Meteor & Meteor Shower Information Pack

Barringer Crater in Arizona. This crater was created by a meteorite 25 meters across that hit the Earth at a whopping 15 kps, releasing the equivalent energy of a 4 megaton atomic bomb. Date of impact: Approximately 15,000 - 40,000 years ago. Diameter of Crater: 1.2 kilometers.

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INTRODUCTION

Have you ever seen a shooting star? Most people have, but these experiences are usually quite rare. Did you know that on an average night you can see upwards of 15 shooting stars per hour? (This figure is an average for after midnight viewing. This is explained in detail a little later) Did you ever wonder what caused the shooting star? Most of us now know that these streaks of light in the night sky are called *meteors,* but what of their origin, and the reason we see them so infrequently. Hopefully, upon completing this reading, you will understand what a meteor is, and why it burns up in the sky. We will also discuss some other related bits of information which will prepare you to watch a *meteor shower* and not only revel in it's beauty, but understand why it happens.

BASICS AND TERMINOLOGY

What exactly is a shooting star? Simply put, a shooting star or *meteor* is a small piece of rock or some other substance that has floated through space until it came into the field of Earth's gravity. Once it started to hit the Earth's atmosphere, it started to heat up because of friction. To help in understanding why this happens think of driving in the car. If you stick your hand out the window, you feel the air rushing by. In actuality it is you rushing through the air. The force of air you feel is caused by your hand pushing the air away from where it was resting. If you were to go faster, you would feel more "push" against the air. Now imagine that you are traveling somewhere between 11 and 60 km/s (24,000 to 134,000 mph!). The force of the air would be so great that as it moved by your hand it would heat up. Now we all know that if you rub two sticks together fast enough it will start a fire right? Well the same is basically true for any two materials. This is surmised by saying friction causes heat. If you could drive that fast, and manage to keep your hand out the window, the force of the air rushing by would cause your hand to ignite and probably make a nice fireball as you sped by the police doing 130,000 miles per hour! This is what happens to meteors. As the sand to pea sized specs of rock hurtle through space and slam into the Earth's atmosphere, they ignite and streak across the night sky, dying in a blaze of glory. Often these meteors will leave trails of smoke across the sky called ***trains***.

Up to now we have used the term meteor rather loosely. In fact these fragments of rock are called different things at different times. As a small chunk of debris floats through space, not having made contact with the earth and not being large enough to be called an asteroid, it is called a ***meteoroid***. If the meteoroid comes into Earth's atmosphere and burns out before it touches the ground (As is most often the case) it is called a ***meteor***. If the meteor is large enough to survive its fiery plummet to earth, it is then called a ***meteorite***. Every so often, a large piece burns up into the atmosphere in a long and glorious ***fireball*** arcing across the sky until it finally burns out. Even rarer still is the ***bolide***. A bolide is a large fireball that may be so bright as to light up the ground like daylight! The bolide may even break up into smaller pieces which could even crash to the ground! Any sighting of a bolide should be reported to the local planetarium, observatory, or astronomy club for research purposes.

Now that we know what to call a meteor, lets look at where they come from and what they are made of. Simply speaking, a meteoroid is a tiny piece of an asteroid, which is just a huge rock flying through space. Picture striking two hand size rocks together. What happens? At the very least, some tiny fragments fly off of the impact. At the most, one or both of the rocks would shatter, breaking up into many smaller rocks. This is how meteoroids form. Two asteroids fly through space and smash into each other at a hundred thousand miles per hour. When they smash together, the tiny fragments that fly out are meteoroids.

Meteorites are a great find to scientists, because they offer us a chance to see what asteroids are made of. Many asteroids have been orbiting the sun for millions of years and have not been altered since they were formed with the rest of the solar system. When a meteoroid is found, we can analyze it's makeup and gather information about what the solar system was like when it was formed 4.5 billion years ago!

Meteorites that are not a result of meteor showers are usually formed in the above fashion (Very few shower meteors ever hit the ground). These meteorites are called ***sporadic*** and can be classified into groups as shown in the following table. Note that these percentages are of meteorites called ***falls***. Falls are meteorites actually seen to fall and which are retrieved, as opposed to found meteorites, called ***finds***, which are found by chance without having seen them land.

Meteorite Type	Percentage of Falls	Remarks
STONY		
Carbonaceous chondrite	5.7	Remnant of early solar system.
Chondrite	80.0	Most common meteorite found. Defined by millimeter scale glassy inclusions "bubbles" of silicon in the rock called ***chondrules***
Achondrite	7.1	Most like rock of Earth. Defined by lack of chondrules (See above)
STONY-IRON	1.5	Contains Iron and stony parts in contact with each other
IRON	5.7	Nickel-Iron composition. Often cut and polished to show beautiful crystalline structure

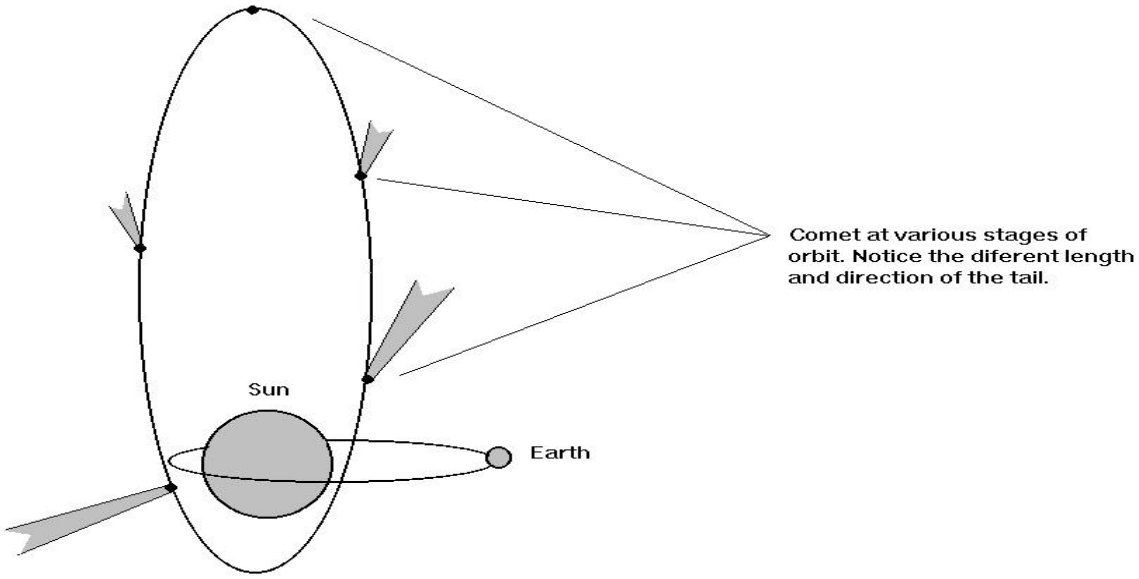
There have been some meteorites in history that have had a lasting impact on civilization here on Earth, not to mention the Earth itself. One rather close to home example is Barringer Crater in Arizona. Sometime around 20,000 years ago, a meteorite roughly the size of a railroad car smashed into the desert displacing about 400 million tons of rock and dirt! While this is obviously a rare occurrence, this crater is proof that it can happen.

In 1908 a mysterious object smashed into Tunguska Siberia in what was then the Soviet Union. The resulting explosion felled trees up to 30 km from the point of impact, and had the equivalent energy release of a two megaton atomic bomb. In actuality there really was no point of impact, as the trees at ground zero (The center of destruction) were left standing. This implies that perhaps the object that struck the Earth was a comet. It appears that the object actually exploded in the atmosphere, causing the resulting damage to trees for miles, but only stripping the branches off the trees directly below the blast. A comet, being mostly ice might have behaved this way, breaking up before impact. An eyewitness 110 km from the blast site was blown off his porch by the blast! Scientists believe the object to have been approximately 90 to 200 meters across. If an object of this size where to hit New York City today, the destruction would easily reach to Newark New Jersey! Remember this was only a comet. Had this been a meteorite or asteroid, the destruction would have been far greater.

METEOR SHOWERS

Every year like clockwork, on certain dates, an amazing thing happens. The number of meteors seen per hour jumps from 10 or so to upwards of 60! This spectacle is called a ***meteor shower***, as the meteors appear to shower down on us from above. For hundreds of years people thought that these showers were omens. Now of course we understand them and can explain them. Every few years however something extra special happens. A ***meteor storm*** may occur, showering upwards of 2000 meteors per hour down from the heavens! Lets look at why these events happen and why they occur so regularly.

Meteors that form meteor showers come from a different source than the normal meteors we talked about earlier. To understand the difference first lets talk about ***comets***. A comet is a large chunk of dirty, sandy ice that orbits a larger body like the sun or as we have recently seen even Jupiter. When the comet gets near the sun, its tail grows from a process called ***sublimation***. What this means is that the ice in the comet goes from a solid to a gas instead of solid to liquid to gas as is normally the case. This gas that is released from the comet trails out behind the comet because it is blown back by the ***solar wind***. Because of this fact you should note that the tail of a comet always trails out away from the sun. This means that when a comet is retreating from the sun, the tail actually leads the comet as opposed to following behind it.



Greatly simplified drawing of a comets orbit in relation to the Earth's orbit. In actuality, the comets orbit may stretch much farther into space and be a much more elongated ellipse. The point in which the comet's and the Earth's orbits cross indicates the point in which a meteor shower will result.

The solar wind is comprised of particles called ions that are emitted from the sun on a constant basis. This solar wind is what causes the Aurora Borealis or northern lights. As the ice of the comet melts, the dirt and ice that was frozen in the comet is also released. The very small particles of comet dust are swept away with the tail whereas the slightly larger pieces are left in space. To help illustrate this principle imagine taking a handful of sand and gravel mixed together and tossing it up into the air as you stand in a strong wind. The sand will blow away with the wind, but the gravel will just go up and fall to the ground without moving much.

The gravel is analogous to the larger, pea sized chunks of debris left behind by the comet. The sand would be the dust that is blown away with the tail. These pea sized chunks are left in a trail behind the comet wherever it goes. Remember now that most of the comets we see orbit the sun just like we do. This is important because eventually the Earth's orbit will intersect with this trail of debris in space. When this happens, these chunks hit the Earth's atmosphere and burn up becoming a meteor! What makes this occurrence special is that there is a great deal of debris in the path so the quantity of meteors seen is increased for the duration of Earth's travel through the comets path. This is called a ***meteor shower***. Meteor showers recur every year on or about the same date. The reason for this is that the trail of dust has for all practical purposes not moved, and the Earth crosses this trail at the same point is its orbit (i.e. the same day) every year.

Every so often the number of meteors per hour is so high that the shower becomes a ***meteor storm***. Meteor storms are quite rare and when they are seen often portend the end of the world to those not knowing their true cause. A storm is caused due the Earth intersecting a particularly dense stream of debris. An interesting phenomenon to point out here is the Leonid meteor storm. For reasons unknown, the Leonid meteor shower (Nov. 17) turns into a raging storm every 33 or so years. The last Leonid storms were 1933 and 1966 so one is quite possibly on its way! This is a mystery to astronomers, but is of course eagerly awaited none the less.

In 1993, some astronomers announced that the Perseid meteor shower would possibly storm that year. The media hype for this event was huge, and many people came to watch their first astronomical event. The storm never came, but the shower was better than average for many viewers, hopefully enticing some viewers to pursue astronomy at least a little further. In 1994, some astronomers are again predicting a storm for the Perseids. In fact these same astronomers said in 1993 that the real storm would be in 1994. Time will tell.

Another interesting point regarding meteor showers and all meteor sightings for that matter, is that the frequency of sightings increases after midnight. Picture the Earth as a ball spinning in space. As it passes through the field of debris that causes the shower, it spins into it. As the point directly over your head (Called the ***observers zenith***), reaches midnight, that point on Earth is now spinning into the thickest part of the debris, causing an increase in the frequency of meteors. For this reason if you decide to look for meteors or watch a shower, plan on being out past midnight.

As was stated earlier, meteor showers occur with startling regularity. This allows us to predict them very easily. Here is a table of the most easily viewed meteor showers and the comets that cause them. One note about the name of meteor showers. If you notice all the showers are named after a constellation. The reason for this is that meteors showers seem to emanate from a common point called the ***radiant***. That is to say all of the meteors seen that night seem to start from the same point in space and arc out away from that point. This is in fact an illusion, as the meteors actually travel almost parallel to each other, and only appear to travel in different directions because our point of view. At any rate, the shower is named for the constellation in which the apparent point of origin lies. If more than one shower occurs in a given constellation, then the shower is named for the closest major star in the constellation. Stars in a constellation are named in order of brightness using the Greek alphabet. Hence alpha Leonid would be the brightest star in the constellation Leo. Sharp amateurs may wonder about the shower called the Quandrantids. It is named for a now defunct constellation called Quadrans now in the Draco-Bootes area.

Shower Name	**Date**	**Meteors/Hr**	**Parent Comet**
Quadrantids	Jan 3/4	95	
Lyrids	Apr. 21/22	15	1861 I
Eta Aquarids	May 4/5	30	
Delta Aqaurids	July 28	20	
Perseids	Aug. 12	95	Swift-Tuttle (1862 III)
Draconids	Oct. 10	15	Giacobini-Zinner
Orionids	Oct. 21/22	20	Halley
S. Taurids	Nov. 3	15	Encke
Leonids	Nov. 17	15	1866 I
Geminids	Dec. 13/14	90	Phaethon (Burnt out Comet)

CONCLUSION

Meteor showers are a wonderful opportunity to start looking at the stars. All you need is a lawn chair that reclines, binoculars (for looking at stars, not meteors), warm clothes and maybe some food and a radio. No special equipment is needed. Just sit back and enjoy the show! Perhaps if you choose a popular spot to watch the shower, some astronomers may be on hand with telescopes set up to have a look at the planets or nebulas and such. Many people get started in their astronomy hobby by looking through a strangers telescope for the first time and seeing Saturn! If you get the chance, sit out and watch a meteor shower, you won't be disappointed. Unless of course it rains. Happy hunting!

GLOSSARY

bolide

comet
chondrules

fireball
falls
finds

ion

meteor
meteoroid
meteorite

meteor shower
meteor storm

sublimation
sublime
solar wind

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ACKNOWLEDGMENTS

PROOF READERS

Grammar, Spelling, Readability Lauren MacKay

Technical, Spelling, Readability Sal LaDuca

MISCELLANEOUS

Software Used This document was prepared using Microsoft Word for Windows ver. 6.0 The primary font used is Arial size 10. The Pictures were included using Microsoft Paintbrush. The Photographs were downloaded from CompuServe using CompuServe Information Manager for DOS and converted from GIF format to BMP format using the shareware program G GIFBMP.

Hardware Used This document was prepared on various 80486 based DOS/Windows PC's. It was printed on a Hewlett Packard Laserjet 4 at 600 dpi with resolution enhancement.

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