Newbury Astronomical Society

The Perseid Meteor Shower

RAL Stargazing 6th August 2021

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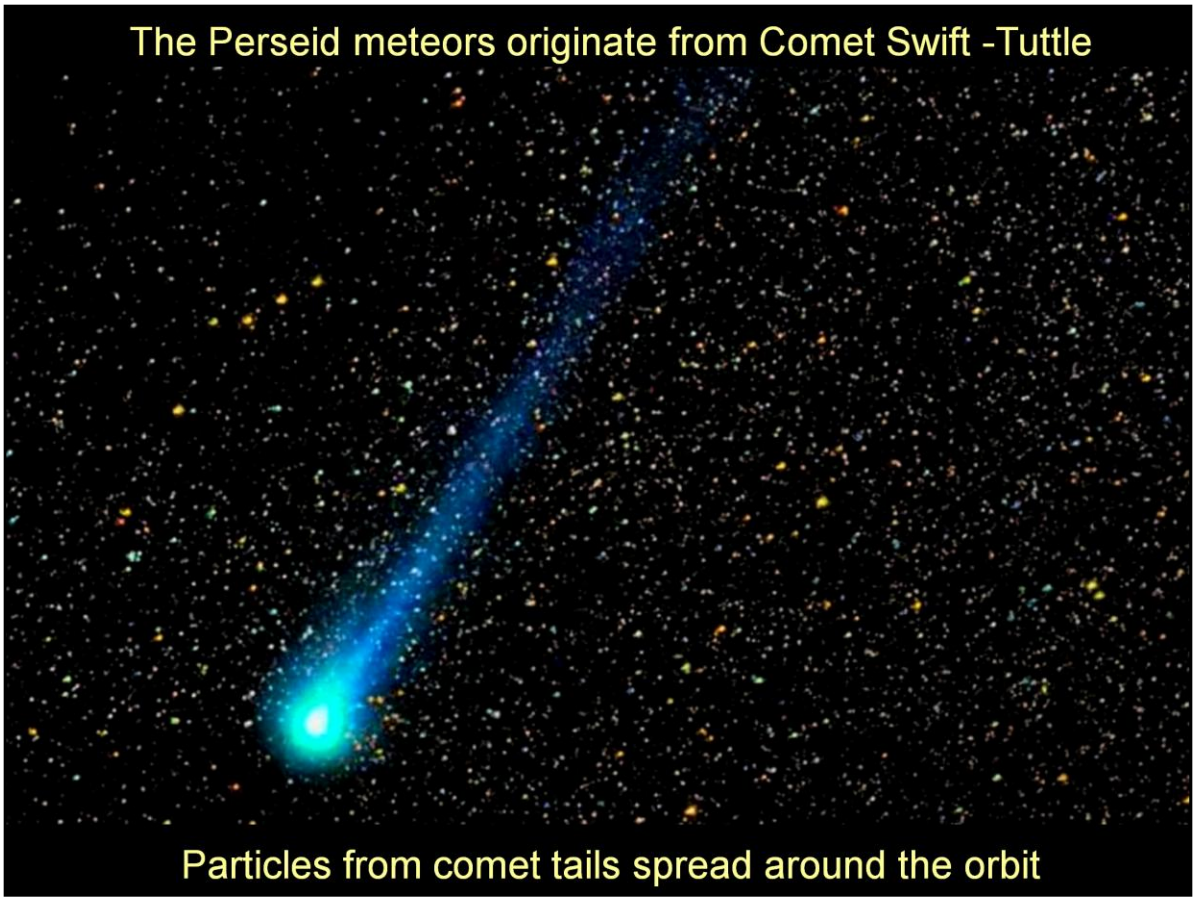
On any clear night if you sit back and look up into the night sky for a while you will more than likely see a streak of light speed across the sky - this will be a METEOR or shooting star. It is not a star at all it is just a small speck of dust known as a METEOROID entering the Earth’s atmosphere at very high speed. Just as the space shuttle or other space craft become very hot as they re-enter the atmosphere at about 30 thousand km/h. However these dust particles get even hotter at their re-entry speed of up to 270 thousand km/h. At this speed the dust is vaporised by the heat and the surrounding air is also heated until it glows in a similar way to a fluorescent light.

A comet is a lump of ice mainly comprised of water ice with frozen Carbon Dioxide (CO_2) as the second largest constituent. It will also have traces of many other frozen gases and dust particles from the nebula (cloud of gas and dust) in which the Sun formed. When the comet is in the outer reaches of the Solar System it does not have a tail and resembles our much closer neighbours the Asteroids. A solid lump of material that has the close encounter with the Sun is called the Nucleus and is typically around 3 to 30 km in diameter.

As the comet nucleus approaches the Sun the frozen gases begin to sublime (melt directly into gas and not form a liquid) and form a cloud around the nucleus called the ‘Coma’. Between the orbits of Jupiter and Mars is the point when the Carbon Dioxide (CO_2) on the surface begins to sublime. As the comet moves across the orbit of Mars there is enough heat from the Sun to sublime the water ice into the coma.

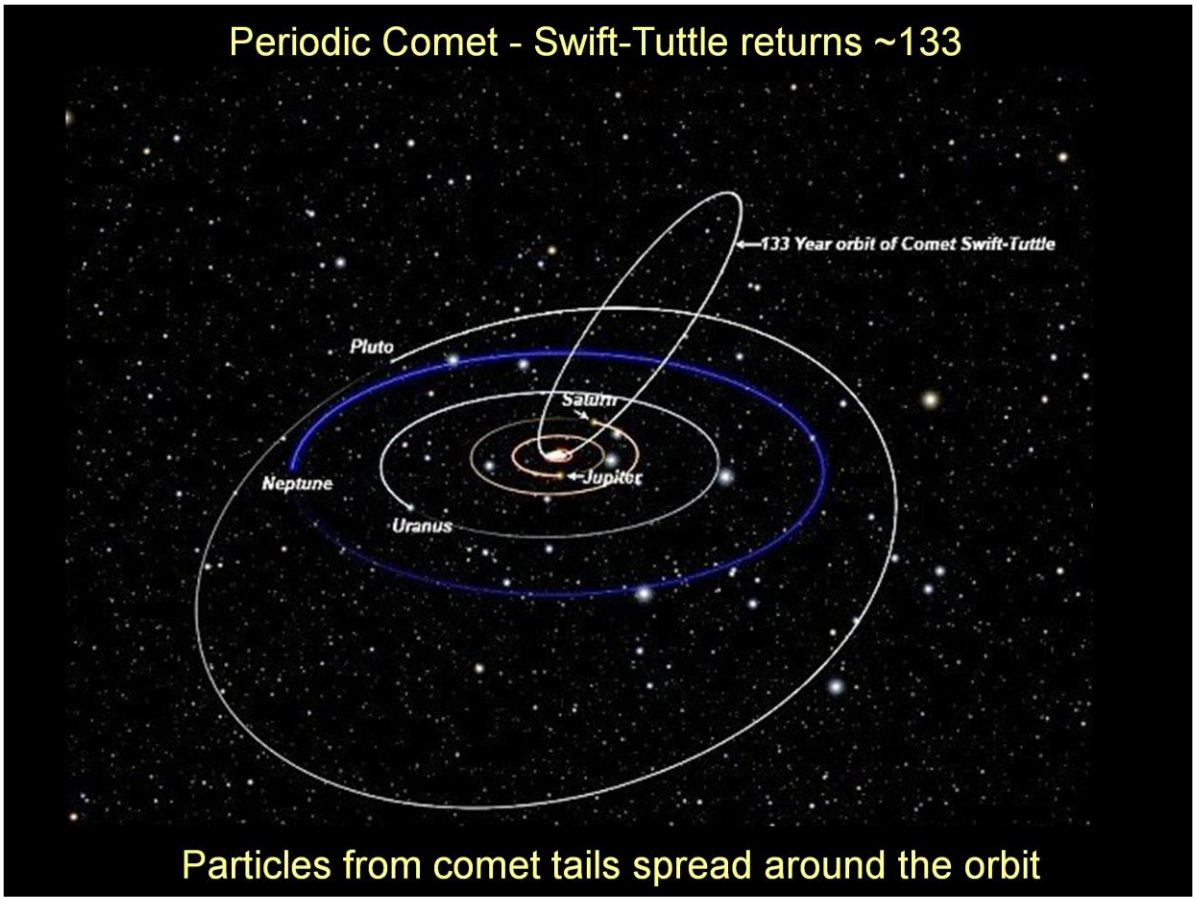
The coma of a comet is extremely tenuous but may be very large, often over 100,000 kilometres in diameter. As the comet approaches the orbit of Mars the radiation from the Sun will begin to sweep the material of the coma into a long tail that trails away from the Sun. When the comet has looped around the Sun and is moving back to the outer Solar System the tail will still point away from the Sun (in front of the nucleus/coma).



Every year, from around July 17 to August 24, our planet Earth crosses the orbital path of Comet Swift-Tuttle, the parent of the Perseid meteor shower. Debris from this comet litters the comet's orbit, but we don't really get into the thick of the comet rubble until after the first week of August. The bits and pieces from Comet Swift-Tuttle slam into the Earth's upper atmosphere at some 210,000 km (130,000 miles) per hour, lighting up the night time with fast-moving Perseid meteors.

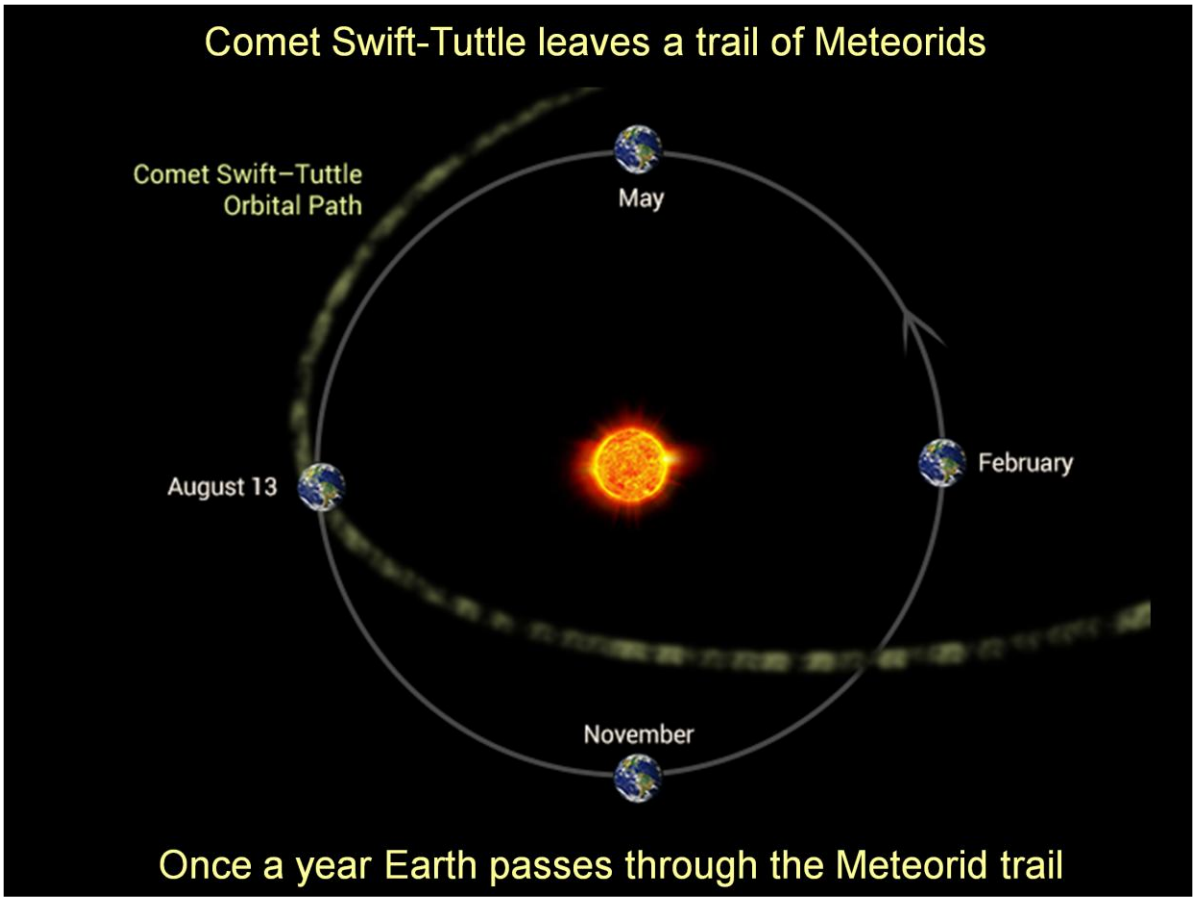
Comet Swift–Tuttle is a large periodic comet with a 1995 (osculating) orbital period of 133 years that is in a 1:11 orbital resonance with Jupiter. It fits the classical definition of a Halley-type comet with a period between 20 and 200 years. It was independently discovered by Lewis Swift on 16th July 1862 and by Horace Parnell Tuttle on 19th July 1862.

It has a comet nucleus 26 km in diameter. The comet made a return appearance in 1992, when it was rediscovered by Japanese astronomer Tsuruhiko Kiuchi and became visible with binoculars. In 2126 it will be a bright naked-eye comet reaching about apparent magnitude 0.7.



Comet Swift-Tuttle has a very *eccentric* (elliptical) orbit that takes this comet outside the orbit of Pluto when farthest from the sun, and inside the Earth's orbit when closest to the sun. It orbits the sun in a period of about 133 years. Every time this comet passes through the inner solar system, the sun warms and softens up the ices in the comet, causing it to release fresh cometary material into its orbital stream.

Comet Swift-Tuttle last reached *perihelion* (closest point to the sun) in December 1992 and will return again in July 2126.



The particles from Comet Swift-Tuttle become spread around the comet's orbit to form an elliptical ring around the Sun. From late July to mid August Earth passes through this trail of particles. Earth passes through centre of the trail of the comet rubble during the second week of August. As Earth moves around its orbit at 60,000 km/h it crashes into the particles left from Comet Swift-Tuttle. These particles slam into the Earth's upper atmosphere at a combines speed of about 210,000 km (130,000 miles) per hour.

At such a high speed the particles are heated enough to vapourise and streak across the night sky as fast-moving Perseid meteors.

The particle stream shown on the diagram above is drawn with lighter and darker patches, this is to demonstrate that the particles in the stream are not evenly distributed around the orbit. They are often formed in wisps so we can sometimes see a very intense period meteors that can occur at almost any time.

How Earth collides with meteoroids

Driving into a snowstorm

Meteor shower 'Radiant'

Meteors appear to radiate from the direction that Earth is travelling
Earth can collide with a Meteoroid at up to 270,000 km/h
Kinetic energy increases by V(velocity)² (V x V)
$E = m \times V^2$

Meteoroid dust particles are usually small and very light and generally have the consistency of cigarette ash but will be travelling very fast (>50 km/sec.). As Earth ploughs into the stream of meteoroids they appear to enter the atmosphere at a single point in the sky. This point is in the direction that Earth is travelling along its orbital path. The meteors will appear to radiate out in all direction from this point, very much like driving a car into a snow storm, see the images above.

Travelling at these enormous speeds the tiny particles carry a huge amount of energy. The amount of energy held by the speeding particle is expressed by the equation $E = mV^2$ where E is the Kinetic Energy (energy due to speed), m is the mass (weight) of the particle and V is the speed it is travelling.

The energy increases by the speed squared (V^2) that is velocity x Velocity.

This means if the particle travels twice as fast V^2 is (2 x 2 = 4)

Then at 4 times as fast the energy is increased by 4 x 4 to16 times the energy.

At 8 times faster the energy is increased by 8 x 8 to 64 times the energy.

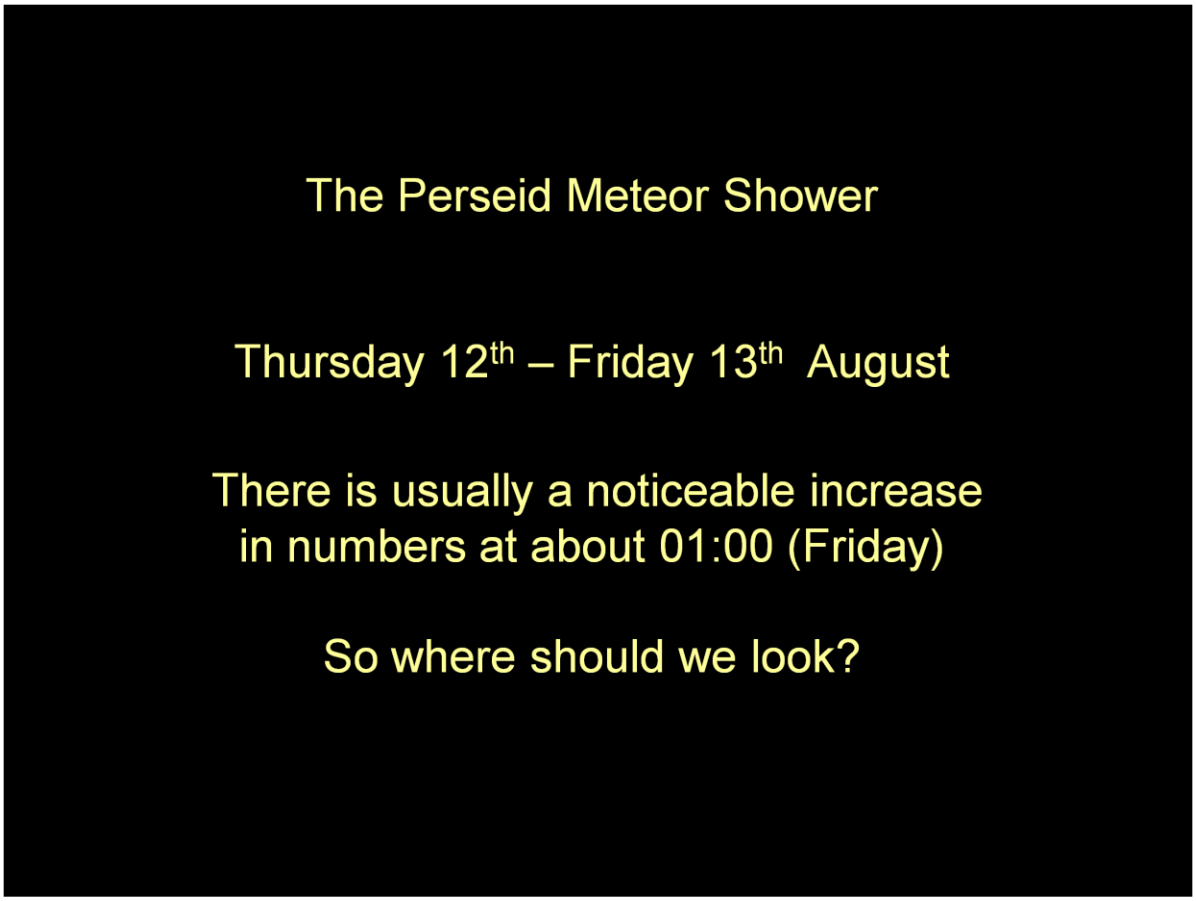
So we can see that at the enormous speed of a meteor dust particle it carries enormous amounts of energy when it hits our atmosphere.

Meteor Terminology

Meteoroid – The dust particle moving through space

Meteor – The streak of light seen when the particle burns up

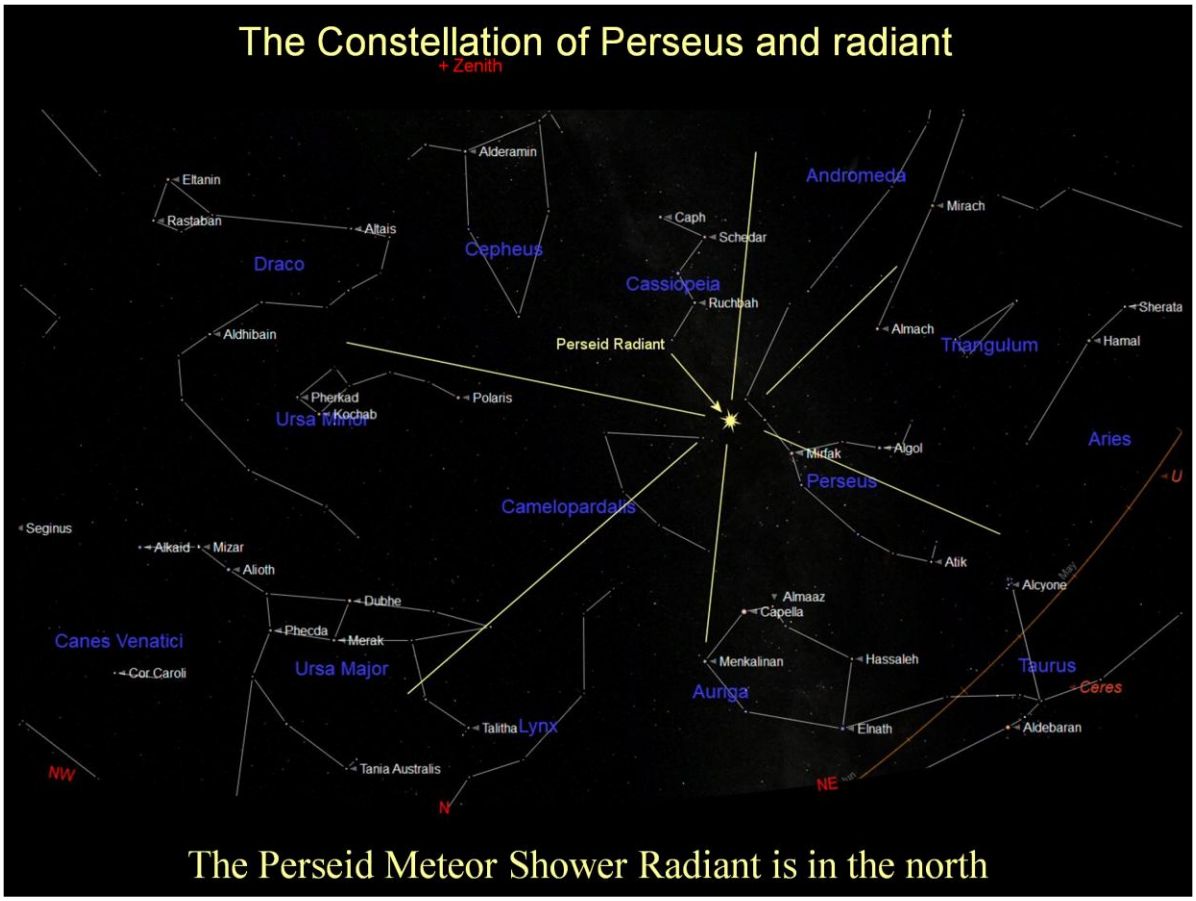
Meteorite – A large particle that hits the ground



Although the Persied Meteor Shower can be seen from July 17th to August 21st there is a noticeable increase in activity from about 10th August to 15th August.

There is often an even more noticeable peak of activity on the night of 12th and early morning of 13th August. The very best time to look for the meteors is around 01:00 BST (00:00 GMT) in the morning of 13th August (midnight).

This is because it is the time when the dark side of Earth is ploughing into the centre of the Perseid particle stream.



The meteors of the Perseid shower appear to radiate from a point in the sky that is called the ‘Radiant’. The meteors of this particular shower appear to originate from a ‘Radiant’ point in the constellation of Perseus so this is why they are called the Perseids. See the chart above.

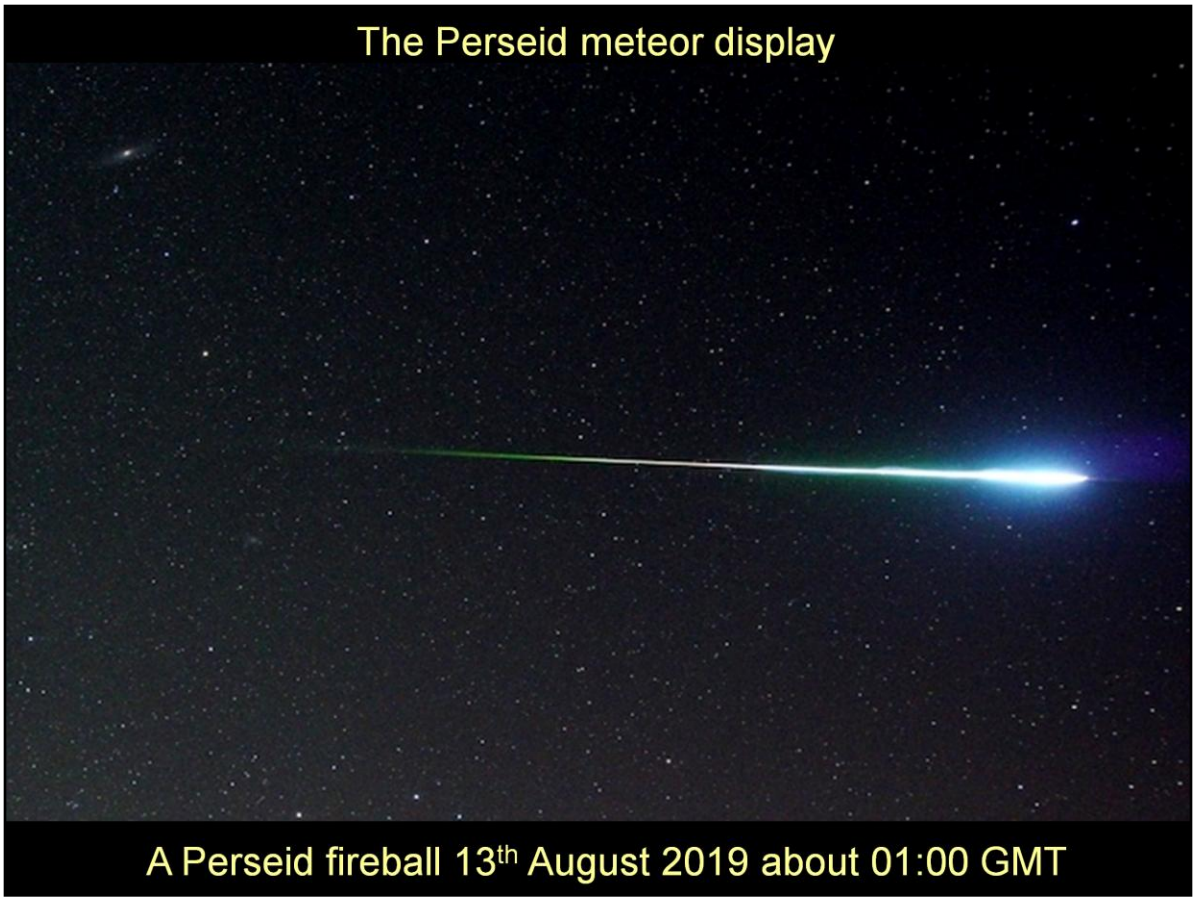
If the trail of any meteor that is seen can be tracked back and found to have originated from this radiant point it will be a Perseid. A few meteors might appear to originate from other directions so these are the meteors that might be seen randomly and not part of the Perseid or any other named shower. These are known as Sporadic Meteors.

From a clear dark site, the constellation of Perseus can be clearly seen as a line of tars stretching from the very distinctive ‘W’ shape of Cassiopeia and down towards the bright star Capella. The brighter stars of Perseus appear to mark out the rough shape of a horse riding spur.

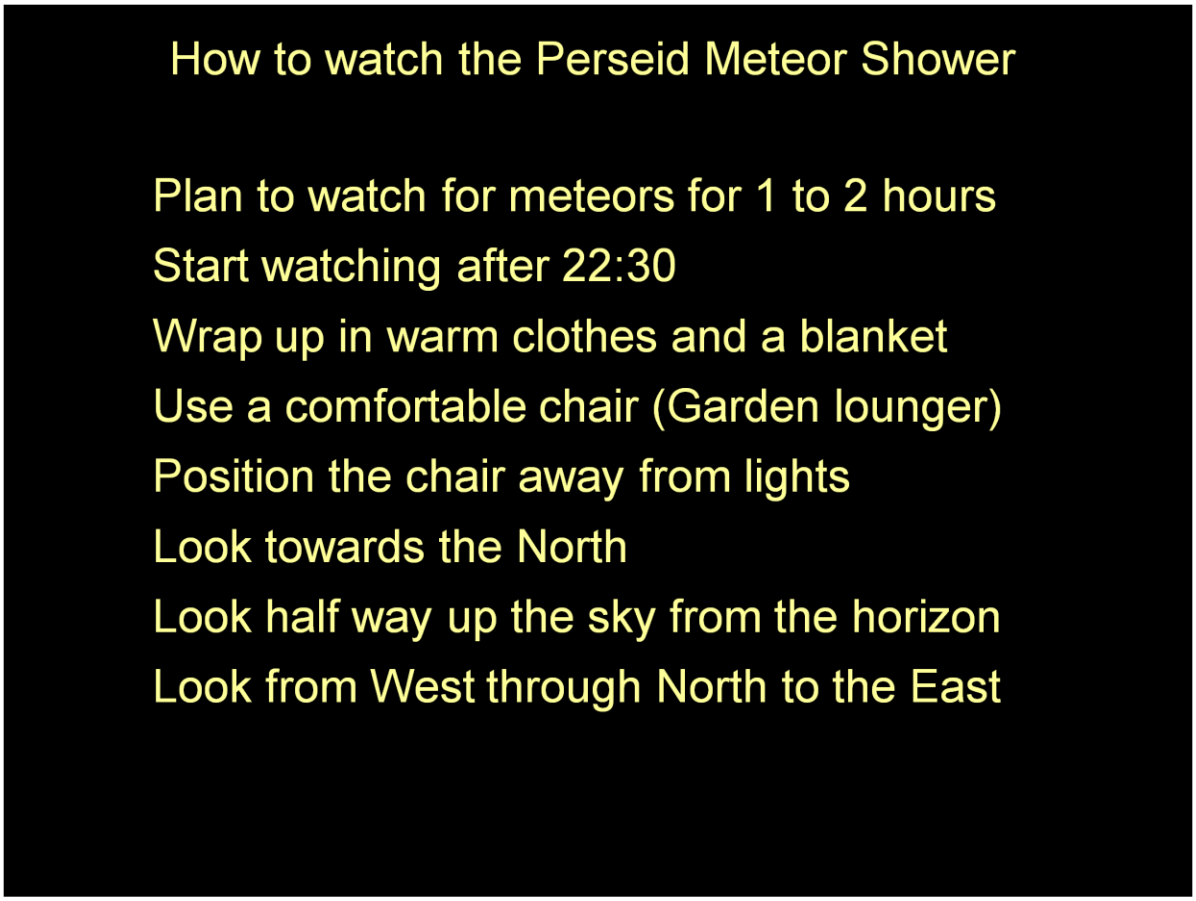
If the sky is clear the Milky Way (our galaxy) can be seen rising up from the northern horizon passing through Perseus, Cassiopeia and right across the sky though Cygnus and the Summer Triangle. The bright star Capella in the constellation Auriga will be twinkling noticeably close to the northern horizon.

Some meteor observers choose to image the meteor shower. This can be done by setting the camera up to continuously take pictures of the sky. A wide angle lens is used to capture as many meteors as possible.

A really good thing to do is the combine all the frames that have captured a meteor into a single frame. This will reveal the Radiant Point of the shower as shown in the image above.



The Perseid Shower can include some very bright and spectacular meteors like the example shown above. Even meteors like this one are created by a small particle that was not any larger than a pea. These are far too small to penetrate our atmosphere a reach the ground as a Meteorite.



It is best to look away from the Radiant Point in the sky because any meteors travelling directly towards us will appear foreshortened. So look to either side or above the Radiant Point where the meteors will appear longer.

Our eyes are very good at catching things move within our wide field of view so we do not need to scan the whole sky. Just look about half way between the northern horizon and directly overhead. If you wish, change your view slowly from time to time to look more to the North West or North East. After a few meteors we soon get used to spotting them.

It is more fun to watch meteors in a group. It can also be more exciting to take turns recording the track of meteors on a chart or just note paper while the others call out the details of their sightings.

Remember the only thing that is predictable about the shower is that the shower will be unpredictable.

This presentation is available

(with notation) on the:

Beginner's Website: naasbeginners.co.uk