

29:52 Exploration of the Solar System
Class Notes for May 7, 2008
Meteors and Meteorites

Last time, I described how asteroids on “resonant” orbits were scattered from orbits entirely within the asteroid belt to those which came into the inner solar system.

Meteors

Meteor is the technical term for a shooting star. If you go outside on a clear dark night and watch the sky for a while, you will see streaks of light move across the sky. These are meteors, and they are particles entering the Earth’s atmosphere from space and heating up.

For centuries or millenia, there were claims that for some large meteors, stones fell from the sky. In the early 19th century, the bulk of evidence accumulated that these reports were correct. For large meteors, it sometimes happens that part of the object causing the meteor survives passage through the Earth’s atmosphere. The remaining object is called a meteorite.

Meteorite

There are many classes of meteorites. The most important ones are

- stony meteorites. These are like rocks. Most stony meteorites are classified as chondrites, because they contain *chondrules*, small, glassy beads within the rock.
- iron-nickel. About 5 - 10 percent of meteorites are nearly perfect pieces of iron and nickel; they are solid metallic objects.
- carbonaceous chondrites. Carbonaceous chondrites have been described as having the consistency of dirt clods. They are very dark, and the black stuff they are made of has a high percentage of organic compounds.

These classifications are very similar to the classes of asteroids. Careful study shows this is not a coincidence. There is a correspondence between classes of meteorites and classes of asteroids.

Orbits of Meteorites

In the case of meteorites which have been seen to fall (i.e. the meteor producing it was observed), it is possible to solve for the orbit. Check the graph in the online lecture notes. These orbits extend out into the asteroid belt, and are virtually identical to the orbits of near-Earth asteroids. This fact, together with the similarity of meteorite and asteroid classes, proves that there is an intimate connection between the two objects. The meteors that produce meteorites come from the asteroid belt. Meteorites are pieces of asteroids.

Visiting Vesta at the Smithsonian Museum of Natural History

A very small class of meteorites is the Vesta meteorites. These have the same brightness and color of Vesta, and are thought to be pieces of the asteroid Vesta which were blown off into space by an impact. You can see them on display at the Smithsonian Museum of Natural History.

We can measure the age of formation of meteorites by doing radioisotope dating. The ages of formation fall into the range 4.48 - 4.55 Gyr. They are therefore “primitive rocks” that formed early in the history of the solar system.

Carbonaceous Chondrites

Carbonaceous chondrites are perhaps the most interesting kind of meteorite. The black material of which they are made is filled with organic compounds. To quote from the book “Moons and Planets” by Hartmann, “Most of the carbon compounds in carbonaceous chondrites are complex, tar-like substances that defy exact analysis. Murchison (a famous CC meteorite) also contains 16 amino acids, 11 of which are rare on Earth ...”.

One of the best known examples is the Tagish Lake meteorite, which fell in Tagish Lake in Canada in January, 2000, and was quickly recovered. See online illustrations for a picture of it.

Big Impacts Again

If the Earth is getting hit by little asteroids all the time, that produce the meteorites, it seems reasonable that it would get hit by bigger ones more rarely. In the next class, we'll see that is certainly true, and those asteroids leave their mark.