

## STEM advent podcast

Winter is a great time of year for star gazing, the evenings are longer and darker and the winter skies have some of the brightest and most beautiful constellations. In this session we will look for some of the main constellations for December and January. We will look for a few bright planets, learn how to meteor watch and look back in time 2½ million years.

On the evening of the 13<sup>th</sup> to 14<sup>th</sup> December we have the annual Geminid meteor show to look forward to, but more of that shortly.

Before we start there are a few tips that will help you to get the best out of your star gazing activities. Firstly make sure you stay warm. When you stand under a clear sky your body loses heat much more quickly than under a cloudy sky so wear a hat and wrap up well. To see the stars at their best you will need to allow your eyes to adapt to the darkness. This takes at least 10 to 15 minutes, you will then be able to see much fainter objects. Exposing your eyes to light after they are adapted very quickly undoes the adaptation, so avoid using torches or phones while observing. You can use a red torch however as your eyes do not respond in the same way to red light.

Plan what you are going to look at before you go out, you could for example listen to this recording and check out the star chart indoors in the warm. You will be better prepared on what to look for when you do go outside.

When you start an observing session start by facing south. If you get into a habit of doing this you will always be orientated the same way and will not get confused, after all you would not try to read a book or a map when it was upside down and the sky is no different. Take your time when looking at the stars and the patterns they make. Your brain needs time to absorb information and remember practice makes perfect. You will find it hard to remember everything the first time you see it but the more you look the more you will see and the more you will remember.

Above all enjoy yourself; an understanding of the night sky is a wonderful skill to have that you can enjoy forever.

Lets start with the solar system. Our solar system consists of the Sun, the 8 planets and numerous dwarf planets and the asteroids and comets. If you are observing in the middle of December find the direction from where you are standing that is south west and a place where you can see almost down to the horizon, the lower the better. Now watch for when the sun sets, in mid-December that is around 4 pm so look out about 45 minutes later or about a quarter to five. Very low in the south west you should be able to see what looks like two exceptionally bright stars very close together. In fact they are not stars but Jupiter and Saturn. When they get close to each other like this astronomers call it a conjunction. On December the 21<sup>st</sup>, which is the winter solstice when the Sun is at its lowest during the day, the planets will be the closest they have been since 1623, only 14 years after Galileo made his first telescope. Some people believe that such a conjunction around 2000 years ago was the origin of the story of the star of Bethlehem but that is quite debatable.

A bit later in the evening, say around 7pm go out and look south and quite high in the sky. You will not be able to miss what looks like a very bright orange coloured star. Look at any other bright stars around you will probably see they are twinkling, but the orange one is not. That is because it is the planet Mars. Stars twinkle because they are so far away to us they are tiny points of light. Even the most powerful of telescopes cannot see them as anything more than dots. Any turbulence in the atmosphere can easily deflect the light

causing them to twinkle and shimmer. In a telescope a planet is a disc and it is much more difficult to deflect and diffract the light so the planets do not twinkle. Mars is presently moving away from the Earth in its orbit, earlier in the year it was much brighter but it is still a beautiful sight. In mid-December the planet is about 110 million kilometres away but in October it was only about 63 million kilometres away. The red colour of the planet is caused by iron oxides on the surface, rust basically. These minerals reflect the red light from the Sun and give it its colour. Looking at it even with a small telescope will show an orange disk with shadowy areas. These are rocky deserts and the lighter parts sandy deserts. Mars has a similar length of day to Earth at 24½ hours although its year is almost twice as long at 687 days. It is really cold there with an average temperature of less than -60 Celsius but it can get as warm as 20 Celsius at midday near the equator. It has a very thin atmosphere made mostly of the gas carbon dioxide. On Earth our atmosphere and clouds provide us with a sort of blanket that protects us from the cold of space, that's why you need a hat on a clear night. Mars does not have that protection so has huge changes in temperature. Scientists believe it may have had oceans of water on its surface billions of years ago that have long since evaporated into space. Still in our solar system, if you look out on the evening of the 13 to 14<sup>th</sup> December and also the following evening you should be able to see shooting stars or meteors to give them their proper name. Meteors are produced by small pieces of grit usually left behind after a comet has crossed the path, or orbit, that the Earth takes through space at some time, possibly thousands of years ago. These meteors are a bit of an exception. It appears that they were not left behind by a comet but by an asteroid called Phaeton, that has an orbit that takes it very close to the Sun. 2020 is a very good year for looking for these meteors because they are falling on Moonless nights, a bright Moon can hide the dimmer meteors. The name of these meteors is the Geminids. Meteors are named after the constellations in the part of the sky that they appear to come from. In fact they are not really coming from Gemini, it is the same effect you get when driving a car in snow at night. The snow appears in the headlights to be coming directly towards the windscreen horizontally but we know it is really falling vertically from the sky. In the case of the meteors it depends on the time of year and therefore the direction the Earth is travelling in its orbit around the Sun. To see the meteors you do not have to look at Gemini, you can look anywhere in the sky, it is just that the direction of flight will seem to have come from Gemini. On the 13<sup>th</sup> December Gemini rises in the East at about 6pm and slowly moves towards the south through the evening, so the meteors should appear to come from the east and later from the south east. The best way to see them is find a comfortable spot in a chair that allows you to easily look up and just wait and be patient. You should expect to see a meteor every few minutes. The Geminids are amongst the brightest and most plentiful of the year's meteor showers so well worth looking out for. Although you can see them all evening the most plentiful time is after midnight in the early hours of the 14<sup>th</sup> of December.

Now we will leave the solar system and look for the furthest object you can see by eye without binoculars or a telescope. This object is so far away that we will be looking back in time 2½ million years, because that is how long the light has taken to reach us. A light year is used by astronomers to measure distance, it is the distance that light travels in one year. We could use kilometres or miles but the numbers would be huge, for example 2½ million light years is 24 million, million, million kilometres or 24 followed by 18 noughts! By comparison the Moon is only about 1.3 light seconds away and the Sun about 8.3 light minutes.

We are going to look for the Andromeda Galaxy. First we need to find some constellations to guide us, you may find the accompanying star chart to this recording will help you find

your way. You can also use a phone app but you must set the screen to its lowest brightness in order to protect your dark adaptation, using clear red acetate over the screen can help a lot, you can find it easily online as florists use it to wrap flowers.

We are first going to look for the square of Pegasus. Pegasus was a mythical winged horse but unfortunately the constellation looks nothing at all like a horse, instead it is a big square. In the middle of December look for the planet Mars again, then look a bit higher in the sky and a bit to the right. You should be able to see a large square of 4 stars, there are hardly any stars inside the square. That is the square of Pegasus. It is quite distinctive and worth remembering for the future as it is a good sign post to other constellations. Now look at the bright star in the top left corner of the square, it the brightest of the 4 and called Alpheratz. It is about 97 million light years away, which is relatively close in astronomical terms. Now move your eye a bit to the left and you will see another dimmer star then move left again and come to a second star that is about as bright as Alpheratz but a bit more yellow, this star is called Mirach. Both Alpheratz and Mirach are in the constellation of Andromeda. Now next instead of moving left look for a star just above Mirach which is quite a bit dimmer when you have found it look for an even dimmer star just above that. When you have found it look very carefully and if your eyes are nicely dark adapted and it is a good clear night you should be able to make out a small fuzzy patch close to it and slightly above. If you cannot see it at first keep looking it is there, binoculars show it very easily. You are looking at the Andromeda galaxy and how it looked 2½ million years ago.

All the stars you can see in the sky are in our local part of our own galaxy called the Milky Way and mostly 10s or hundreds of light years away. The Andromeda galaxy is out in intergalactic space. This was not understood until 1923 when an astronomer called Edwin Hubble managed to observe a particular type of star in the Andromeda galaxy using the world's largest telescope at the time at Mt Wilson in the USA. This star allowed him to estimate the distance to the Galaxy and to confirm that it was not part of the Milky Way. The Hubble Space Telescope that was launched in April 1990 was named in his honour. The Andromeda galaxy is about twice the size of our Milky Way and contains around a million million stars. It is our closest intergalactic neighbour and the two galaxies are moving towards each other at around 400 thousand kilometres per hour, but don't worry it will still take them another 4 billion years to collide. Even when they do collide they will sort of pass through each other like smoke rings and eventually merge.

Hopefully you have managed to find Pegasus, Andromeda and its galaxy and perhaps a few meteors as well. The stars, galaxies and meteors are around in the same place every year but the planets will be in different positions next year as they move around the Sun. Learning to star gaze is a skill that does need a bit of practice but you will quickly find it easy to locate and identify the constellations and other objects and build on what you have learned.

I hope you have enjoyed this session, thanks for listening and keep looking up!

Nick Busby November 2020