

# Astronomy

## Level 2

### Meteorites, Shooting Stars, and Comets

#### Meteorites

Most people are familiar with the term "shooting star," but few know its importance. Actually, it is not a star shooting across the sky, but a small piece of solid matter called a meteoroid colliding with the atmosphere. As the meteoroid enters the Earth's atmosphere, the friction created by its incoming velocity causes its surface to heat up, and the brilliant flash of light records the passage of a meteor. Should the object survive this fiery plunge through the atmosphere and hit the ground, it then becomes a meteorite. On very rare occasions when an extremely bright meteor is observed, it is referred to as a fireball. It is from these fireballs that most meteorites of recoverable size originate.

The arrival of a meteorite is a totally unpredictable event. Meteor showers are regular annual occurrences, but have never produced a recorded meteorite fall. When a large fireball is observed, recovery of specimens is almost solely dependent upon the accounts of chance observers who just happened to see the event. Even rarer is the observed impact of a meteorite on someone's roof or in a backyard. Meteorites recovered in this manner are termed falls, indicating that the specimen was observed while falling. The majority of meteorites are recorded as finds, those specimens which were not observed to fall. Finds are generally reported by people who happen to pick up a strange looking rock and later have it identified as an actual meteorite.

#### Classification of Meteorites

Meteorites are classified into three main groups because of their particular mineral compositions: irons, stony-irons, and stones. Mineralogically, meteorites consist of varying amounts of nickel-iron alloys, silicates, sulfides, and several other minor elements. Classification is then made on the basis of the ratio of metal to silicate present in the various compositions. No two meteorites are completely alike, and specific compositional and structural features give a particular meteorite its unique identity.

Iron meteorites are characterized by the presence of two nickel-iron alloy metals: kamacite and taenite. Depending upon the percentage of nickel to iron, these subdivisions are classified as:

- hexahedrites (4-6% Ni)
- octahedrites (6-12% Ni)
- ataxites (12+% Ni)

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Octahedrites, which are the most common type of iron meteorite, exhibit a unique crystal pattern when etched with a weak acid. This unique crystal pattern is the result of the combination of the two nickel-iron minerals kamacite and taenite being present in approximately equal amounts.

Stony-irons consist of almost equal amounts of nickel-iron alloy and silicate minerals. Although all stony-irons may not be genetically related or have similar composition, they are combined into one group and divided into two subgroups for convenient classification.

- The Pallasites
- The Mesosiderites

Stony meteorites are the most abundant of the three meteorite groups and come closest to resembling earth rocks in their appearance and composition. Aside from being the most abundant meteorite type, stony meteorites have the greatest variety in composition, color, and structure. One particular structural feature called chondrules divides the group into two main subgroups:

- Chondrites, those with chondrules
- Achondrites, those without chondrules

Many scientists believe that these small, rounded, nearly spherical chondrules may represent the most primitive material in the solar system.

### What do Meteorites Look Like?

As compared to Earth rocks, meteorites have several features which can be used to establish their extraterrestrial origin. The surface of a meteorite is generally very smooth and featureless, but often has shallow depressions and deep cavities resembling clearly visible thumbprints in wet clay. Meteorites which have fallen recently may have a black "ash-like" crust on their surface. This provides evidence of their flaming entry through the atmosphere. However, this crust weathers to a rusty brown color after several years of exposure on the Earth's surface and will eventually disappear altogether.

The size of a meteorite will vary from microscopic to a very large mass several feet in diameter. Most recovered meteorites measure between 2 inches and 2 feet in diameter. The largest meteorite ever discovered is still in the ground in South Africa because it was too large to move. The shape of a meteorite is seldom round; they are usually very irregular in appearance and come in a variety of different shapes and sizes. Unusual weight is one of their more characteristic features. Iron meteorites are generally 3.5 times as heavy as ordinary Earth rocks, while stony meteorites are about 1.5 times as heavy.

Stony meteorites are not as obvious as the irons because they often resemble a common rock called basalt. They also contain metal as do the iron meteorites but in much smaller amounts which appear as small fragments within the surrounding rocky material. Very often this metal can be seen where a chip of the meteorite has been broken off. Because of their metal content

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most, but not all, meteorites will be strongly attracted to a magnet. This can be a good clue to the meteorite's true identity.

Several Earth materials are easily mistaken for meteorites. Furnace and smelter slag often look like meteorites, but because of their generally light weight and porous texture they can easily be distinguished from meteorites.

Iron ore minerals, such as hematite and magnetite, can also be confused with meteorites, but a simple laboratory test for nickel will determine their true nature. Earth rocks have either very small or very large amounts of nickel, but in meteorites the nickel content falls within a very specific range.

### **Why Study Meteorites?**

Prior to the Apollo moon landings, meteorites supplied the only extraterrestrial materials available for study. In their basic characteristics, meteorites represent materials which formed in a region of the solar system far removed from Earth. Meteorite studies have also provided spacecraft designers an economical means to observe the effects of high speed aerodynamics without the costly expense of experimental re-entry vehicles.

When scientists study a meteorite they look for clues to its origin by studying its mineral composition. Through the use of special microscopes and high magnification we can learn about the conditions in which the meteorite formed. A chemist can examine a meteorite's chemical composition and determine from where in the solar system it came.

### **What is a shooting star?**

Shooting stars look like stars that quickly shoot across the sky, but they are not stars. A shooting star is really a small piece of rock or dust that hits Earth's atmosphere from space. It moves so fast that it heats up and glows as it moves through the atmosphere. Shooting stars are actually what astronomers call meteors. Most meteors burn up in the atmosphere before they reach the ground.

### **How often do they occur during the night?**

As the Earth moves around the Sun, it will run into some of these small rocks that collide with the atmosphere at great velocities. Going through the atmosphere they begin to heat up, start to glow, and then burn down.

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There are millions of such particles colliding with the atmosphere every day (I mean day and night). But since you can only see them at night, and you can only look at a small part of the sky at once, when stargazing you can expect to see a shooting star every 10 to 15 minutes.

This is on a regular night. When we get meteor showers, we get many more. A meteor shower happens when the Earth goes through a region of space that is especially filled with dust and chunks of rock. Therefore we get many more meteors at these times. More precisely, meteor showers happen when Earth, on its way around the Sun, passes through the path of a comet. That's because as a comet orbits near the Sun, it starts to melt down and ejects on its path lots of dust and chunks of rock. The yearly meteor showers are caused by this. In any given night, you can also see more shooting stars (in fact about twice as many) just before dawn. That's because at dawn we are facing the direction in which the Earth is moving, so we intercept more of the stuff in space.

### **Comets:**

#### **What is a comet?**

Comets are basically dusty snowballs which orbit the Sun. They are made of ices, such as water, carbon dioxide, ammonia and methane, mixed with dust. These materials came from the time when the Solar System was formed. Comets have an icy center (nucleus) surrounded by a large cloud of gas and dust (called the coma). The coma is created as the ice in the nucleus is warmed by the Sun and vaporizes. Comets can develop two tails as they travel closer to the Sun: a straight gas tail and a curved dust tail. The gas tail is created by the solar wind, pushing gas away from the comet's coma and pointing straight back from the Sun. The dust in the coma is not affected by magnetic fields but is vaporized by the Sun's heat, and forms a curved tail which follows the comet's orbit.