

## Comets and Mass Extinction

### What is a comet?

- A mixture of ice and dust that did not synthesize during planet formation.

### Parts of Active Comets Near the Sun:

- The nucleus, coma, hydrogen cloud, dust tail, ion tail.

### Orbits of Comets:

- Elliptical orbits
- The comets' speed changes depending on its proximity to the sun.
  - Aphelion- point where comet is furthest from sun (slower)
  - Perihelion- point where it is closest to sun (faster)

### Famous Comets:

- Halley's: first comet discovered to have a periodic orbit, will return in 2061
- Comet Wild 2: spacecraft collected particles from the coma of the comet
- Comet Hale-Bopp
- The Great Comet of 2007, Comet Ikeya-Seki flew by January 12, 2007 and for the next couple of weeks rivaled Venus for the brightest point in the sky

### The Tunguska Event:

- June 30, 1908 in central Siberia a 12-megaton explosion lit up the sky with a blue-white fireball brighter than the sun

### Craters:

- Impact in Chicxulub, on the Yucatan peninsula

### Comet Impacts:

- Comets with a 10 km diameter: mass extinctions every 50 to 100 million years
- Comets with a 2 km diameter: Global climate disruption, every 300,000 years
- Comets 2km diameter: leaves a 40km crater, would wipe out Monroe County
- Comets under 2km: The impact would be localized, not global

### Effect of Impacts:

- Superheated water vapor, melted rock and other debris would be sent into the upper atmosphere that forms a global cloud that lowers temperature worldwide
- The shock wave from the impact would level an area the size of New England
- The heat would immediately incinerate cities and forests

### 10 km or larger? = Possible Extinction

- That's a crater with a diameter of roughly 200 miles, the size of South Carolina
- An impact would force debris into the sky, block the sun and cut off sunlight to the Earth for several years
  - Causes lower temperatures, no food, which would cause all people and most species to die
  - If it lands in the ocean a tidal waves up to 300 meters high would occur

### Evidence of Mass Extinctions

#### •Craters

#### •Layers of Iridium

-found in 1980, layer of iridium in the clay at two sites

-dating on iridium layer coincides with dates of date of mass extinction

(dates found through radiocarbon dating= radioactive decay/ half-life calculations)

#### Shocked quartz

-narrow, parallel bands crisscrossing at various angles --evidence of impact

#### •Discovery of fluellenes

-new impact theory proposed by Luann Becker (with help from UR Professor Robert Poreda)

## Nemesis Theory

A brown-dwarf companion to the sun?

So what does this mean for Earth?

- Well, in several million years it will mean quite a bit, considering the destructive power of a comet...

- Kinetic Energy =  $(1/2)mv^2 \rightarrow$  Kinetic Energy per gram =  $(1/2)v^2$

- A comet has approximately 100 times more kinetic energy per gram than 420J/g of TNT!

### Jupiter—the trashcan

- As large as 2.5 times all of the other planets in the solar system combined, known as a “Gas Giant,” 318 times as massive as the earth and therefore has a much greater gravitational pull, holding at least 63 moons in its own orbit, often termed a “failed star” as it is nearly as large as the smallest red dwarfs and with more mass would collapse into fusion reactions.
- Because of its large mass, diameter, and gravitational pull, Jupiter has, by far, the largest amount of comet strikes in the solar system.
- It is widely believed that Jupiter factors largely in the formation of asteroid belts throughout the solar system.
- Several asteroids known as the “Trojan Asteroids” actually follow Jupiter in its orbit around the sun.

### Shoemaker-Levy 9:

- In March 1993 astronomers Shoemaker and Levy discovered a comet orbiting Jupiter that collided with on July 16, 1994. A large fireball, easily observable from the spacecraft Galileo, brought the atmospheric temperature in the region of impact up from 130 K to 24,000 K. Fragments continued to rain down on the planet, the largest, hitting on July 18 and releasing a blast of energy estimated at around 6,000,000 megatons of TNT.

### Will a Comet Hit Earth?

- NEO (near-Earth objects) hunters estimate that 9,000 objects 0.5 kilometer or larger are in near-Earth orbits, of which only 350 have been found to date. Collision with any one of them is unlikely to kill every human being, but in the aftermath of having 25 percent of the Earth's population perishes, civilization is likely to topple as a result.
- To date, none of the cataloged NEOs seem hazardous, but nevertheless organizations such as Spaceguard are attempting to improve public awareness of the NEO threat.

### How Will We Prevent an Impact?

- NASA Comet/Asteroid Protection System (CAPS)
- “Don Quijote” Mission
- Russian nuclear explosion of asteroids

NASA's CAPS : Detection System put in Moon to identify NEO's .

Don Quijote: Involves two spacecrafts: Sancho and Hidalgo

Sancho arrives first and orbits asteroid for several months deploying penetrating probes to examine its structure before and after crash.

Hidalgo smashes into asteroid at 10 km/s to throw off the original orbit.

Russian Plan: Destroy asteroids with nuclear bombs, put in large missiles

Problem?  $E = mc^2$

Blowing up a large asteroid given a 1 – 2 year notice, just gives you many smaller ones. The energy and the mass are the same. The only thing changed is the fact that the asteroid will hit a wider surface area of the Earth with the same devastating effect.