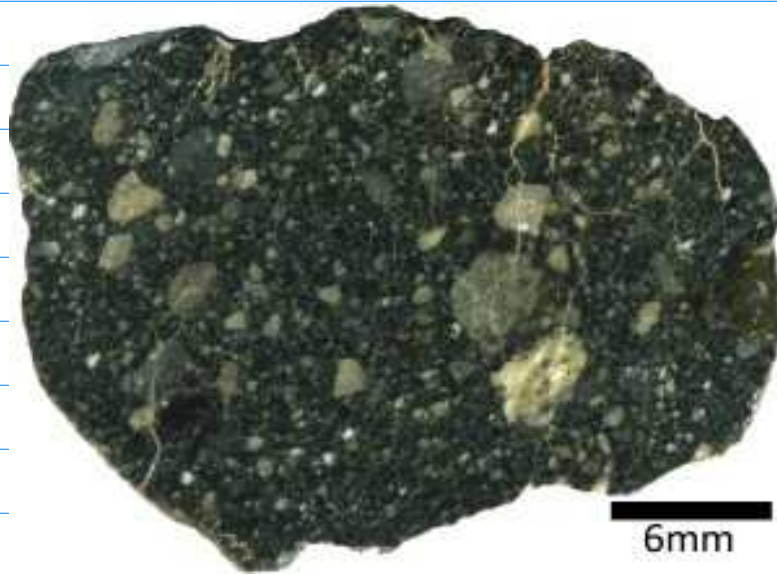


SOME FRAGMENTS  
ARE IRON/NICKEL  
OTHERS ARE  
ROCK

MARS METEORITE :



## MOON METEORITE :



MANY METEORS RESULT FROM THE METEOROIDS WHICH ARE SMALL BITS OF DEBRIS SCATTERED FROM COMETS.

EVIDENCE : CONNECTION BETWEEN METEOR SHOWERS AND EARTH CROSSING THE ORBIT OF A COMET. THE BEST KNOWN METEOR SHOWERS ARE :

PERSEID SHOWER (ON AUGUST 12)

LEONID SHOWER (ON NOVEMBER 17)

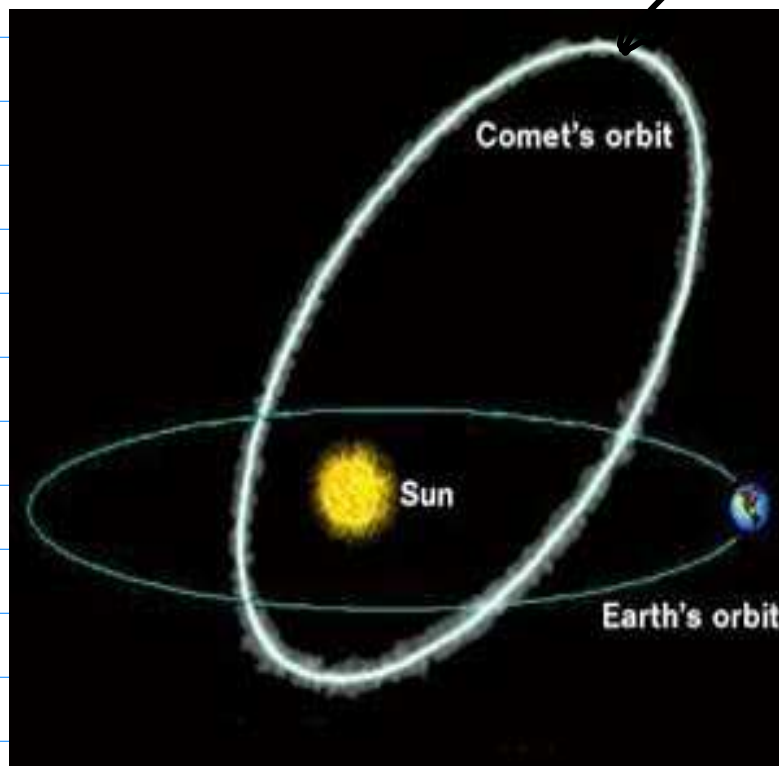




## PERSEID SHOWER

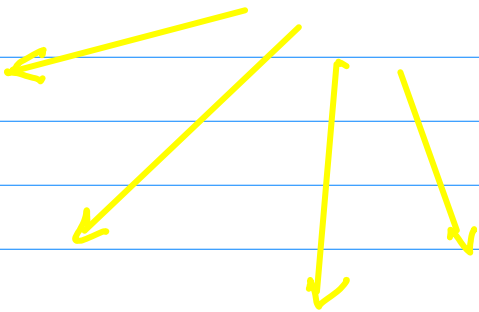
CONNECTION BETWEEN METEOR SHOWER  
AND CROSSING OF A  
COMETS ORBIT:

A SWARM OF SMALL  
METEOROIDS



IT LOOKS AS IF ALL METEORS COME FROM THE SAME POINT IN THE SKY (SO-CALLED RADIANT):

RADIANT  
x



ANALOGY:

