When Worlds Collide

GET-WISE

Presentation on

Collisions in the Solar System

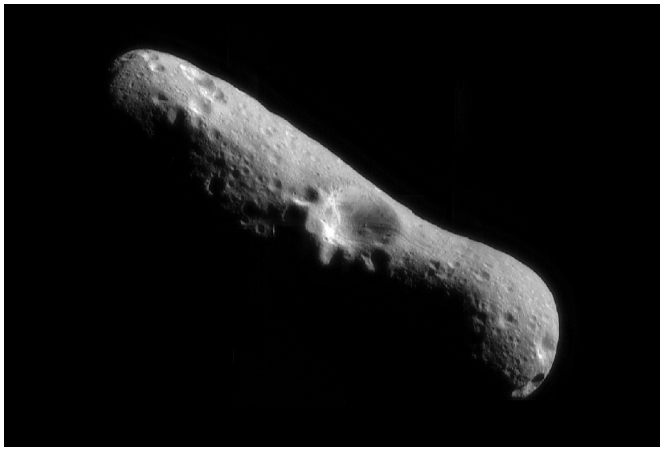
Dr. Jeffrey Morgenthaler

Introduction

This talk is about impacts between objects in the solar system

After this talk, you should be able to answer the following questions:

- Do things run into each other in the Solar System?
- Why don't things run into each other more often?
- Is there evidence of impacts on Earth? On the Moon? Elsewhere?
- What is the difference between an asteroid, meteor, meteorite, comet, and planet?
- Are we likely to be hit by another planet?

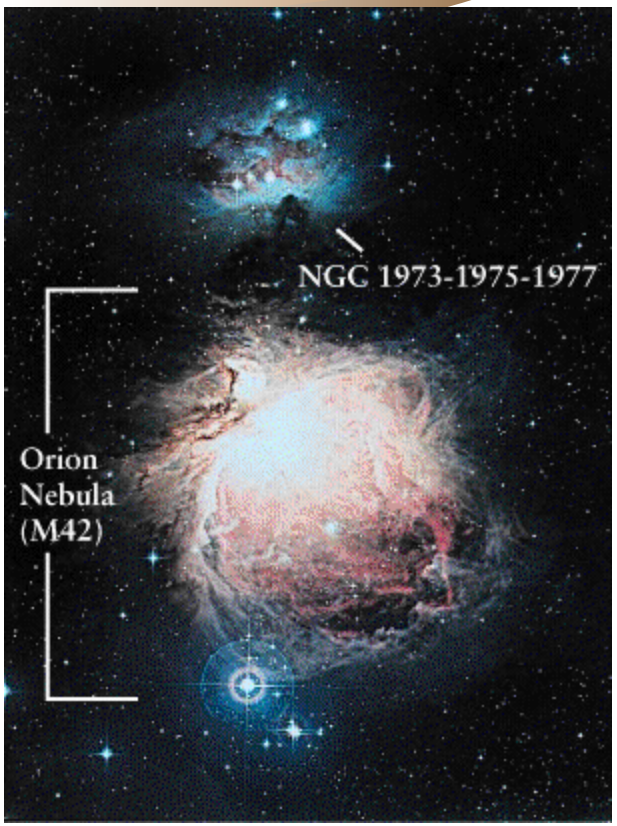


Additional things you'll learn

- Basic structure of the Solar System
- Formation theory of the Solar System
- What planets are made of
- Some cool web sites

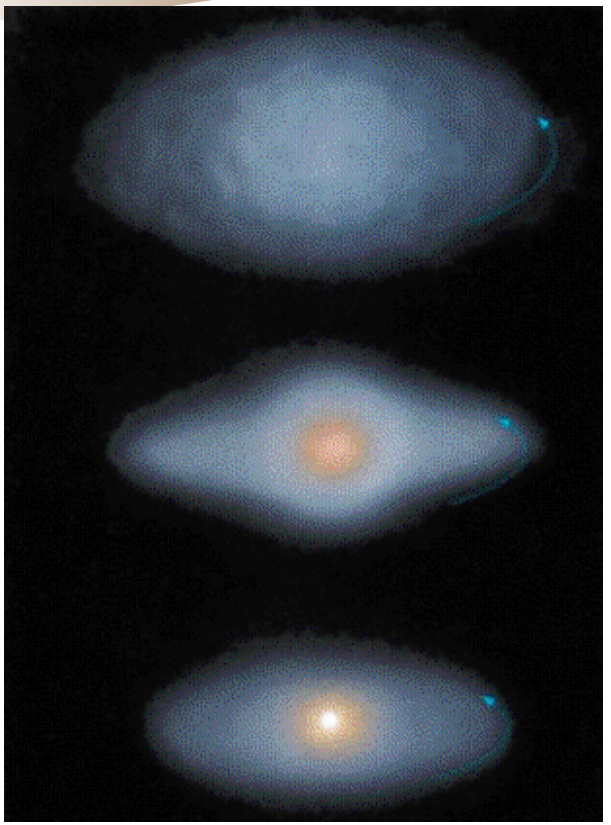
Solar System Formation

- The Sun and Planets formed from a cloud of material similar to the Orion Nebula
  - Some material left over from the Big Bang
  - Some recycled star material from supernova explosions (start barf)



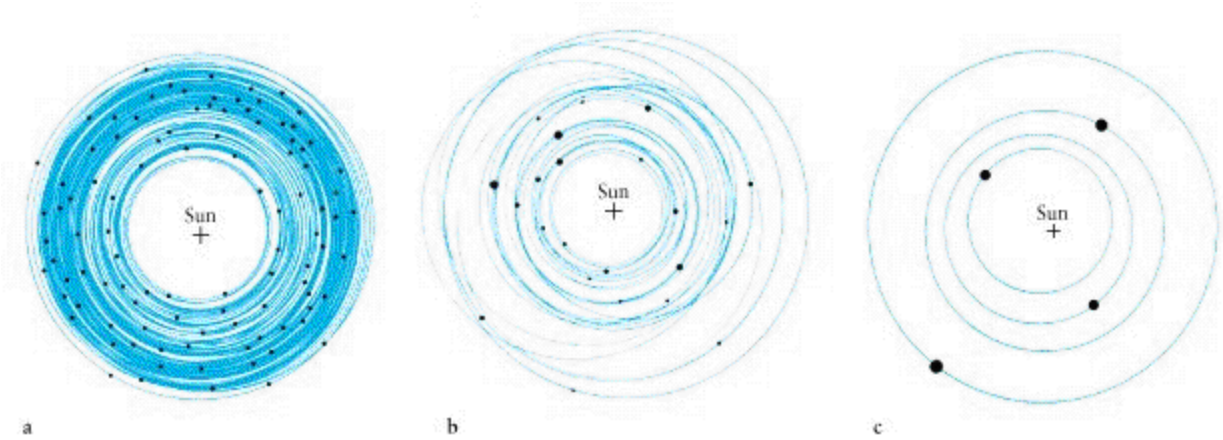
Solar System Formation

- Material started falling in toward densest region (self gravitation)
  - Not all infalling material aimed at the center
    - Center becomes Sun
  - Material starts to orbit
  - Because of the effect of gravity and the orbits, the material organizes itself into a disk



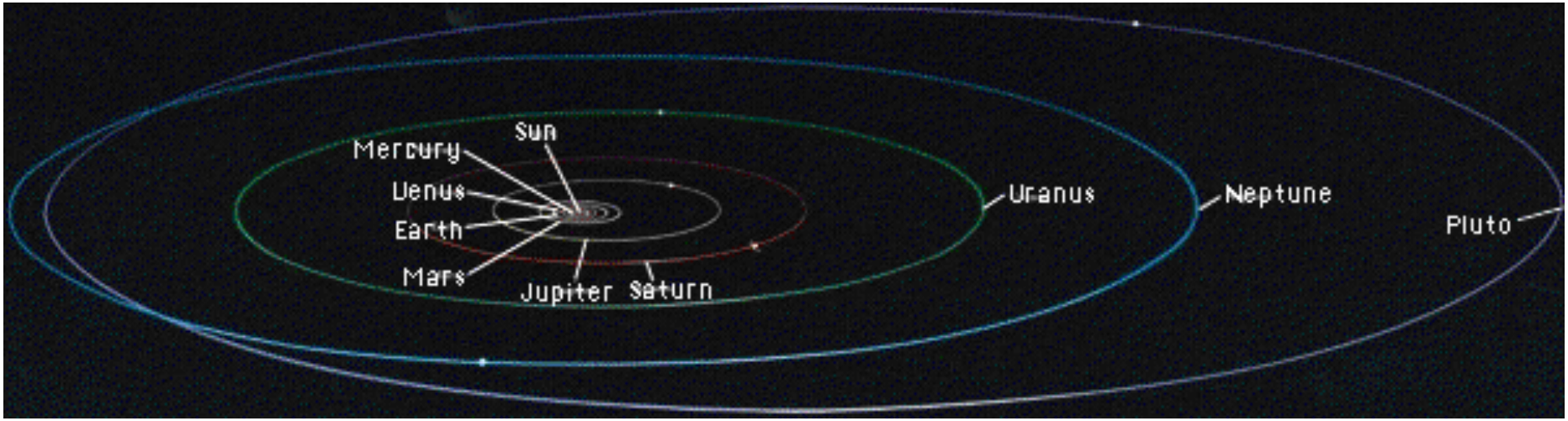
Solar System Formation

- As more material falls in, it gets crowded
- Particles collide and stick to each other -- planetesimals
- Planetesimals, attract even more material (by gravity), grow into planets
- Most planetesimals got vacuumed up by planets long ago
- **Some planetesimals are still left!**
  - These are the modern day minor planets (asteroids, comets)



Basic Structure of the Solar System

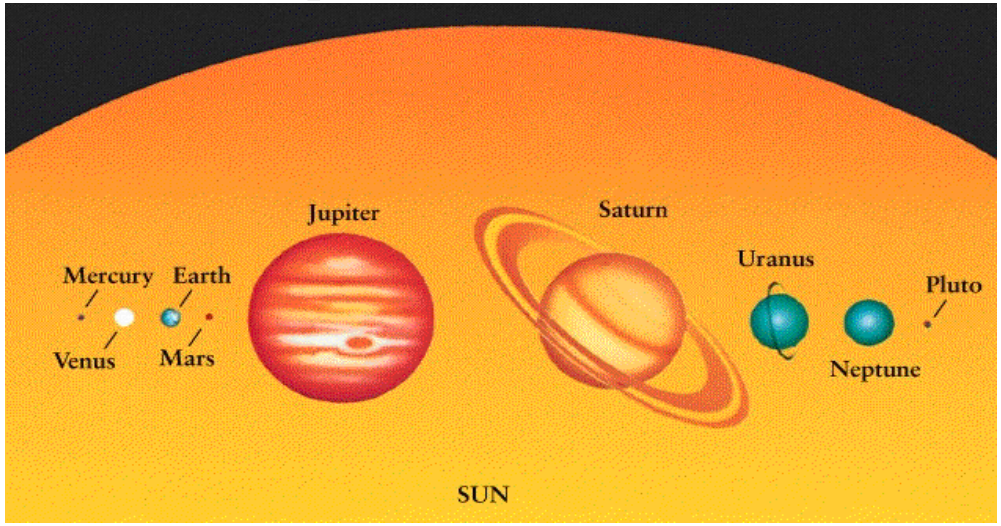
- The Sun is at the center
- All other objects in the Solar System orbit (go around) the Sun
  - Planets, like Mercury, Venus, Earth, Mars, Jupiter…
  - Minor planets (asteroids and comets)
- Not all orbits are circular
  - elliptical (oval)
  - hyperbolic (fling by the Sun once)



More on the Solar System

Space between solar system objects is HUGE compared to size of objects

- Are planets likely to hit each other?
- Something **Really Big** would have to come along to move the planets towards each other
- Planets are **Really Big** compared to minor planets
- Gravitational interaction between minor planets and a planet (e.g. Jupiter) can send minor planets on a **collision course!**



Midpoint Summary

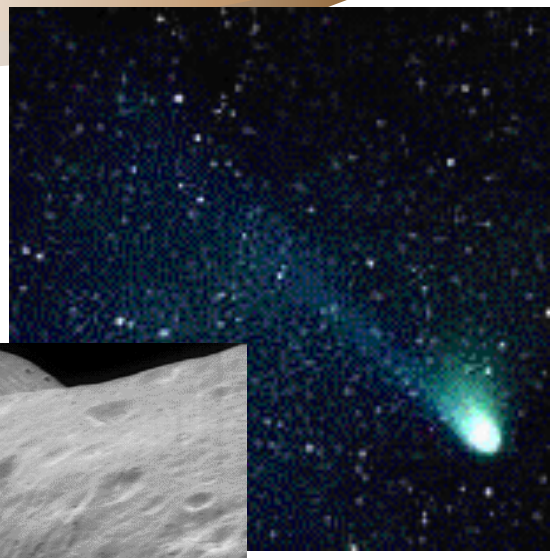
- Minor planets (asteroids and comets) are a remnant of the formation of the Solar System
- They orbit the Sun like planets, but not always with circular orbits
- Mostly they mind their own business, but sometimes they get too close to a planet and get flung off towards another planet

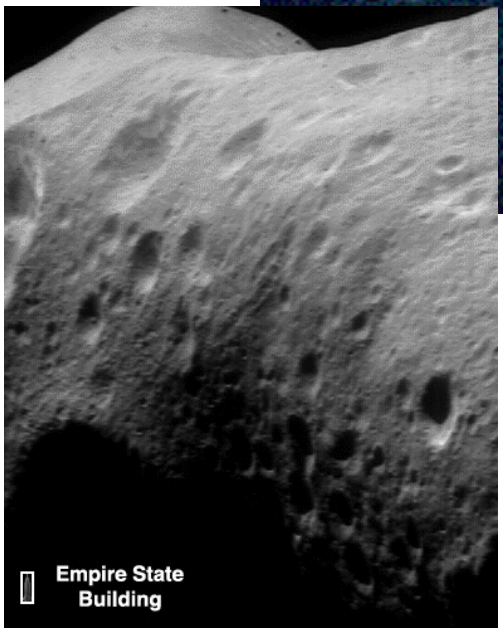
- Next topics:
  - What are the minor planets made out of?
  - Where do they like to hang out?
  - What happens when they hit another planet?

Minor Planets

What are minor planets made out of?

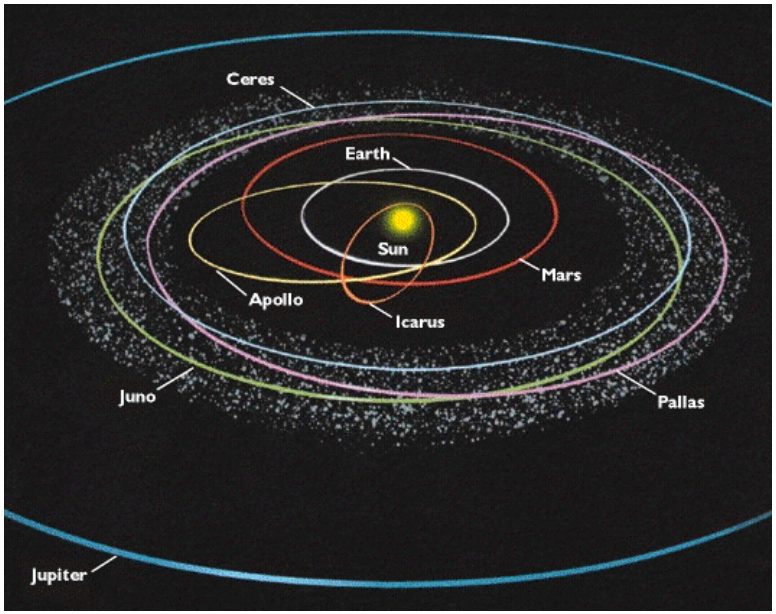
- All the basic building blocks that we are made from
- They **are** left over building blocks
- Minor planets that are mostly water turn into **comets** when they get close to the Sun
- Minor planets that are mostly rock or metal (usually iron) are **asteroids**

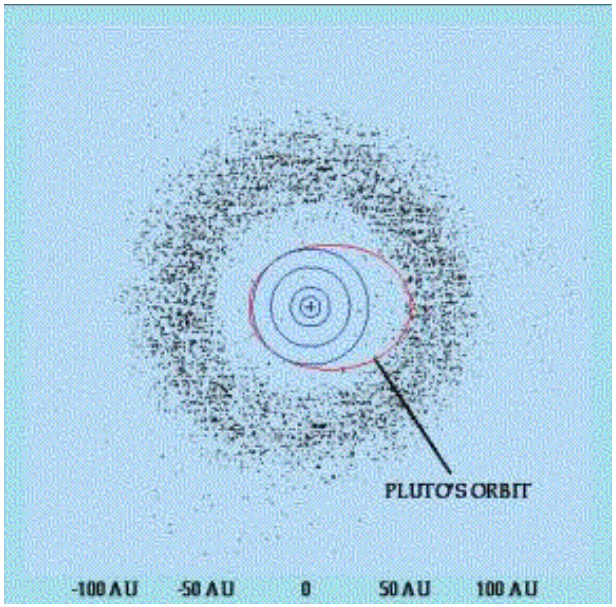




Minor Planet Orbits

- In general, minor planets hang out in places not regularly vacuumed by planets
- Asteroid Belt between orbits of Mars and Jupiter
- Kuiper Belt outside orbit of Pluto
- Oort cloud way beyond Kuiper Belt
  - Original cloud from which Sun and planets formed
- Cool web site on the minor planet orbits





Impacts!

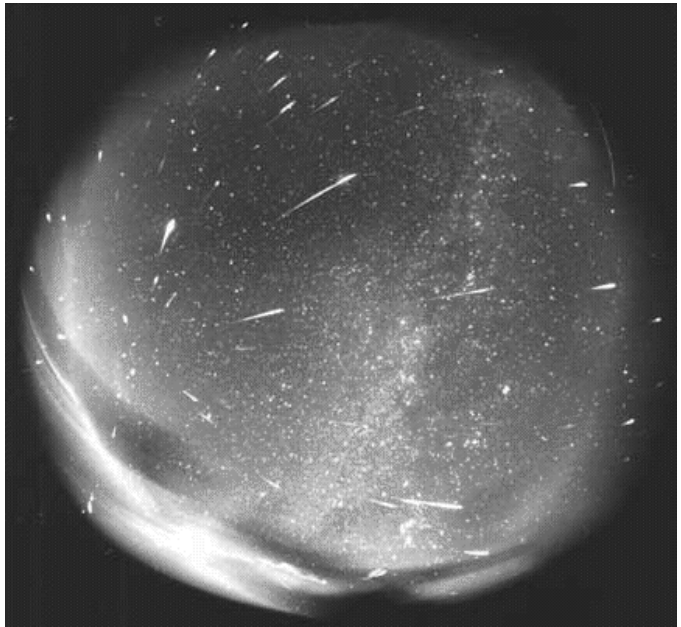
- What happens when a minor planet hits a planet?
- It depends

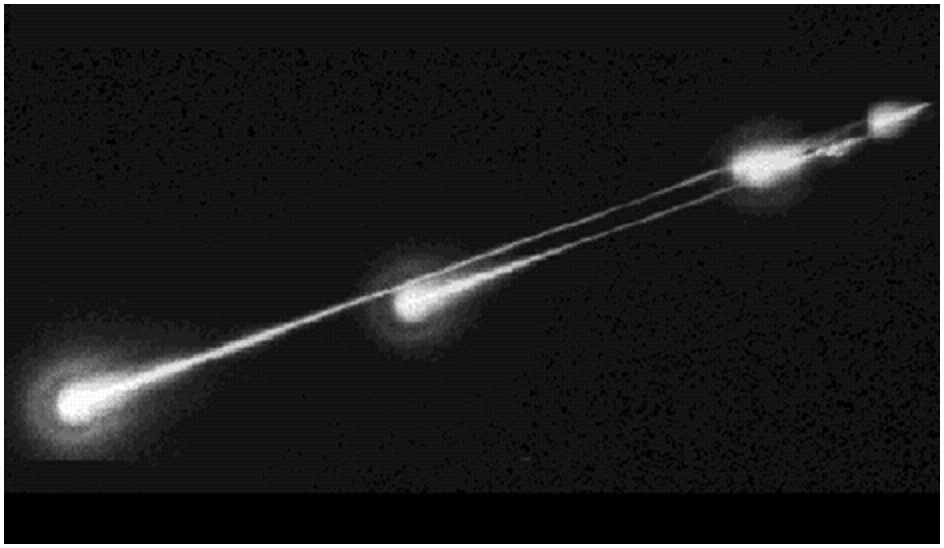
- Click on me:

Impacts!

- Most things burn up in the atmosphere
- Meteors -- shooting stars
- Meteor showers are comet tail debris
  - Tend to happen at the same time each year
  - Perseids in mid August
  - Leonids in mid November

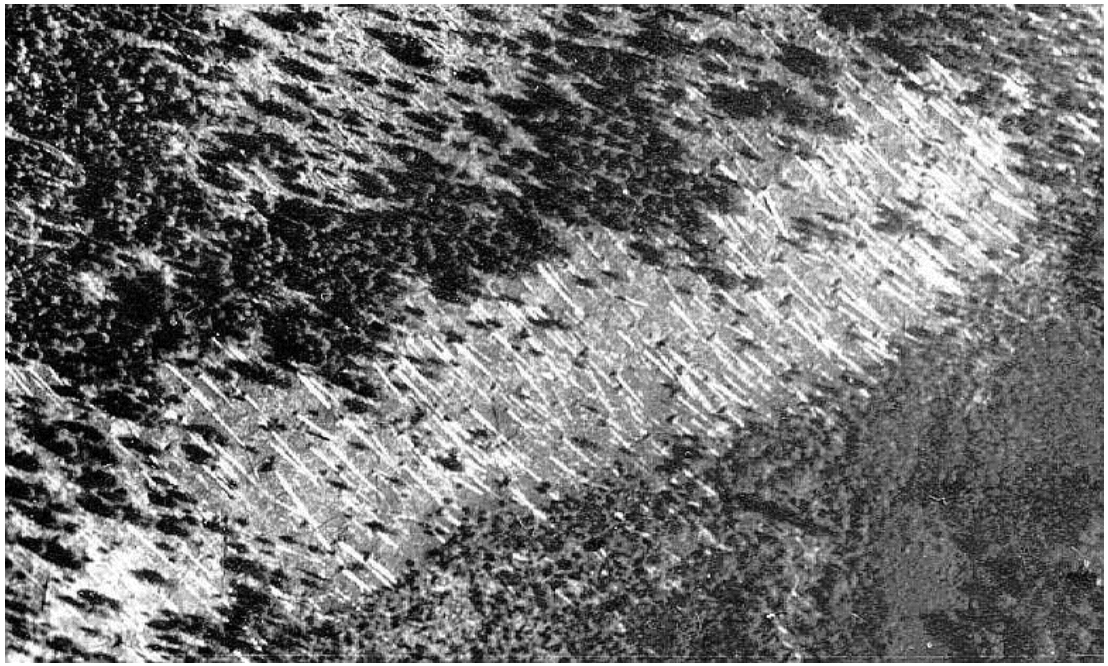
A 1994 Perseid fireball captured by James Riggs





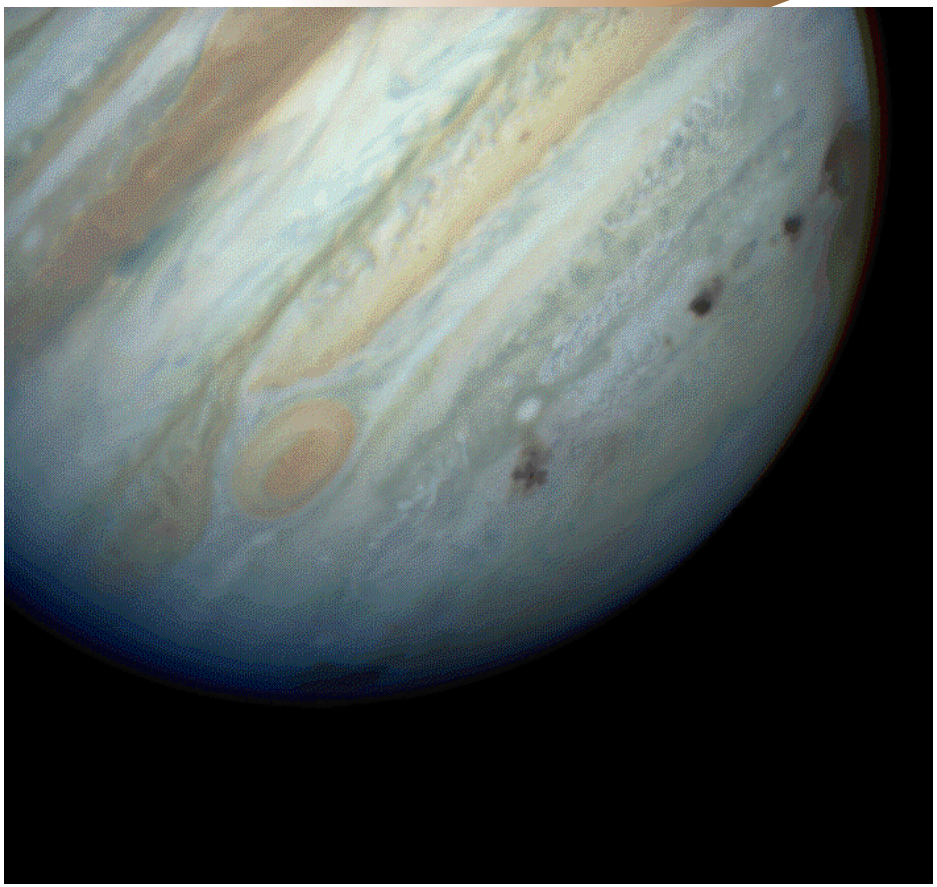
Impacts!

- Tunguska event, 1908 in Siberia
  - Huge explosion knocked down trees for miles
  - No impact crater
  - Probably a comet



Impacts!

- Comet Shoemaker-Levy hit Jupiter in 1994
- Poked holes in Jupiter's atmosphere

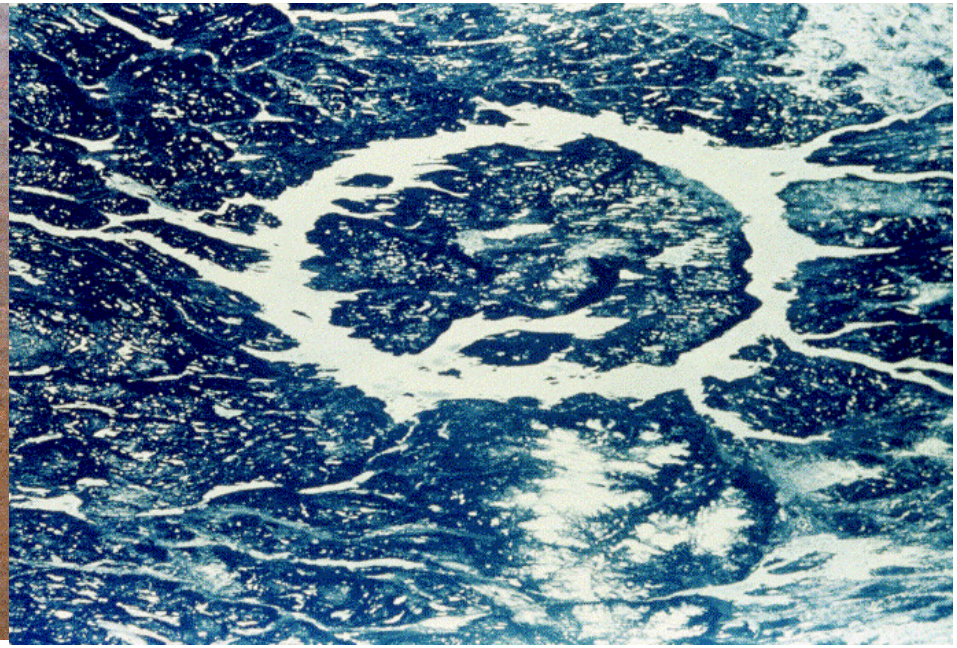


Meteorites

- When meteors make it all the way to the ground, they are called meteorites
- Several classifications based on amount of rock vs. metal

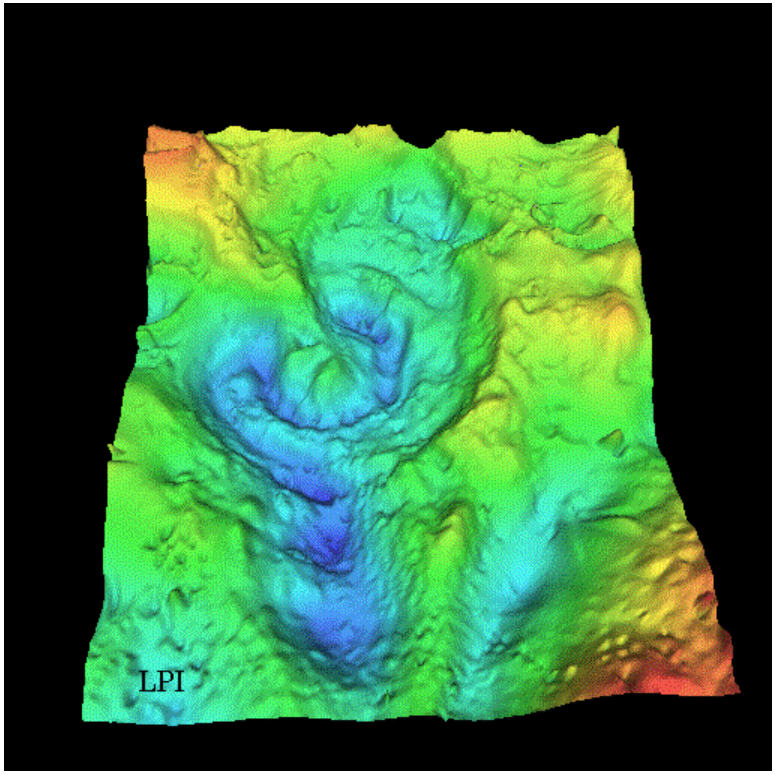
Visible impact craters

- Impact crater pictures
- Why are most visible craters in desert locations?
- Less erosion



The Big One

- Chicxulub, Yucatan Peninsula, Mexico
- Kicked up **billions** of tons of dirt into the atmosphere
  - Iridium rich clay layer found around the world
- Responsible for extinction of the dinosaurs 65 million years ago

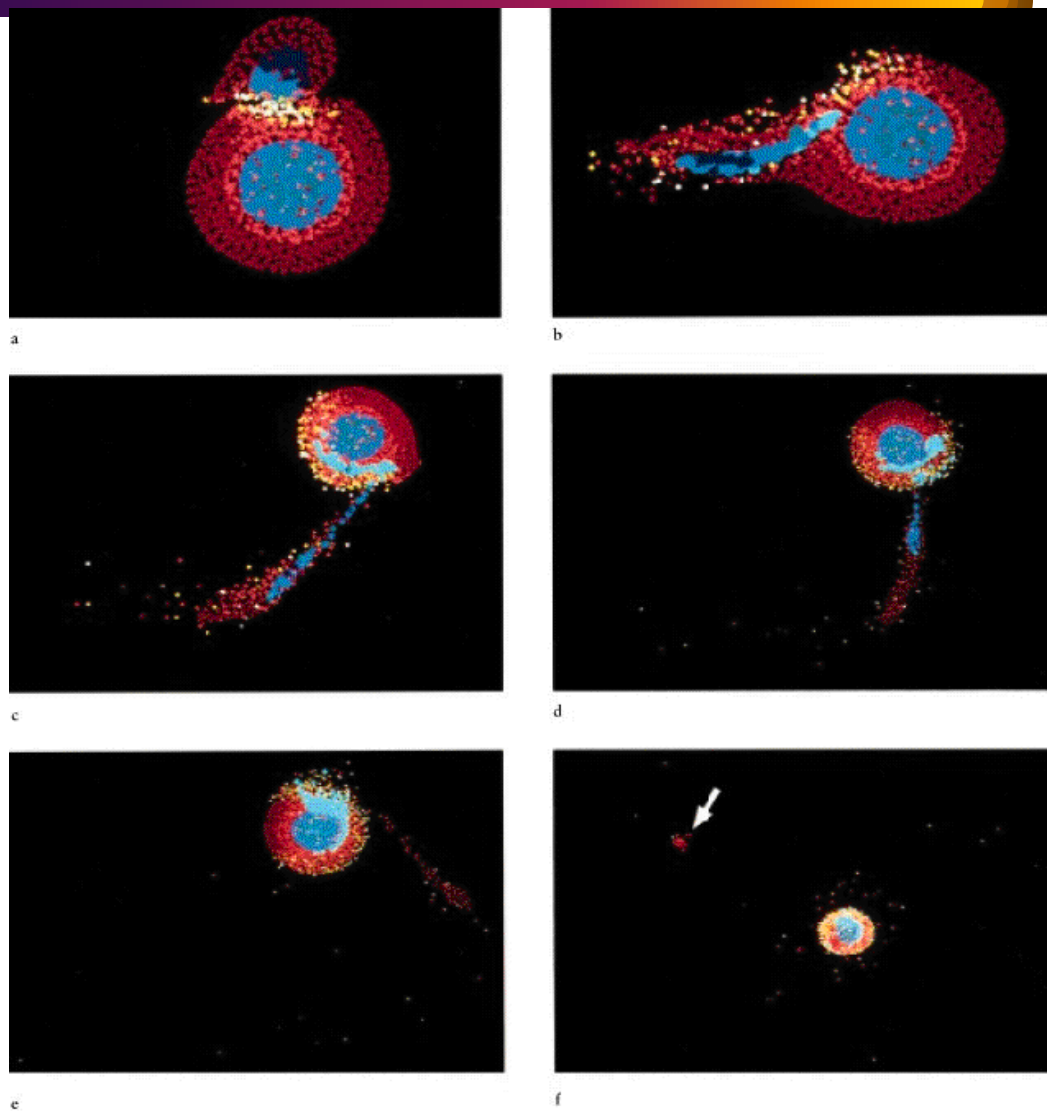


Can it happen again?

- What do you think?
- Various space agencies are looking into the probability of a large impact
- Chances are pretty small
- Sleep well

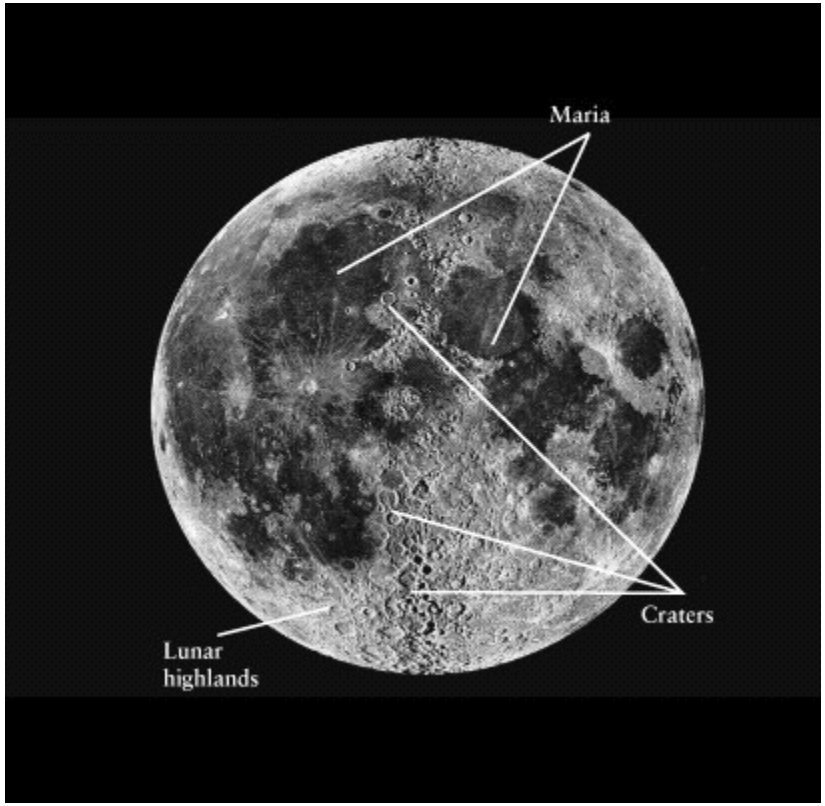
Impact craters on the Moon

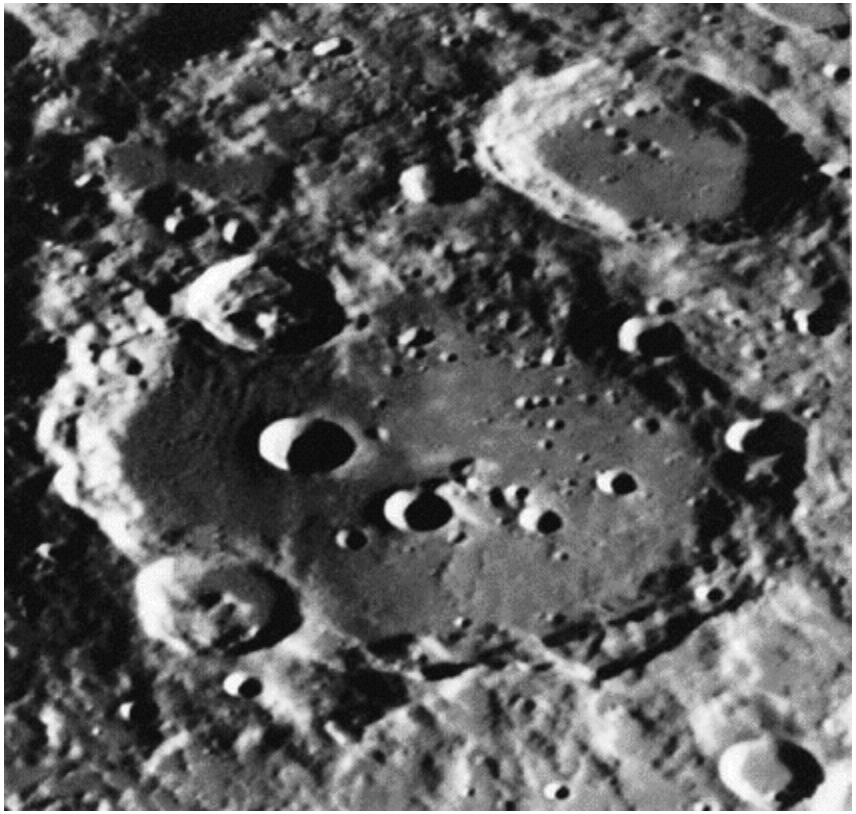
- The moon probably formed from an impact between Earth and a Mars-sized planetesimal 5 billion years ago



Impact craters on the Moon

- Early on, the moon had volcanic activity, probably from impact craters breaking through the crust
  - Formed *Maria*
- Since then about the only weathering activity comes from other craters



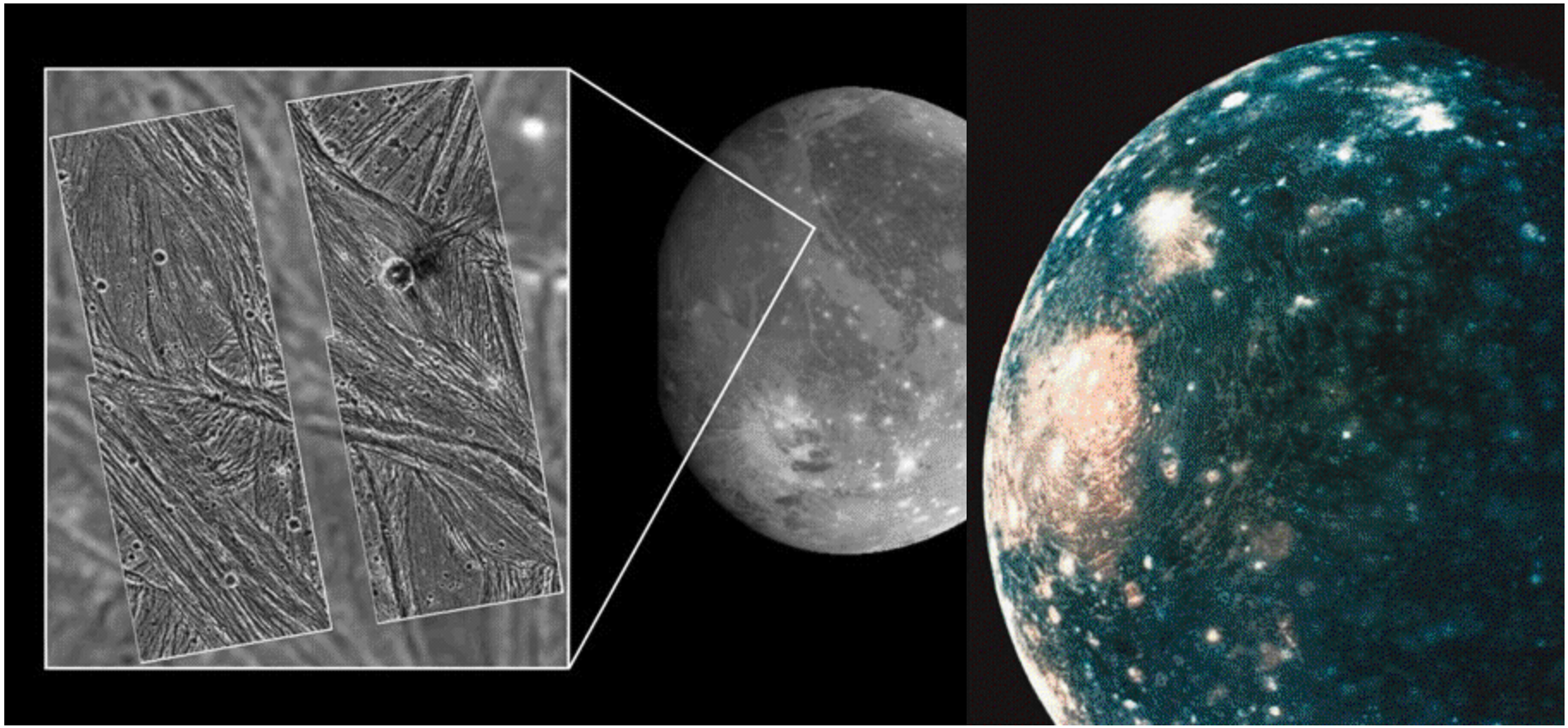


Impact Craters Elsewhere

- Mercury and Mars have visible impact craters

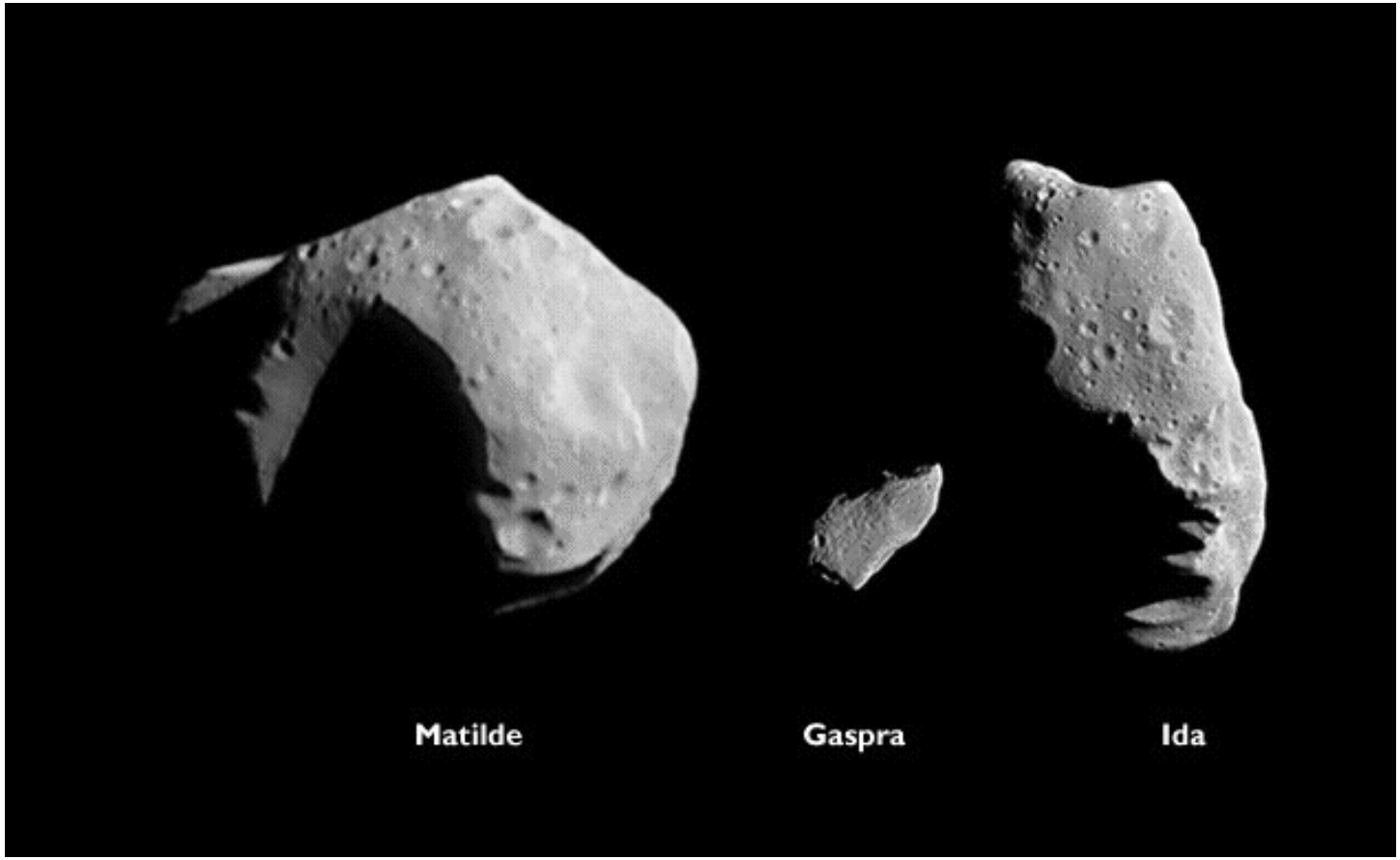
Impact Craters Elsewhere

- Two large moons of Jupiter (Ganymede and Callisto)
- Craters erased by geologic activity on Jupiter's other large moons



Impact Craters Elsewhere

- Asteroids



Summary

- Why does stuff hit us from outer space?
- There is stuff left over from the formation of the Solar System floating around -- minor planets (asteroids and comets)
  - Random motion brings a minor planet close to a real planet
  - Minor planet disturbed from usual orbit
  - Minor planet can become a meteor or meteorite
- Where do we see impact craters?
- What roll have impacts played in the evolution of life on Earth?

Acknowledgements

- Most of the figures in the presentation were taken from the text
  - *Universe* William J. Kaufmann III & Roger Freedman
- You may also be interested in a project designed to use Madison Metropolitan School District's telescope facilities to track asteroids
  - http://www.wisc.edu/gspd/kti/mmsd_observatory.htm
- Crater making activity
  - http://webs.wichita.edu/lapo/o30.html