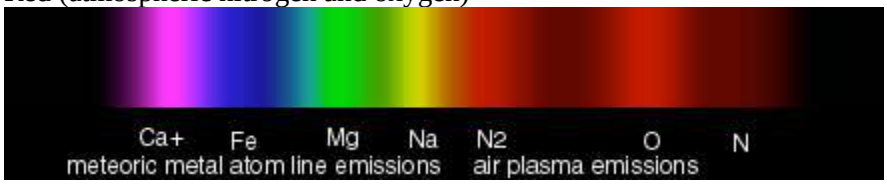
Observing Meteor Showers

The Solar System is a dynamic arrangement of planets, dwarf planets and small solar-system bodies in orbit around the Sun. However, solid bodies much smaller than asteroids and comets, orbit in the solar system too, and such objects (measuring between 10 µm and 1 m in diameter) are commonly known as meteoroids, even though the Minor Planet Centre does not use the term. Finer particles are referred to as cosmic dust and micrometeoroids, some of which is found in the dust left behind by comets as they orbit the Sun. Hundreds of tonnes of the stuff intersect with the earth each day.

A micrometeoroid enters our atmosphere typically at speeds between 11 and 72 km/s (40,000 and 260,000 km/hr.), and it very quickly compresses air molecules as it encounters them converting its kinetic energy to heat energy. It doesn't take much energy to heat particles the size of a grain of sand to high temperatures; they will evaporate and the resultant atoms leave a visible train at an altitude of between 70 and 115 km above the surface of the Earth. A slightly larger object, at 10 cm and more, would produce a shock wave known as ram pressure that ionises the air leaving positive and negative ions in its wake.

The colour of the light from a meteor depends on its speed and composition and is a result of interactions between meteoroidal matter and superheated air molecules causing them to emit photons of certain specific wavelengths.

Violet (calcium)
Yellow (iron)
Blue-green (magnesium)
Orange-yellow (sodium)
Red (atmospheric nitrogen and oxygen)



Source: http://leonid.arc.nasa.gov/meteor.html

Some terminology;

A **meteor** is the flash of light derived from physical phenomena such as heat, shock or ionization that is seen in the sky when an extra-terrestrial body rushes headlong through our atmosphere. Meteors are what most people commonly think of as shooting, or falling stars. The term "meteor" comes to us from the Greek *meteōros*, meaning "high in the air" or "atmospheric". Meteors are known to occur in the atmospheres of other planets.

Sporadic meteors appear in the atmosphere travelling in any direction and are most often caused by meteoroids, which are tiny asteroids.

A **meteoroid** is an extra-terrestrial object measuring between 10 µm and 1 m in diameter. **Micrometeoroids** are fine particles less than 10 µm,. Both objects can found in the debris shed by a comet as it orbits the Sun.

A **meteoroid stream**, also known as a "**dust trail**", is the result of meteoroids spreading out along the entire orbit of its parent body.

A **meteoroid swarm** consists of any large number of meteoroids moving in resonant, parallel paths within a stream. Meteor swarms are not spread out evenly around their orbit.

Micrometeorites are the smallest extra-terrestrial objects which reach the ground, the largest are called **meteorites**.

The **path** is the trajectory of a meteor, as seen by an observer, projected on the celestial sphere.
The **radiant** is the region on the celestial sphere from which a meteor shower appears to emanate.
Zenithal Hourly Rates - ZHRs are the number of meteors in a meteor shower that would be seen under good seeing conditions with the radiant immediately overhead. The actual hourly rate observed depends critically on the altitude of the radiant at the time of observing, because we see less through the atmosphere at lower altitudes.
A **fireball** is a meteor with at least the same brightness as Venus at its best. The International Astronomical Union (IAU) specifies an apparent magnitude of −4 or greater.
A **bolide** has no IAU definition, but is regarded as a very bright (mag -14) fireball, especially if it breaks up.
Meteor trains: Some meteors, especially the faster and brighter ones, may leave a glowing ionization train along their trajectory, high in the atmosphere, for many seconds or minutes after they have disappeared. A **persistent train** can last up to an hour.
A **meteor shower** is a noteworthy fall of associated meteors appearing to arrive from a predetermined region of the sky, the radiant. They occur when the Earth passes through a meteor stream left by a comet in its elliptical path around the Sun. Meteor showers are named after the part of the sky, the radiant, from which they appear, and are usually best observed at 90° from the radiant.
A **meteor storm** or **meteor outburst** usually occurs only when the Earth intersects with the fresh meteoroid swarm from a large or dying comet. The hourly rate for these types of meteor showers can be higher than 10,000 visible meteors per hour!
The terms used in this field of science can be frustrating at first, but meteor observers are usually fussy about their use.

Photographing Meteor Showers;
Modern DSLRs can be very sensitive and can capture brighter meteors.
Best to find a site with low light pollution, and set the camera on a tripod with as wide angle a lens you have to cover as much sky as possible. Exposures of around 20 seconds will generally not be long enough for stars to leave trails but enough to capture meteors. Many DSLRs can be used for up to 30 second exposures, for longer than this use a remote shutter release and set the camera to "bulb". Set the ISO to about 1000. The camera is best pointed high in the sky to avoid light pollution and around 90 degrees from the radiant point. To make life easy it is possible to purchase intervalometers for about £15. These plug into your camera and can be programmed to automatically take pictures all evening. Compact cameras and camera phones are less good for this work as they tend to be noisier and not very sensitive owing to the small sensors. Longer exposures can be made if an equatorial mount is available to avoid the star trails. Longer exposures can then be used. Usually after a minute or so at most sites, light pollution starts to show limiting the exposure time. Some experimentation is called for.

Some meteor showers seen from the southern UK;
On an ordinary clear, Moonless night, when there is no meteor shower, about 10 sporadic meteors per hour streak through the heavens. Sporadic meteors appear in the atmosphere travelling in any direction and are most often caused by meteoroids, which are tiny, tiny asteroids. Some of these random meteors derive from ageless meteoroid streams or fractured asteroids that have diffused into random orbits eons ago.
The significance of a meteor shower or storm is that they originate from comets or less commonly asteroids, and at specific times in the year, appear from one part of the sky, and are therefore easier to observe. A good illustration of this can be found at;
https://www.meteorshowers.org/view/Perseids

Meteor Showers					
Name	**Maximum**	**Usual Limits**	**ZHR**	**Radiant**	**Speed km/s**
Quadrantids***	3 - 4 Jan	1 - 6 Jan	40 - 110	15h 20m +49°	41
Virginids*	11 - 12 Apr	Mar - Apr 6 -17 Apr	5	14h 04m -09° 13h 36m -11°	°24 - 49
Lyrids	22 Apr	18 - 25 Apr	10 - 15	18h 06m +33°	49
Eta Aquarids**	5 May	24 Apr - 20 May	45	22h 30m -01°	67
Delta Aquarids	29 July 6 Aug	15 Jul - 20 Aug	20 10	22h 36m -17° 23h 04m +02°	40
Perseids***	12 - 13 Aug	23 Jul - 20 Aug	75 - 100	03h 11m +58°	60
Orionids	21 - 24 Oct	16 - 27 Oct	25	06h 24m +16°	67
Taurids	5 Nov 12 Nov	19Sep-20Nov 20Oct-30Nov	5 - 10	03h 33m +13° 03h 54m +22°	21 29
Leonids***	17 - 18 Nov	15 - 20 Nov	15	10h 16m +22°	70
Puppid-Velids**	9 Dec	1 - 15 Dec	15	09h 00m -48°	40
Geminids***	13 - 14 Dec	8 - 17 Dec	100+	07h 33m +32°	35
Ursids	22 - 23 Dec	17 – 25 Dec	10 - 50	14h 28m +78°	35

* A very poor shower

** Poorly placed from the UK

*** Generally the better showers

A month by month list of some meteor showers which may be observed from the UK.

January

One of the best showers seen from the UK, the **Quadrantids** can be seen from 1st to 6th January. The Zenithal Hourly Rate (ZHR) varies between 40 and 110 and is at its best around about the 3rd or 4th, the peak only lasts a couple of hours. The radiant, in northern Boötes, is circumpolar and lies towards Alkaid the last star in the tail of Ursa Major, in a part of the sky that once contained a constellation called Quadrans Muralis; the Mural Quadrant! At about 40 km/s, these meteors are relatively slow, but brighten just after maximum with occasional green, yellow or blue hues. The Quadrantids' associated parent body is not known for certain, however, 2003 EH_1 is a contender.

February

February is a poor month for meteor showers, and it will be quite quiet until mid-April. Sporadic meteors can of course be spotted, but require much more patience to observe than do

showers because they are not associated with any one part of the sky. The **Virginids** are only just evident from February through to April, becoming a little better in March and again in April.

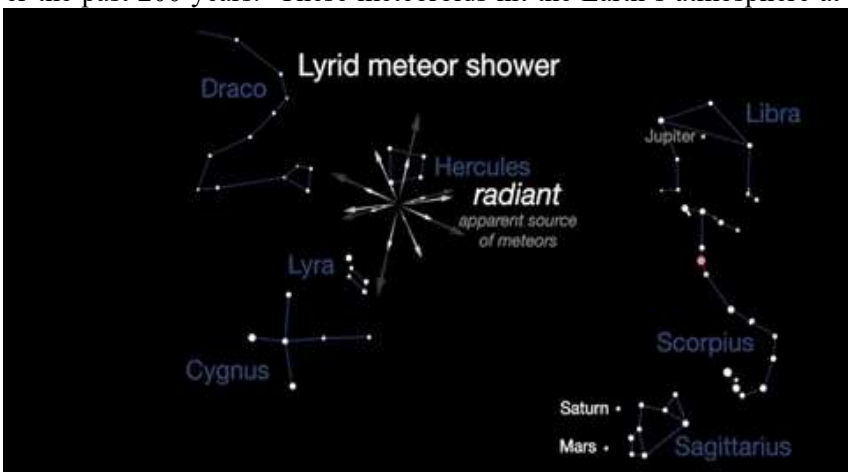
March

March is a poor month for meteor showers, and it will be quite quiet until mid-April. Sporadic meteors can of course be noticed, but require much more patience to observe than do showers because they are not associated with any one part of the sky, and from March until the end of June is the low season for sporadic meteors. The protracted tracks of the Virginids are only just evident from February through to May, but at 5 ZHR, become a little better around 20th in March (the March Virginids) and again in April. This series of defuse radiants moves slowly from Leo into Virgo during this time.

April

The first half of April gives us an opportunity to find meteors in Virgo. The Virginids, with an average fall rate of about 1 or 2 per hour, are not easy to spot. They are slow but bright meteors, emanating from near Spica with its maximum around the 11th and 12th.

The April **Lyrids** are seen from the 18th to the 25th of April. ZHR is about 10, and the peak lasts about two days. The radiant is on the border of Lyra and Hercules. The shower is associated with Comet Thatcher, and has been observed since about 500 BCE, although it has been getting less active over the past 200 years. These meteoroids hit the Earth's atmosphere at around 49 km/s, so some bright, fast meteors can be seen, some leaving vivid trains in their wake. The maximum occurs in the early morning of April 21st / 22nd, with a usual ZHR of about 10 to 15. Very occasionally the rates can be as high as 200, so it may be worth observing.



May

The **Eta Aquarids** are best seen between 1st and 8th May. ZHR is near 45 at around about the 5th. The radiant is in Aquarius. Associated with Comet P/Halley, the shower has been observed since about 74BCE. This shower varies in intensity in a cycle lasting twelve years or so with a ZHR between 35 and 80. Like Comet P/Halley, the shower travels in a retrograde direction and so these meteoroids hit the Earth's atmosphere at around 67 km/s and very fast meteors can be seen. The trails of some of these meteors persist in the sky for a longer time as a consequence. Unfortunately the shower rises with the morning twilight and seeing only lasts until the radiant is only about 10º above the horizon. This shower is more noteworthy in more southerly latitudes. However, look out for 'grazers', meteors that skim the upper atmosphere.

August

The **Delta Aquarids** can be seen from about 15th July to 20th August, but are not noted for their brightness, these meteoroids hit the Earth's atmosphere at around 40 km/s. There are two radiants to this shower. The southern stream is the richest, radiating from near the star Skat in Aquarius, it has a maximum around about 29th July. The ZHR is about 20 with a medium atmospheric entry velocity.

The **Perseids**, another good meteor shower, can best be seen between 9th and 14th August. This shower is noted for the higher percentage of bright meteors observed compared to

most showers. The ZHR is about 75 or more, and the meteors can be very fast; these meteoroids hit the Earth's atmosphere at around 60 km/s, with persistent trains, with a maximum at about 12th. The radiant is in the north of Perseus. The Perseids are associated with Comet P/Swift-Tuttle.

September

September is a poor month for meteor showers, but sporadic meteors are becoming more evident at this time of year through to the end of December. However sporadic meteors are, of course, not associated with any one part of the sky, and require much more patience to observe than do showers.

October

The **Orionids** can be seen emanating over the eastern horizon at about 11.00 pm between 16th to 27th October. With a ZHR around 25, the meteors can be very fast; these meteoroids hit the Earth's atmosphere at around 67 km/s, with persistent trains, with a maximum at about 21st. This is the second shower associated with Comet P/Halley, and has its radiant in the north of Orion. At this time of year Orion rises very early in the morning.

November

The **Taurids** are seen emanating over the eastern horizon at sunset in the east for a protracted period. It is thought that some tens of thousands of years ago a large comet fragmented, and spread out along its orbit, producing Comet P/Encke and the broadest meteor stream in the inner solar system.

Meteoroids from this stream tend to be 5 cm pebble-sized, hitting the Earth's atmosphere at around 30 km/s, producing slow but brilliant meteors or fireballs. Larger fragments may produce bolides. Its two radiants lie between Taurus and Aries near the Pleiades and Hyades, with a ZHR between 5 & 10 and are best observed around midnight.

This shower peaks twice; the **Southern Taurids** are active from about September 10th to November 20th peaking around early-November.

The **Northern Taurids** are active from the 20th October to 30th November, peaking in the first half of November. This shower may well be associated with minor planet 2004 TG_{10}.

The **Leonids** can be seen emanating over the eastern horizon at about 11.00 pm from the 15th to 20th November. Its maximum is around the $17^{th}/18^{th}$, with a ZHR of about 15. The Leonids hit the Earth's atmosphere at around 70 km/s and can provide very fast, magnificent displays, with persistent trains from its radiant around the neck of Leo. They are associated with Comet 55P/Tempel-Tuttle which has an orbital period of about 33 years. Consequentially, the Earth intersects a meteor swarm from Tempel-Tuttle with some regularity. Storms were observed in 1933 and 1966 with a lesser event in 1998.

December

The maximum of the **Puppid-Velids** meteor shower occurs in the morning of December 9th. With a ZHR of about 15 per hour, this particular meteor shower may only be visible to those far enough south to see the constellation of Puppis. Viewing will be possible all night long although Puppis is highest in the south after 2:00, and most of the meteors are faint and the radiant is very low, this shower is known to produce an occasional fireball.

The **Geminids**, one of the most hauntingly beautiful displays of celestial fireworks, are associated not with a comet but another type of small solar-system body; an asteroid called 3200 Phaethon, which may well be an extinct comet. The shower can be seen from the 8th to 17th December with a ZHR around 50 to 120 on about the 13th. It is generally the most splendid shower of the year, and can be rich in fireballs, though most are slow meteors since the meteoroids hit the Earth's atmosphere at around only about 35 km/s. The radiant is near Caster in Gemini.

The **Ursids** are associated with Comet 8P/Tuttle, and can be seen from the 17th to 25th December. The Ursid meteoroids hit the Earth's atmosphere at around only 35 km/s and the shower is quite weak with a ZHR about 10 and in some years occasionally about 50. The

maximum is on about the 22nd from a radiant near Kochab in Ursa Manor. Many people are quite preoccupied at this time of year and Christmas light-pollution makes observations of the Ursids less numerous than others.