Astronomy Section
Bulletin

September to November 2024

Astronomy Meetings for September to November

A couple of members have asked if it is possible to start the Tuesday evenings a little earlier in the winter. So, we will be opening at 7.30pm and starting the talks at 8.00pm for the remainder of the year. Please note: the first talk is on a Wednesday and starts at 6.50pm.

Wednesday 11th September live online lecture at 6.50pm

A Mirror in the Sky by Professor Chris Lintott

The Hubble Space Telescope is the most famous astronomical instrument of all time. A project more than forty years in the making; Hubble overcame an initial disaster with a misshapen mirror to provide us with iconic views of everything from a comet crashing into Jupiter to the surprisingly active very distant Universe. This lecture tells its story – and explains what Hubble has revealed about the life of stars, and our own cosmic origin.

Professor Chris Lintott is a Professor of Astrophysics at the University of Oxford, and a Research Fellow at New College. He is perhaps best known to the public as a presenter for the BBC Sky at Night program.

The lecture starts at 7pm and will last for about 1 hour. If you wish to have a drink while listening, come along a little earlier.

This would be a suitable lecture children.

Please note: This is a Wednesday evening and not the usual Tuesday night meeting.

17th September

Von Karman Lecture: InSight End of Mission: Our Time on Mars.

The InSight Mission to Mars began its journey to the Red Planet in May 2018. Upon its arrival in November 2018, InSight began an ambitious mission to reveal the internal structure of Mars. The lander detected more than 1,000 marsquakes, studied the Martian weather, and even found magnetic "ghosts" from an old electrical field.

Speakers:
Dr. Mark Panning, InSight project scientist, NASA JPL
Dr. Ingrid Daubar, InSight participating scientist, NASA JPL

1st October

Goddard Space Flight Centre: Explore New Hubble Images of Celestial Objects from the Caldwell Catalogue

As Hubble turned 30 NASA decided to share HST images of 30 celestial objects from the Caldwell Catalogue showing stunning cosmic sights, many of which you can see with a backyard telescope! Explore some of these beautiful images with experts, as well as learn more about the Caldwell Catalogue and the science within these gorgeous views from Hubble.

Hosted by Elizabeth Tammi, Hubble Social Media Lead
Speakers:
Dr Jennifer Wiseman Hubble Senior Project Scientist
Dr Michelle Thaller Deputy Director for Science and Education

15th October

Ancient Astronomers by Jason Hill

Jason looks at the great astronomers of the past that laid the foundations of modern astronomy from Pythagoras to Sir Isacc Newton and Edmond Halley.

29th October

Gresham College Lecture: The Journey from Black-Hole Singularities to a Cyclic Cosmology

The "singularity theorems" of the 1960s demonstrated that large enough celestial bodies, or collections of such bodies, would, collapse gravitationally, to "singularities", where the equations and assumptions of Einstein's general relativity cannot be mathematically continued. Such singularities are expected to lie deep within what we now call black holes. Similar arguments (largely by Stephen Hawking) apply also to the "Big-Bang" picture of the origin of the universe, but whose singularity has a profound structural difference, resulting in the 2nd law of thermodynamics, whereby "randomness" in the universe increases with time. It is hard to see how any ordinary procedures of "quantization" of Einstein's theory can resolve this contrasting singularity conundrum,

Yet, a deeper understanding of the special nature of the Big Bang is obtained from the perspective of conformal geometry, removing the distinction between "big" and "small, and whereby the Big-Bang singularity, unlike those in black holes, becomes non-singular, and can be regarded as the conformal continuation of a previous “cosmic aeon”, leading to the picture of conformal cyclic cosmology (CCC) according to which the entire universe consists of a succession of such cosmic aeons, each of whose big bang is the conformal continuation of the remote future of a previous aeon. Some recently observed effects provide some remarkable support for this CCC picture.

Speaker: Sir Roger Penrose
Sir Roger Penrose is a British mathematician and relativist who in the 1960s calculated many of the basic features of black holes.

12th November
SPHEREx: Zooming Out to See The Big Picture
Meet NASA’s next cosmic mapmaker! SPHEREx – or the Spectro-Photometer for the History of the Universe, Epoch of Reonization and Ices Explorer – will create a map of the universe like none before. The space telescope will survey the sky in optical and near-infrared light, creating an all-sky map every six months. This unique spectral survey will enable science ranging from our solar system to the very beginnings of the universe.

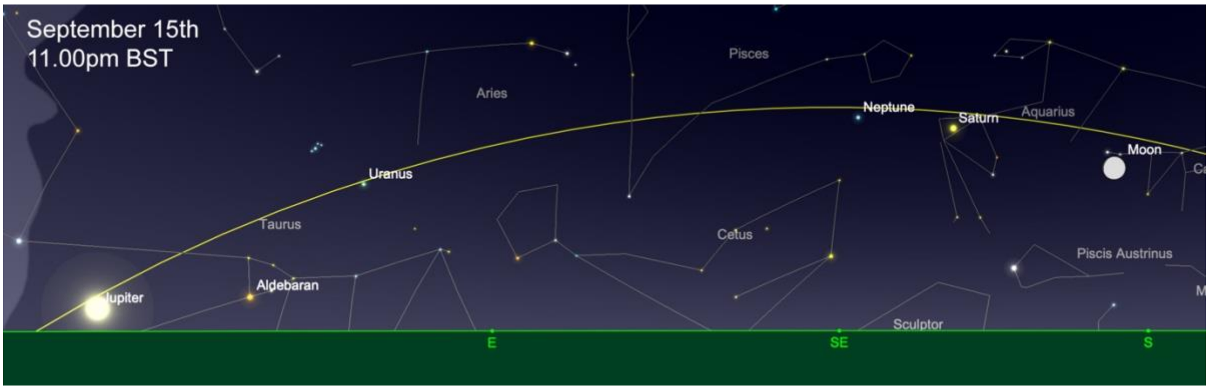
Speaker:
Dr. Jamie Bock, SPHEREx Principal Investigator, Caltech/NASA JPL

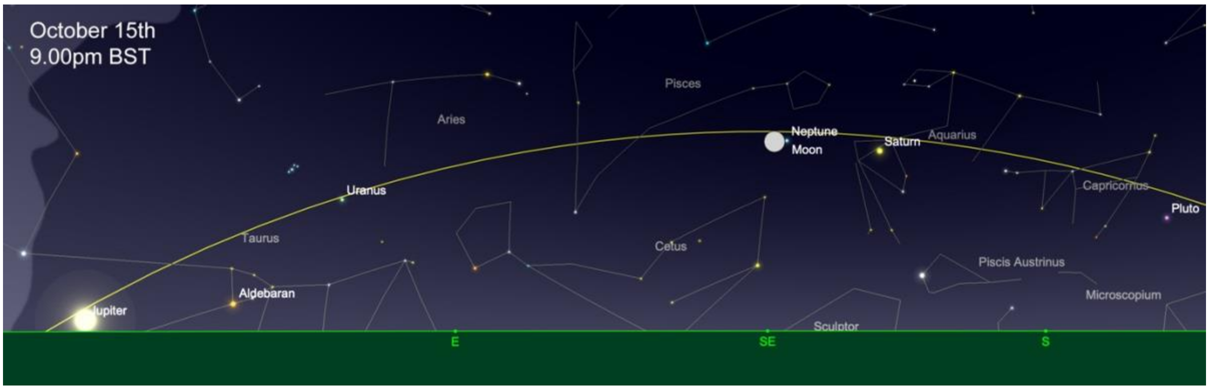
26th November – Annual Business Meeting
Details to follow.

10th December – Mince pies and members favourite astronomy image
Details to follow.

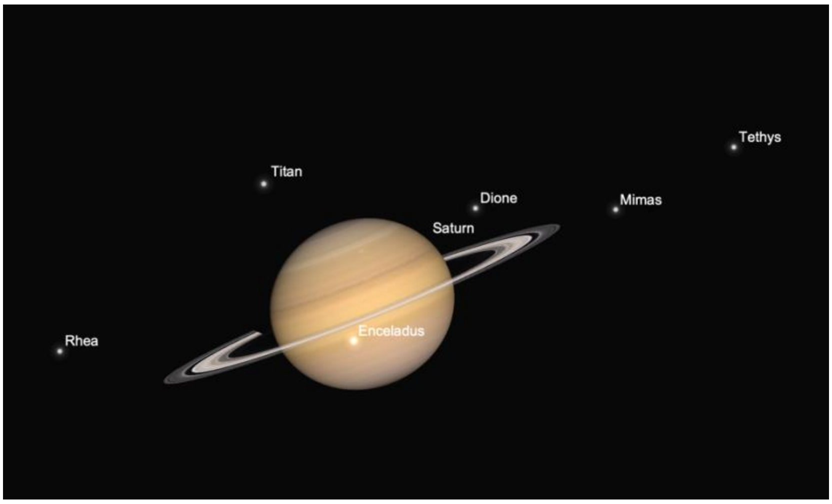
Stargazing

As we move into autumn and the nights are drawing in, the gas giants Saturn and Jupiter will start to appear earlier in the night sky and are objects that can easily be seen with the naked eye.

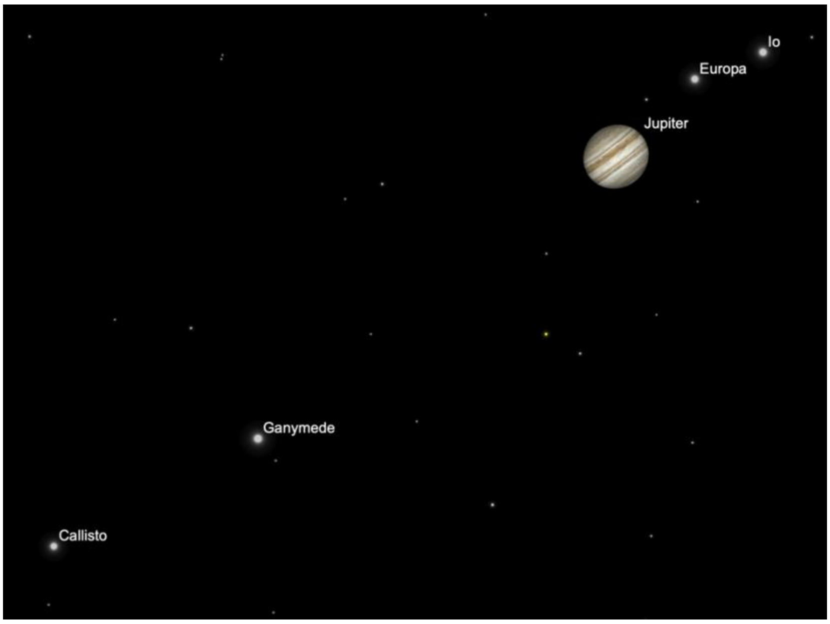




With a pair of binoculars or a small telescope you should be able to see the four Galilean moons of Jupiter, named after the Italian astronomer Galileo Galilei, who made observations of them in 1610 - there will be more about this in Jason Hill's talk on 15th October. You will also be able to see many of Saturn's moons and should notice that the planets rings are disappearing from view, as we start to see the rings more edge-one. This occurs when the Earth passes through Saturn's ring plane, as it does approximately every 15 years.



Saturn and moons



Jupiter and Galilean moons

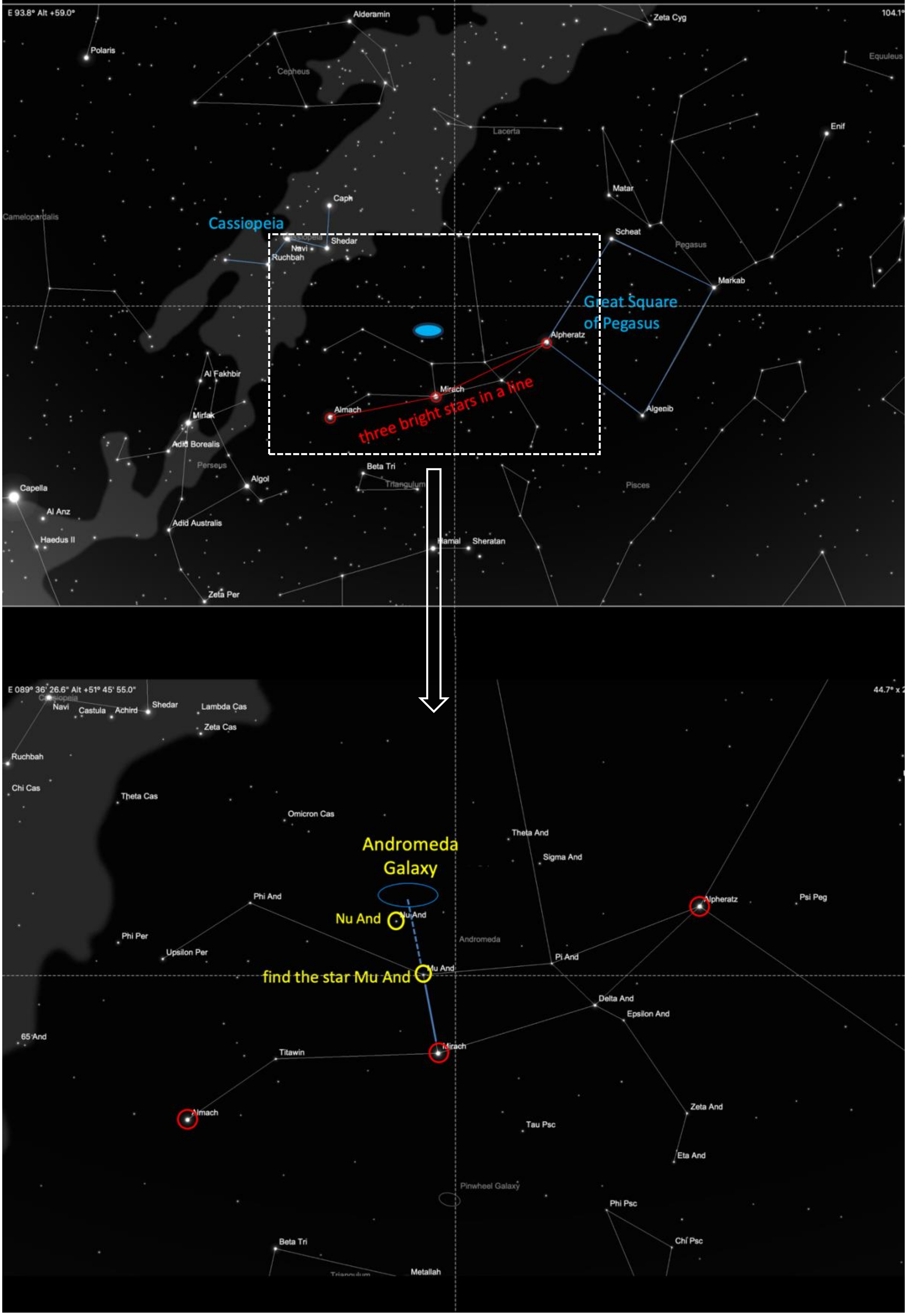
The Summer Triangle will remain high overhead for September and into October. But as we move through autumn it will start to set earlier in the west. The Great Square of Pegasus will then sit overhead, as will the constellation of Cassiopeia. This will be a good time to look for the Andromeda Galaxy which is 2.5 million lights year distance and just visible with the naked eye from a dark location. Towards the east we will start to see the appearance of The Pleiades open star cluster, followed by the Orion Constellation as we head towards winter.

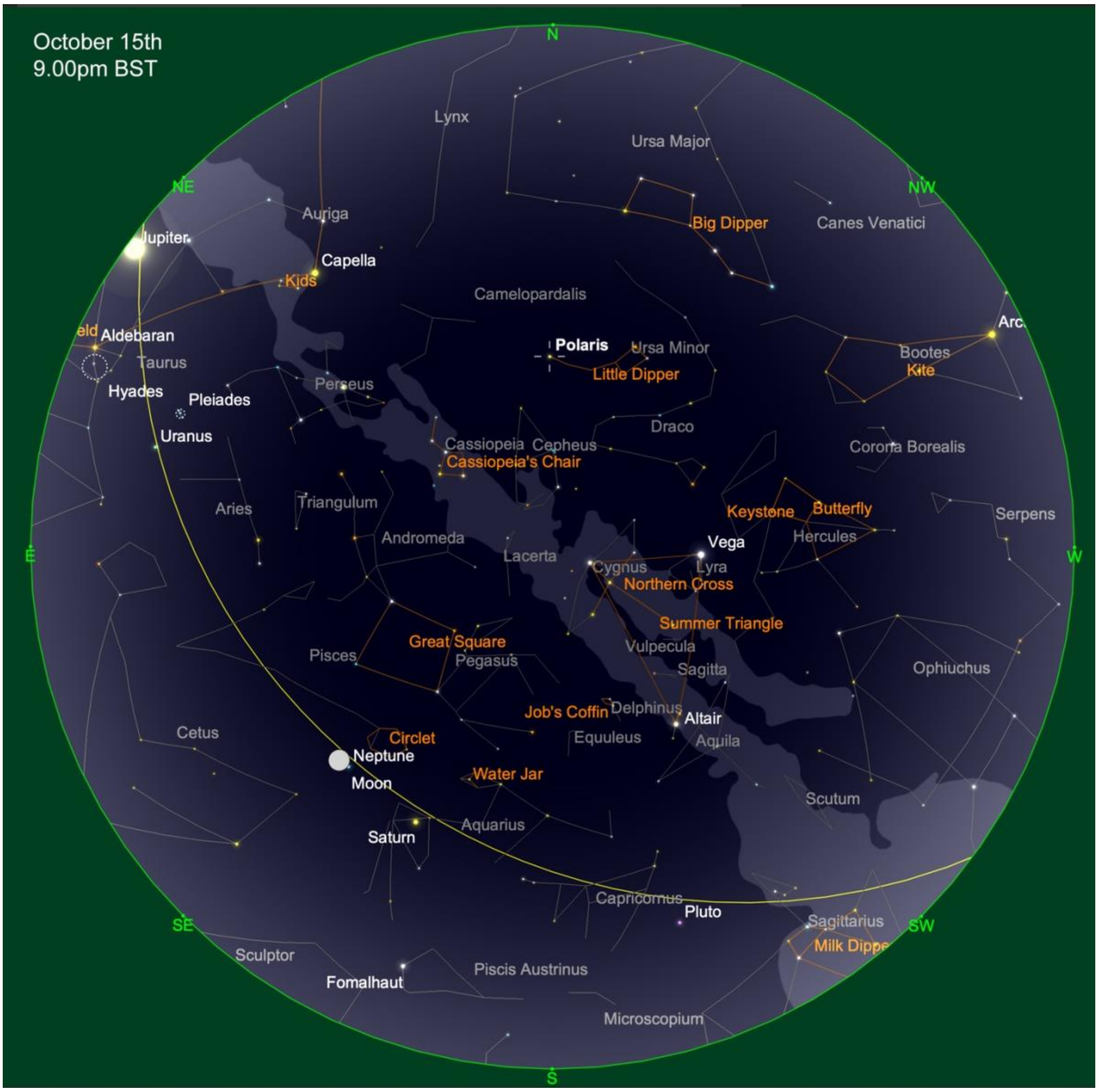
The Pleiades Star Cluster (Jean Dean)

Andromeda Galaxy (Jean Dean)

To find the Andromeda Galaxy: locate Cassiopeia and the Great square of Pegasus, then find the three bright stars of *Almach*, *Mirach* and *Alpheratz* that make a line. From *Mirach* find *Nu Andromedae* and draw a line between the two, project it by the same length again and you will find the Andromeda Galaxy. Often when finding faint objects, it helps to use averted/peripheral vision, which is when you look slightly to the side of the object where our eyes are more sensitive in the dark. With a pair of binoculars, you will see the bright, central core.

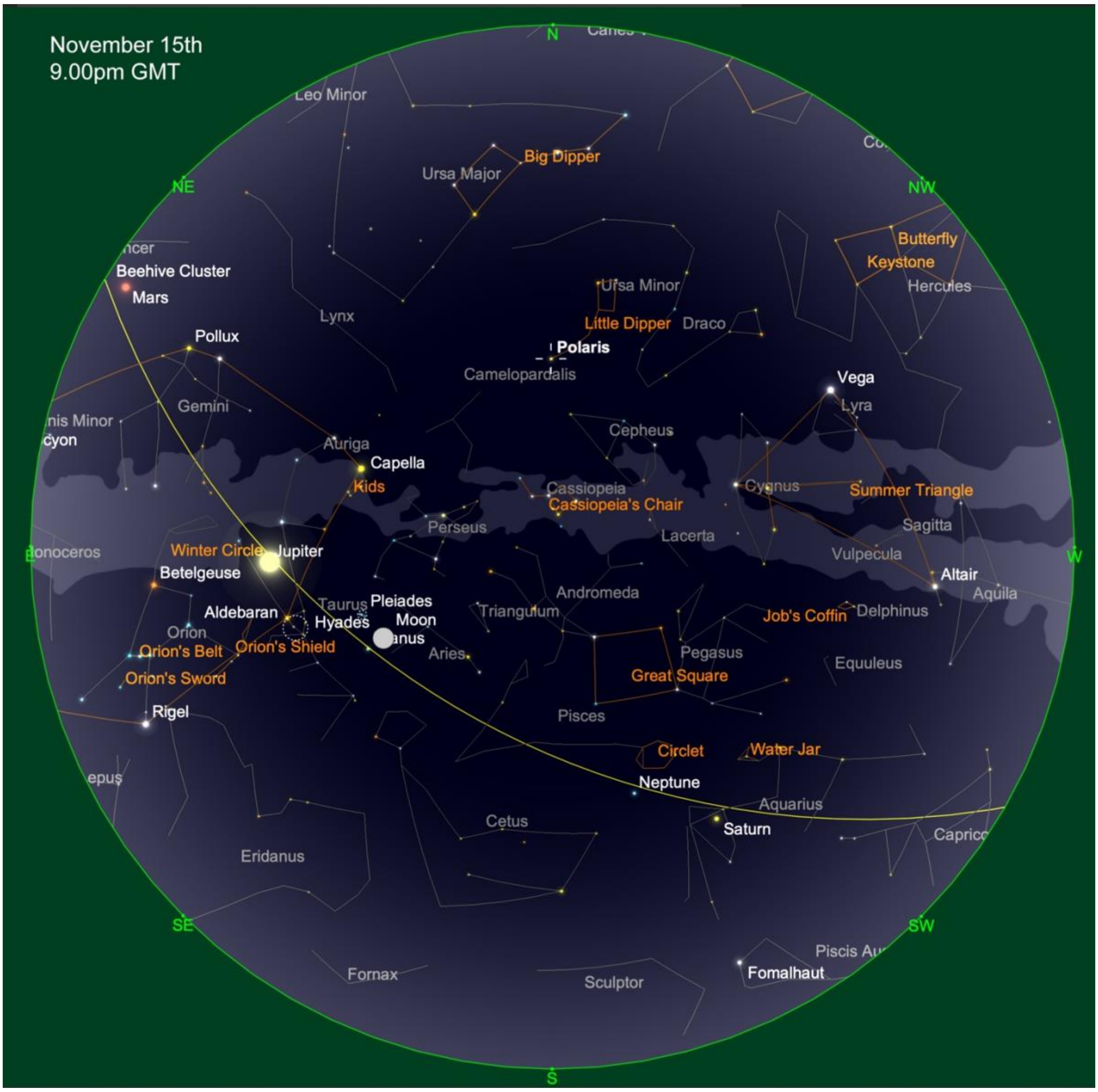
Finding the Andromeda Galaxy





October 15th
9.00pm BST

To use the chart: hold it so the direction you are facing is at the bottom, the lower half of the chart shows the sky in front of you and the centre of the chart is the region directly overhead.



Northern Lights Summer 2024

The northern lights, also known as the aurora borealis, are beautiful dancing ribbons of light that have captivated people for millennia. They are typically confined to high latitudes, but as solar activity has increased, they are occasionally visible as far south as Guernsey, including during the night of 10/11th May 2024. To see a recording of the entire event captured from the observatories All Sky Camera please see: *astronomy.org.gg>All Sky Camera.*

Aurorae are the visible manifestation of a solar storm, associated with a coronal mass ejection, where high energy solar particles are discharged into space and head towards Earth, where they can travel down the magnetic field lines at the north and south poles into the atmosphere. When charged particles from the Sun strike atoms in Earth's atmosphere, they "excite" the gasses, moving electrons to higher-energy orbits, further away from the nucleus. Then, when an electron moves back to a lower-energy orbit, it releases a particle of light or photon. This process goes on all the time, but during high solar activity a large number of solar particles bombard the atmosphere, when the oxygen and nitrogen can emit enough light that it is detectable by the naked eye.

The colour of the aurora depends on which gas is being excited by the solar particles, and how excited it becomes. It also depends on how fast the solar particles are moving, the faster they are, the higher the energy at the time of collision with electrons in the atmosphere. High energy electrons cause oxygen to emit green light, while low energy electrons result in red light. Nitrogen tends to give off blue light. All these colours can be blended in a display to give shades of purples, pinks, and whites. The various colours can be seen in photographs taken by Astronomy Section members.

Aside from being beautiful and mesmerising, the aurora show eloquently how the Earth's magnetic field protects life on our planet. Our neighbour Mars once had a global magnetic field that provided similar protection and thus, it also had oceans and an atmosphere. However, Mars lost its global magnetic field over time, this meant that the intense bombardment by solar particles gradually stripped away its atmosphere and oceans, leaving behind an inhospitable, dry and dusty planet.

Descriptions of the aurora can be found in many early cultures, where ancients thought of them as great dragons or serpents in the skies. In Scandinavia, Iceland and Greenland where the aurora borealis is common, it was seen as the great bridge Bifröst, the burning archway between and by which, the gods travelled between their realm and Midgard (Earth).

To find out more about the Aurora Borealis and to set up an alert to your mobile please see this link: https://aurorawatch.lancs.ac.uk/alerts/.

Several members took photographs of the event:

Rousse Tower
Carl Bideau

Fort Le Marchant powder
magazine, L'Ancresse
Jacques Loveridge

Pembroke Bay
Hugh Whitchurch

Ladies bay
Alison Moulin

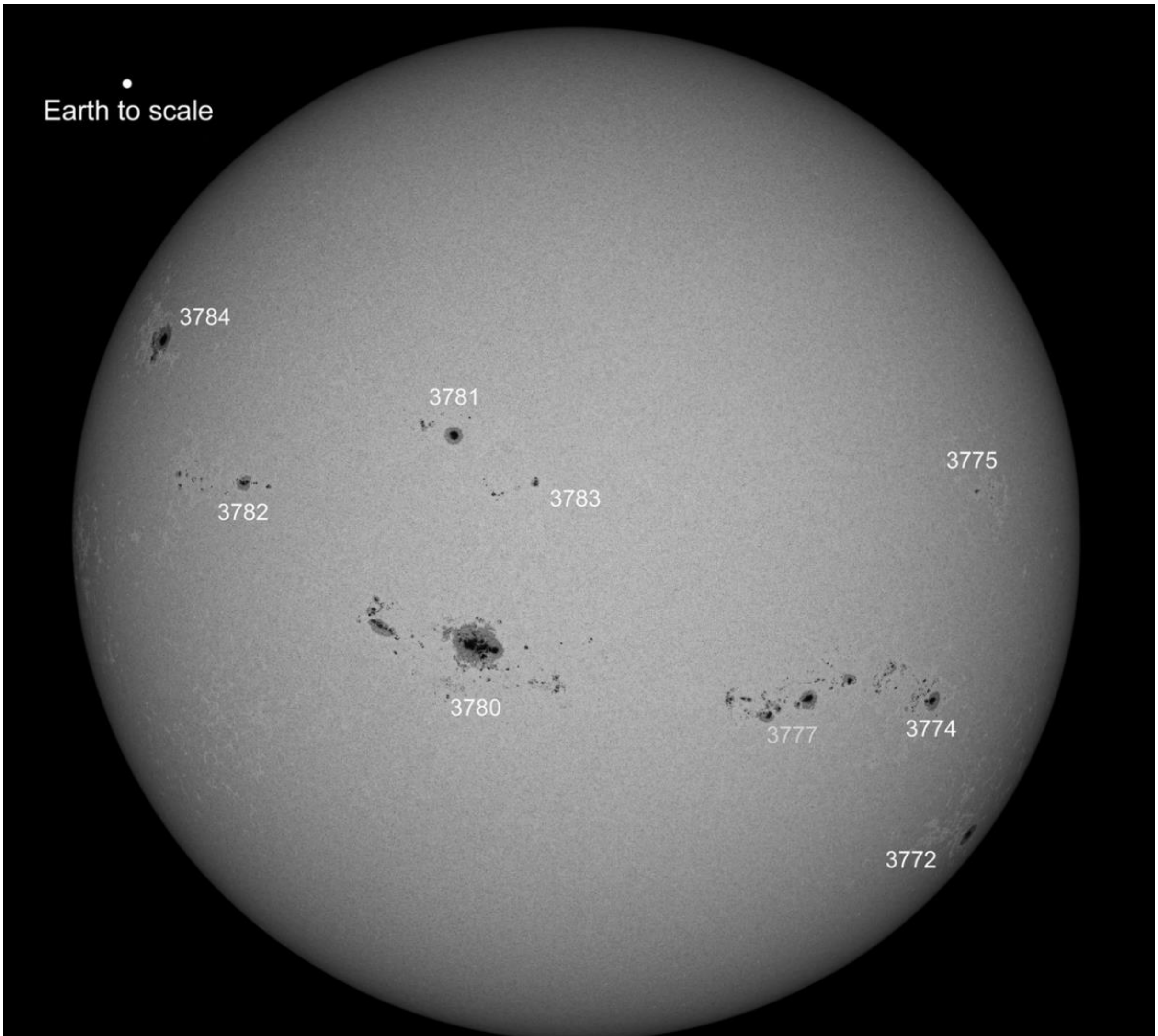
La Jaonneuse Bay
Jean Dean

We were treated to a second display on the night of the Perseids meteor shower on 12th August, when Astronomy member Martin Sarre captured the aurora and a Perseid meteor over Fort Grey.

Aurora and Perseid meteor over Fort Grey, Martin Sarre

Solar Activity 9th August

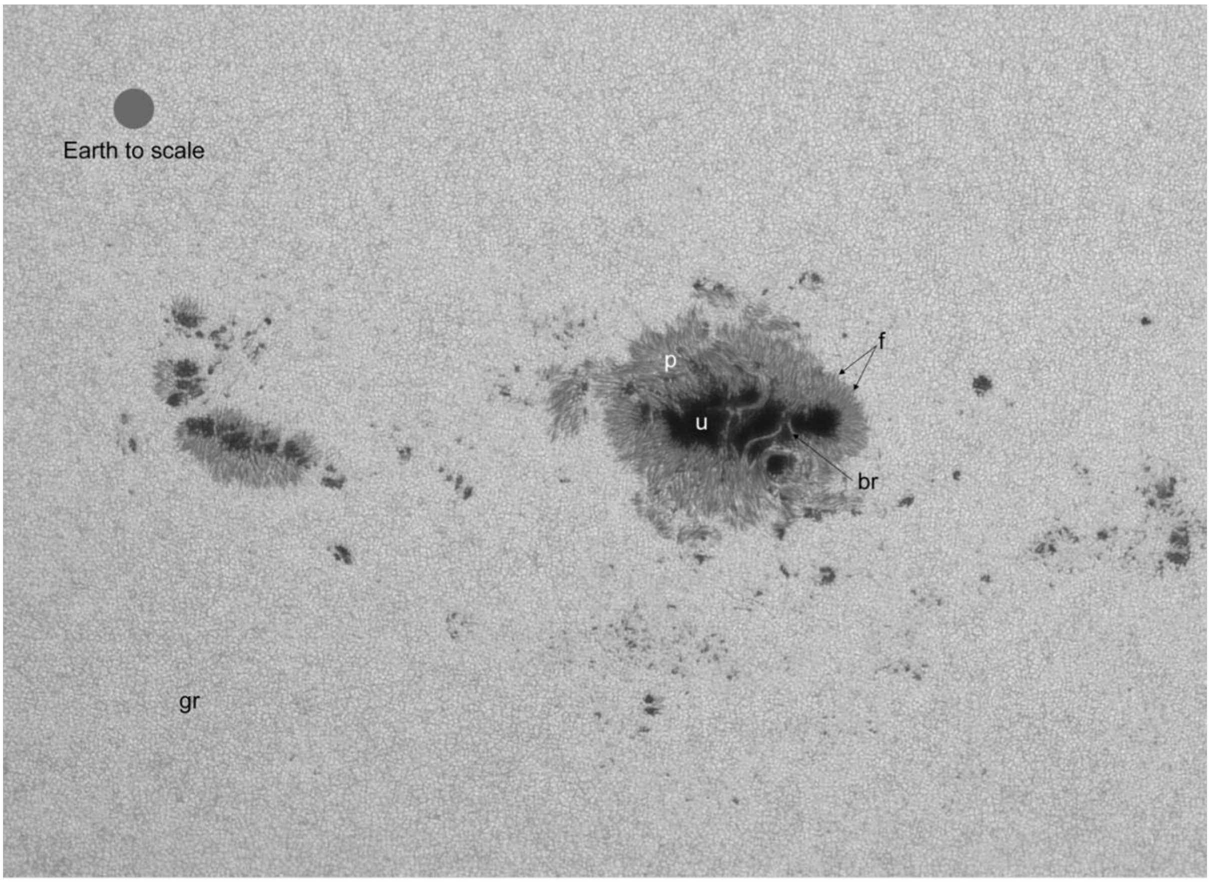
The Sun is very active at the moment and was imaged by Jacques Loveridge during a group visit from Club Bon Amis on the 9th August. Nine active regions are visible, which are manifestations of high concentrations of the solar magnetic field, where the strong magnetic field inhibits the normal convective transport of plasma and energy from the solar interior to the surface. The largest sunspot region was AR 3780 which contained 128 sunspots.



Sun's photosphere on 9th August 2024 showing active regions
David Le Conte Astronomical Observatory
(Image Credit: Jacques Loveridge)

The enlargement of AR 3780 shows the central, dark (cooler) umbra and lighter (hotter) penumbra with numerous filaments radiating outwards. Temperatures in the umbral zone are typically 2,200˚ C, reaching as high as 3,500˚ C in the penumbral region. Penumbral filaments surround the umbra, with light bridges spanning the umbra of AR 3780.

The grainy appearance of the photosphere is produced by the tops of convection cells where hot plasma rises, cools and then sinks. A single convection cell is normally about 1,500km in diameter and typically persists for between 10 to 20 minutes. At any one time there may be about 4 million granules on the photosphere surface.



Active Region 3780 on the Sun's photosphere 9th August 2024
p penumbra; u umbra; f filaments; br light bridge; gr grannulation

(Image Credit: Jacques Loveridge)

Perseid meteor shower

Around 70 members of the public were treated to a few Perseid meteors during an open evening on 10th August. The Astronomy Section gathered at the observatory on the 12th August with clear, dark skies to watch the peak of Perseid meteor show, which members estimated to be about 15 meteors per hour. The Section's All Sky camera captured the brighter meteors.

Meteor showers occur when the Earth passes through a debris field left by a comet or asteroid. The Perseids are caused by debris left behind from comet 109P/Swift-Tuttle, which takes 133 years to orbit the Sun and will return to the inner Solar System again in 2125.

Perseid Meteor Shower on the nights 11/12 and 12/13 August 2024
David Le Conte Astronomical Observatory Starlight Xpress Oculus 150° fov All Sky Camera

Rd Radiant; P Polaris; V Vega; D Deneb; A Altair; C Cassiopeia; An Andromeda Galaxy

(Image Credit: JM Dean)

What is Cosmology (Part 2) – Peter Langford

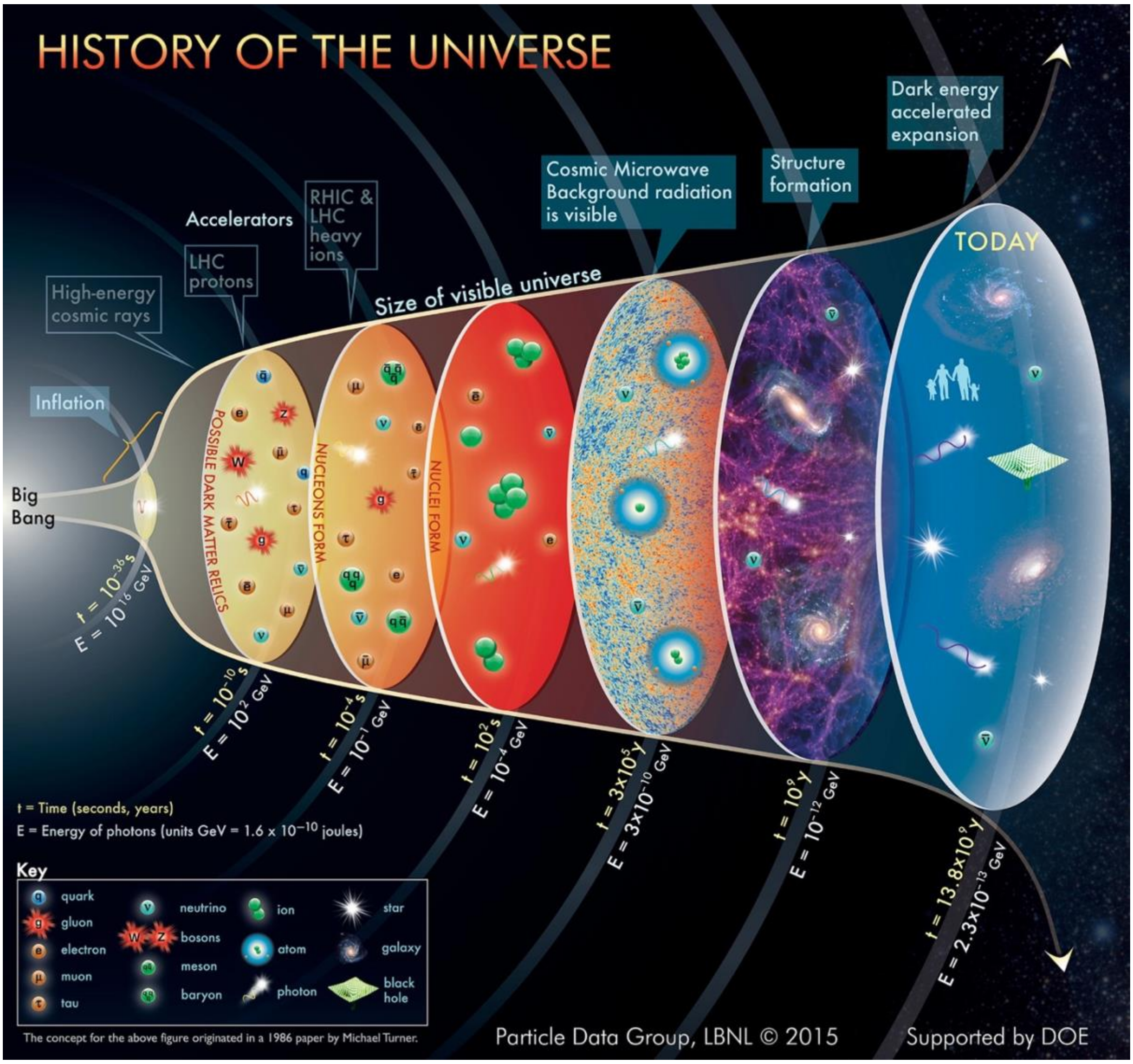
Another important discovery was that of dark matter. In 1933 Fritz Zwicky examined galaxies in the Coma Cluster. Zwicky was a brilliant but unconventional character. He often referred to his colleagues as ‘spherical bastards’ because, he said , they were bastards whichever way you looked at them. He found that the motion of the galaxies in the Coma Cluster was not explained by the amount of visible matter in the cluster. It was far too little. He coined the term ‘dark matter’ for the extra matter needed to account for their motion.

Fritz Zwicky, 1898-1974

It wasn't until around the 1970s, when astronomers investigated how stars were moving around galaxies and how light was deflected by galaxy clusters (by gravitational lensing) that a consensus emerged that dark matter was indeed required to explain their observations. The conclusion is that dark matter permeates and surrounds galaxies and there is about five times more dark matter than ordinary matter.

Dark matter and ordinary matter act in the same way gravitationally and together make up the CDM (Cold Dark Matter) in the Lambda-CDM model. The dark matter has to be cold since hot matter would disperse rather than cluster around galaxies. Dark matter presents a puzzle however. The Standard model of particle physics accounts for all the known behaviour of fundamental particles. The puzzle is that there is no particle in the Standard model which would be a candidate for dark matter and neither are there any gaps in the Standard model where a dark matter particle might fit.

The Lambda in the Lambda-CDM model refers to dark energy. Before 1998 it was not part of the model. Matter, ordinary and dark, was thought to be the only significant factor in the



evolution of the scale of the universe. The model still permitted different scenarios depending on how much matter there was. Immediately after the Big Bang space would have been expanding rapidly.

Matter, which is gravitationally attractive, would act to slow down the expansion. If the matter was sufficiently dense the expansion would slow down, eventually come to a stop, then reverse. The result would be a Big Crunch, the opposite of the Big Bang. On the other hand, if there was insufficient matter the universe would continue expanding forever, albeit at an ever-slowing rate. In both scenarios the expansion rate would be slowing down. However, at that time there was not enough data from observations to determine how fast. Since light takes time to travel, we can look back in time. However, the Cepheid variables that Hubble had used are not bright enough to look further back than 100 million years, enough to tell us the current expansion rate but not enough to tell us how the expansion rate is changing. That requires looking back billions of years. What was needed were objects of known brightness that were much brighter than Cepheid variables.

The answer was supernovae. A supernova is a rare event in a galaxy but when it occurs it can briefly outshine the whole galaxy. A particular class of supernova, Type 1a, has a known brightness. In 1998 two international teams began scanning the sky for supernovae and detected a sufficient number to determine the rate of change in the expansion of the universe. The result came as a surprise. Rather than the expansion rate slowing down it was found to be accelerating. Matter, ordinary or dark, could not account for that. Something new was needed to incorporate into the model to account for the expansion and it was termed ‘dark energy’.

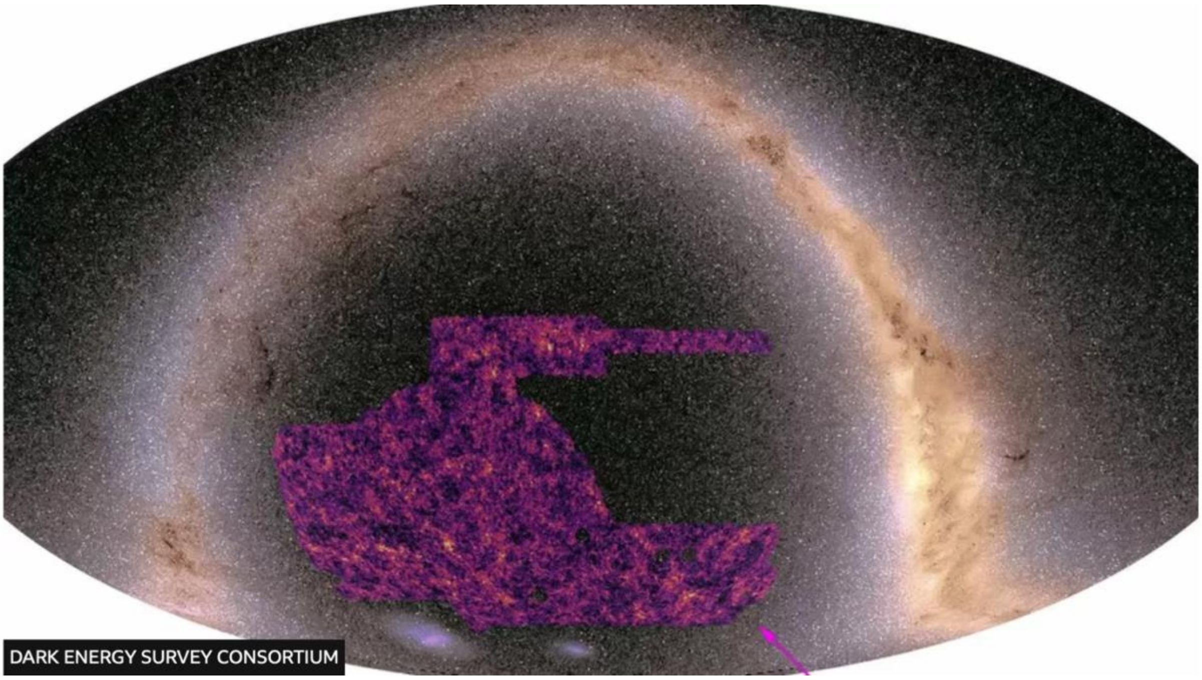
Type 1A supernova 1994D exploded near the outskirts of Galaxy NGC 4526 (NASA/ESA)

In Einstein’s General Relativity a factor could be included, which was usually denoted by the Greek letter lambda (Λ), also known as the cosmological constant, which determined the properties of empty space. Lambda can take any value one chooses but generally, since the vacuum of space was thought not to contribute anything, the value was taken as zero. If lambda is positive the vacuum will contribute positive energy and cause empty space (i.e. in the absence of matter) to expand. A negative lambda would do the opposite. By choosing a small positive lambda the model could then account for the dark energy that had been observed. The adjusted model became the Lambda-CDM model.

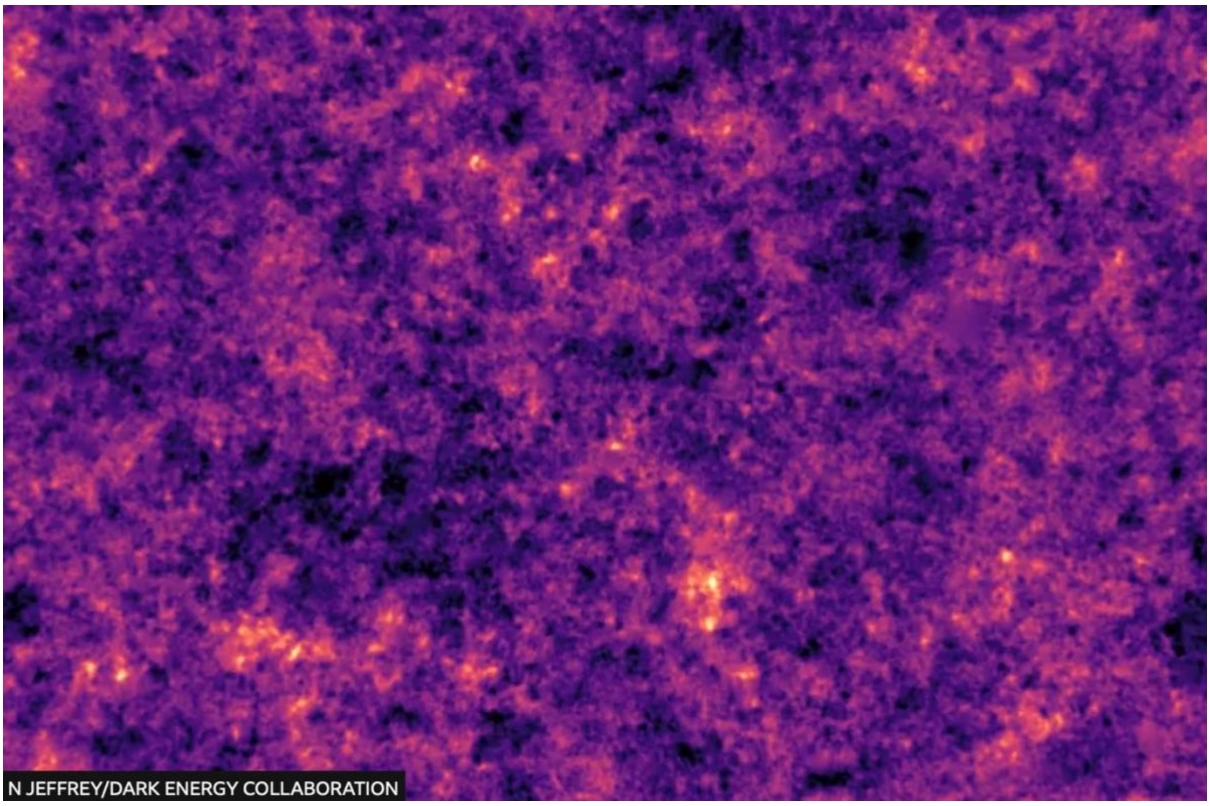
The cosmological constant is the simplest but not the only possible explanation of dark energy. It can though provide another missing piece of the jigsaw. In General Relativity space can be flat or curved. We know what a flat surface looks like in two dimensions. Curved surfaces in 2D are also easy to visualise; the surface of a sphere is positively curved while that of a saddle has negative curvature. We can’t really picture how such curvature looks in three dimensions. However, one can work out the astronomical implications. The path of light travelling through curved space becomes bent. In 1989, 2001 and 2009 space telescopes were launched to examine the cosmic microwave background. Of particular interest were the patterns in the minute differences in temperature in the cosmic microwave background.

The idea was that by studying these one could determine the flatness or otherwise of space. Physicists knew the processes at work in the early universe and could calculate how that would show up in the temperature patterns in the cosmic microwave background. If the light from the cosmic microwave background was distorted on its travels by the curvature of space, then it would show up as a difference between the theoretical temperature patterns and the ones observed. The results showed that the two were closely aligned so it was concluded that the space in our universe is flat or very close to flat. In the Lambda-CDM model there is a particular density of energy required if space is to be flat. That is called the critical density. Before the discovery of dark energy, it was calculated that the energy contributed by ordinary and dark matter was considerably short of the critical density.

However, when dark energy was added it filled the gap and the total energy was close to the critical density. Hence the energy of matter and dark energy together account for the observed flatness of space. Currently it is estimated that ordinary matter contributes about 5%, dark matter 25% and dark energy about 70% of the critical density. The model also tells us that if the total energy is equal to the critical density at the present time, then it will be equal to the critical density throughout the evolution of the universe. The proportions will change over time however. In the early universe matter would have contributed almost 100%. As the universe evolved, space expanded as did the amount of dark energy, while matter became less dense. Hence, the proportion of dark energy increased and the proportion of matter decreased until we arrive at the proportions we see today. In the long term it will be dark energy that will predominate and contribute almost everything and matter hardly anything.



Dark Matter Map: The oval represents the entire sky, with the purple as the area that has been surveyed to date. The dark Energy Survey Consortium is a collaboration of 400 scientists from 25 institutions in seven countries.



The most detailed map of the distribution of dark matter in the Universe. The bright areas represent the highest concentrations.

In summary, in the Lambda-CDM model we have a coherent theory of cosmology supported by a variety of observations. Although the model involves some advanced mathematics it is essentially simple in that if you feed in your estimates for the density of matter and dark energy at the present time, together with the current rate of expansion of the universe, the model will tell you how those things have evolved from the beginning of the universe and how they will continue to evolve to the end. Such is the progress in modern cosmology over the last century. It would be disappointing though to think that that was the end of the story. Dark matter and dark energy, which we think comprise 95% of the universe, are still essentially a mystery. There have been so many surprise findings from observations in the past we can surely expect more in the future. Maybe someone will come up with an improvement on the Lambda-CDM model. Einstein’s theory of general relativity has so far stood the test of time but, who knows, even that may be superseded.

Note: If you missed Part 1, you can find it in the April – June Bulletin.

Clear Skies from the Astronomy Section Committee