Understanding and Observing Meteors, Aurorae and Noctilucent Clouds

While it is commonly thought that telescopes or other optical aids are necessary for astronomy, there are some types of objects that are best seen with the unaided eye. This brochure will introduce you to three phenomena that require no optical aid to be seen well, and unlike many astronomical phenomena which happen at great distances from the Earth, all three occur within the Earth's tenuous upper atmosphere and allow you to conduct real science with your observations. Best of all, all three can be part of a single observing evening!

Meteors

A meteor, falling or shooting star is the name for the thin, rapidly moving, streak of light seen in the sky. The source of this light is incandescently-glowing meteor material (a meteoroid) and gases in our atmosphere that were heated by the meteoroid's high speed (11 to 74 km/s) entry into the Earth's atmosphere. When a meteor burns, it leaves a trail of smoke and atoms of metal. A typical meteor is caused by a sand-sized grain and is visible at 120 to 80 km altitudes. Occasionally, larger objects (fireballs) may be seen down to about 20 km above the Earth's surface. Note that a meteor is distinct from a meteorite – a rock that has landed on Earth after travelling through space. All meteorites were likely fireballs during their passage through the Earth's atmosphere.

When a swarm of dust to sand-sized particles in orbit around the Sun collides with the Earth's atmosphere, the result is a meteor shower. Each swarm represents material ejected from a single parent object, typically a comet. Meteor showers normally last for several days or even weeks, but commonly have a shorter peak in which the rate of observed meteors is highest.

Since meteors in swarms travel along similar orbits, their paths are almost exactly parallel. During a meteor shower, these parallel paths appear to converge in the distance at a single point called the *radiant*. Individual meteors do not have to start in their named radiant constellation. Instead, trace the line of a meteor backwards across the sky. If that line approaches the radiant then you probably have observed a shower member. If the imaginary line does not go near the radiant then you have observed a non-shower meteor.

Meteor watching is one of the easiest and cheapest forms of astronomy. All it takes is patience, a lounge-style lawn chair, warm clothing and a blanket or sleeping bag. The best time to observe is during the hours after midnight because the radiant of most showers will be fairly high above the horizon then and also because by then you'll be on the Earth's leading side as it sweeps across the Solar System. The hour or two before dawn is typically best.

Choose a dark site with an open view of the sky. No buildings or trees should block your view except perhaps at the very edges. Ideally, they should block no more than 20 percent of your view, otherwise the uncertainty in the calculated correction factors become too large for the resulting data to be reliable. Watch the sky at least 50° up from the horizon, choosing a direction away from the radiant. Bring a watch or clock and a dim, red-filtered flashlight to read by. Make notes with a clipboard and pencil.

The simplest project is just to count the number of "shower" (S) and "non-shower" (NS) meteors that you see. Later, split your observations into periods an hour long, giving the beginning and end to the nearest minute. You may wish to use shorter periods if the radiant was low during your observations, as certain calculations are very sensitive to radiant elevations near the horizon. As well, Quadrantid and the Leonid meteor showers' intensities changes sharply with time. For each period, add up the number of shower and non-shower meteors you observed. List the numbers of each type of meteor at each brightness level if you made notes on this detail. One of the most enjoyable ways to collect data is to draw meteor paths on a star map and to interpret the position of the radiant. Although, most radiant positions are pretty well mapped, sketching forces you to really observe closely.

The table below lists the major annual meteor showers for northern hemisphere observers. The Quadrantids are named after an obscure and now defunct constellation between Ursa Major and Hercules. The η (Eta) Aquarids' radiant is always low in the southern part of the sky so this shower is better for observers in southern parts of the country.

Shower	Start	Peak	End	Max Rate	Comments
Quadrantids	Jan 1	Jan 3	Jan 6	90	brief maximum
Lyrids	Apr 19	Apr 21	Apr 25	15	fast, some outburst years
Eta Aquarids	Apr 21	May 4	May 20	50	very fast, fireballs after peak
Perseids	Jul 25	Aug 12	Aug 20	100	fast
Orionids	Oct 15	Oct 21	Nov 2	20	very fast
Leonids	Nov 15	Nov 17	Nov 20	20+	71 km/s, comet Tempel-Tuttle, some outburst years
Geminids	Dec 7	Dec 14	Dec 15	95	slow

Fireballs

Sometimes you are lucky enough to see a very bright meteor – a fireball. Electronic fireball reporting forms can be found at:
Meteorite and Impact Advisory Committee:
miac.uqac.uquebec.ca/MIAC/fireball.htm
or e-mail: fireball@mta.ca

Aurora

The aurora is a beautiful luminous display of various forms and colors in the sky. Aurorae occur in two luminous ovals roughly centered on Earth's north (aurora borealis, "northern lights") and south (aurora australis, "southern lights") magnetic poles. Because auroras appear during geomagnetic storms, when the Earth's magnetic field is subjected to a gust in the solar wind (charged particles flowing from the Sun), they most often occur during the equinoxes and at times of great sunspot activity.

The magnetosphere, a magnetic 'bubble' around the Earth, traps charged particles. The impact of a solar wind gust knocks loose some of those trapped particles which then rain down on Earth's atmosphere where they cause the air to glow where they hit - like the picture tube of a color TV. Electrons colliding with oxygen atoms high in the atmosphere (up to 250 km high) produce a very bright yellow-green light. In the lower atmosphere, there are more ionized nitrogen molecules. Therefore, the lower edge of the Aurora (down to 80 – 100 km) can be mostly red and blue.

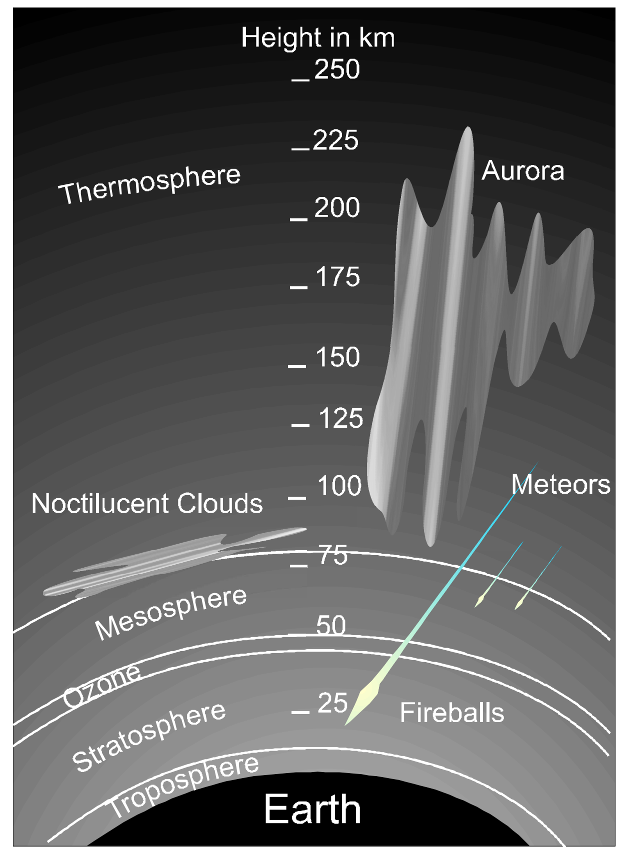
Noctilucent Clouds (NLC)

Noctilucent or "luminous night" clouds are high atmosphere cloud formations thought to form when rising water vapor condenses on meteoric particles filtering down from space. At about 82 km above sea level, they are completely separate from normal weather or tropospheric cloud, which tops out at about 11 km.

NLC's are only visible against a twilit sky background when the clouds occupy a sunlit portion of the Earth's atmosphere and the Sun lies between 6 - 16 degrees below the horizon. These clouds are never seen in the daylight. Generally, NLC will be seen close to the northern or sunward horizon, perhaps extending to around 15 - 20 degrees above the horizon, along the twilight arch. They can be more extensive (on rare occasions encroaching the equator ward half of the sky) close to dusk and dawn when the solar illumination is at its most favourable. Normal visibility limits for northern hemisphere observers are from mid-May to Mid-August with the weeks closely centered on the summer solstice being the best. They are most often seen from locations that lie between Latitude 50 and 60 degrees in both hemispheres.

NLC are best seen with the naked eye, though binoculars come in handy to nab some of the fainter clouds. They are very tenuous in nature and appear as complex interwoven streaks or knots of cloud. Colour is generally white or a distinctive pearly-blue tone, sometimes with a golden lower edge. Structure is reminiscent of daytime cirrostratus.

NLC forms are classified into 4 easily identified structures types, plus a group of complex structures. Type 1 or veil is a simple sheet, sometimes as background to other forms. Type 2 forms are lines or streaks, parallel or crossing at small angles. Fine herringbone structure like the sand ripples on a beach at low tide is characteristic of type 3 NLC. Type 4 structures are large-scale looped or twisted structures. There are also complex structures that do not fit into these classes.



Summary

These projects not only represent a cost effective way to get into astronomy, they are also an opportunity for amateur astronomers wishing to make a significant contribution to science, with only a modest investment of time and energy. There is the added bonus of actually witnessing an NLC, auroral or meteor storm. More information on the topics covered in this brochure is available in the *Observer's Handbook*, which is included with your membership in the Royal Astronomical Society of Canada.

Find out more

To learn more about the Royal Astronomical Society of Canada or membership in the Society contact your local Centre or the Society's National Office:

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