South-West Herts Astronomical Society Newsletter Apr. 2021

Notes of our online meeting on 26th March 2021

By Richard Westwood

Astro-news presented by Len Mann

Astro News - Gravity

This month Len discussed that most enigmatic of the fundamental forces, gravity.

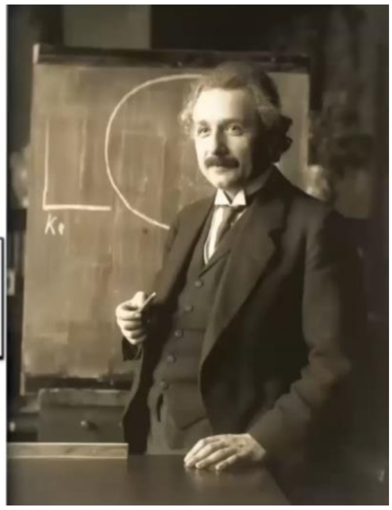
Gravity   Isaac Newton 1687

In the seventeenth Century, Isaac Newton wrote one of the greatest scientific papers of all time, the Principia Naturalis; this defined to laws governing gravity and its relationship to matter, unlocking the mystery of the movement of celestial bodies and the projectiles of cannon balls.
We still use it today for launching spacecraft and calculating orbits.

Relativity

Einstein 1915

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

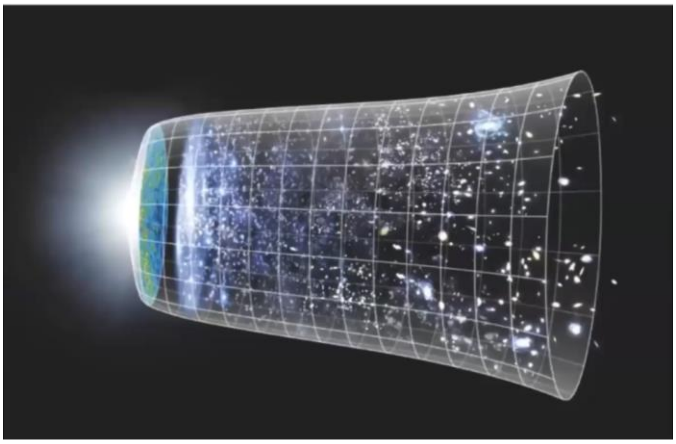


In the twentieth century, Albert Einstein gave us a new way to look at gravity as a warping of Spacetime, as this better explained new discoveries not reconcilable with Newtonian physics.

Dark Matter   Vera Rubin 1970

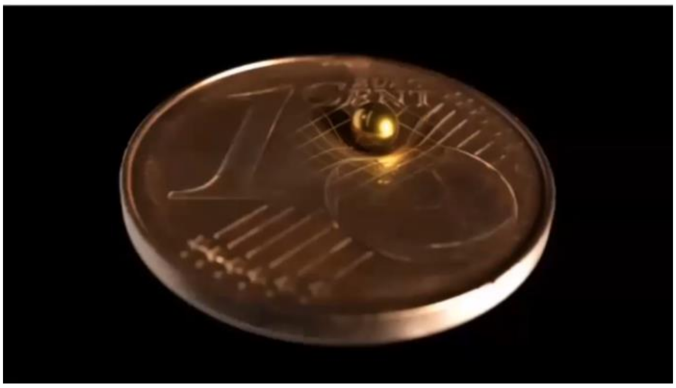
In 1970 Vera Rubin discovered that galaxy rotation implied that the mass of the galaxy was much greater than the visible portion – thus began the search for Dark Matter – probably made up of Weakly Interacting Massive Particles.
He pointed out that maybe this isn't gravity but, some scientists believe that MOND (Modified Newtonian Dynamics), could be involved; removing the need for Dark Matter.

Dark Energy 1998

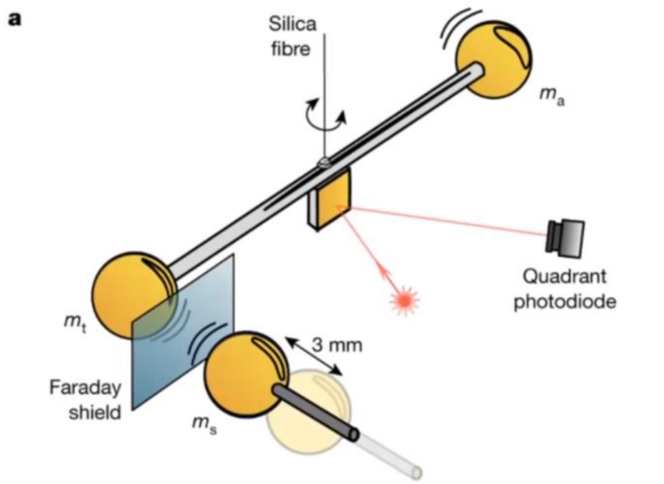


But in 1998 Dark Energy was discovered; so, our Universe is not only expanding but the process is accelerating! So, this is a type of gravity – anti-gravity. On thing is certain: whoever crack these gravitational mysteries will get us much closer to understanding the nature of the Universe.

Gravity on a Small Scale



To this end, an Austrian physicist, Marcus Aspelmeyer has conducted experiments with gravity measurements on the small scale.



For the last ten years he has been trying to measure the attraction between two tiny gold balls. Their combined weight is less than four grains of rice. Placed at each end of a bar, supported by a silica fibre, making a torsion pendulum.

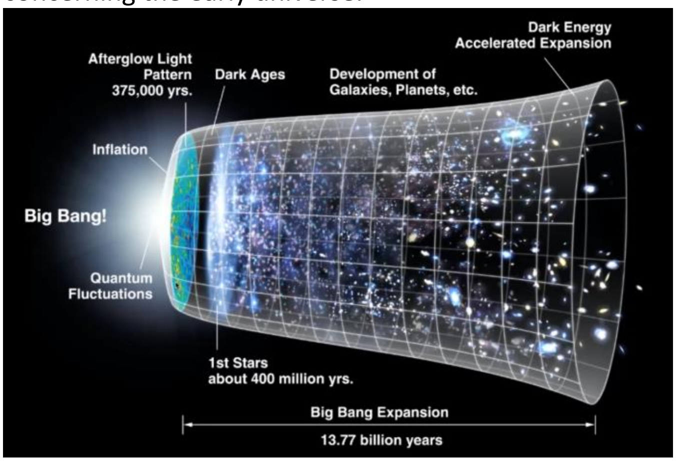
The force he was trying to measure was 10 million times smaller than a falling snowflake.
However, he was successful and detected movement that agreed with Newton's figures, within 10%. This is a very delicate experiment, requiring great pains to exclude any outside influence – as it was conducted in Vienna, this meant at night, and not on a Friday or Saturday.
He is still refining the experiment, and expects an improvement of x5000.
This will really advance the physics of gravity to a new level!
Len Mann (Despite the gravity of the subject, Len treated it with a certain amount of levity!)

Stars, Galaxies and Black Holes in the Early Universe – Dr. Aayush Saxena

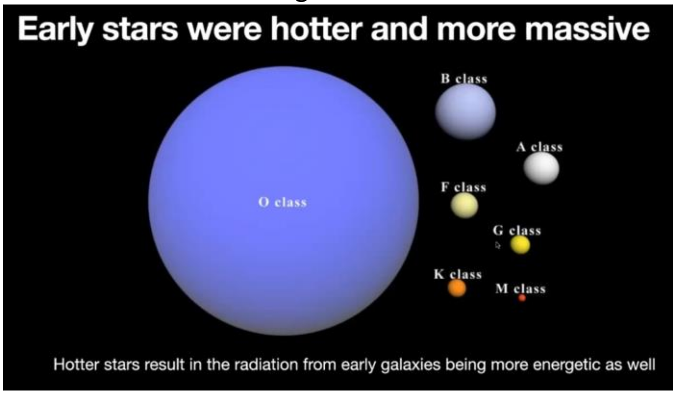
"Man is a most audacious artist. Only yesterday he was drawing pictures of wild animals on the walls of his cave. Today he would picture all the universe and how it came to be!"

Starlight Nights – The Adventures of a Stargazer; Leslie C Peltier. 1965

How times have changed! Only 50 years ago, the Big Bang was just one of the two competing ideas regarding the creation of the universe. In this fascinating talk Aayush gave us a look at the current research concerning the early universe.

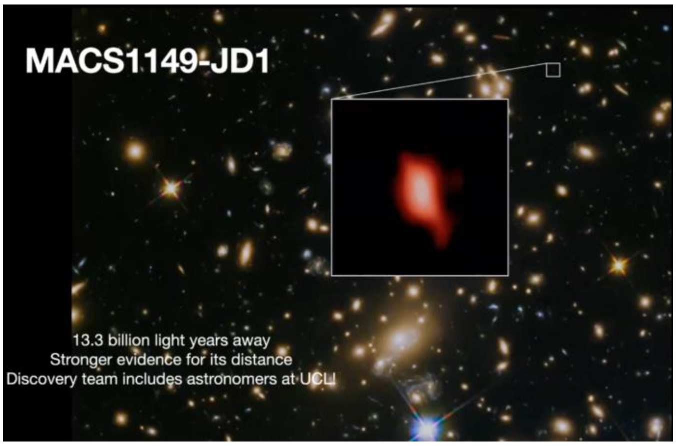


He began by showing us the classic image of the time-line from the singularity initially expanding very quickly – the inflationary period – and then the very hot 'Dark Age'. 400 million years would elapse before the conditions were suitable for the hydrogen and helium atoms could clump together and contract so that the nuclear reactions could ignite the first stars.



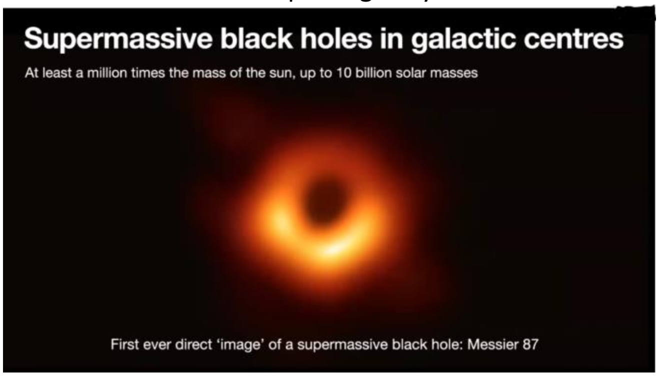
These early suns were much bigger that stellar populations are today – about 40% – this, Aayush told us is due to their being composed of just hydrogen and helium. This distinction of two different populations of stars was discovered in the 1940's by Walter Baade, working at Mt Wilson. Using a red-sensitive film he managed to resolve the stars in the hub of the Andromeda Galaxy. He found that they were 'metal poor'* compared to the stars in the gas and dust laden spiral arms; implying that they were older. He called them Population II stars and the 'metal rich' Population I, of which our Sun is an example.

One of the primary goals of the Hubble Space Telescope with its 2.4 mtr mirror was to take very long exposures of selected star poor regions of the sky – the Hubble Deep Field. After the north and south images were taken; it was considered such a success that the experiment was repeated with a longer exposure: the Hubble Ultra-Deep Field (HUDF). Aayush showed us this image and pointed out that it contained the extremely red-shifted galaxy GN- Z11; he pointed out that this star system was 13.4 billion light years distant! Astronomers call this 'look back time', so we are seeing an object from not long after the Big Bang. From this and other galaxies 'on the edge of time' it appears that these objects are irregular, so have no spiral structure.

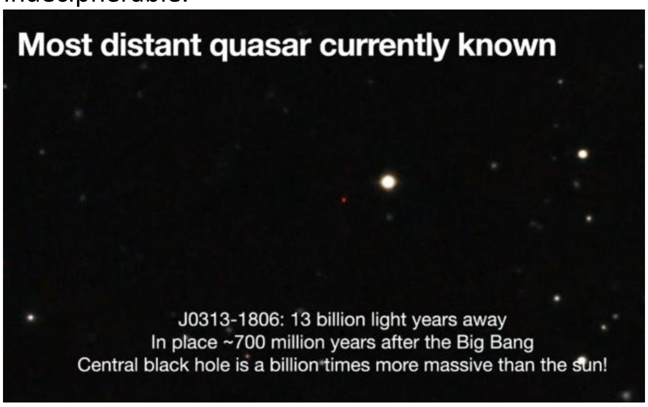


Aayush then discussed MACS 1149 JD1; a gravitationally lensed blue giant star, located about 14 billion light years distant This is the first star to be discovered this way, an Aayush was proud to say – it was found by UCL! This object is thus a 'pet project'.

We then looked at Super Massive Black Holes (SMBH). We know that low-mass stars (like the Sun) will eventually become red giants and end their days passing through the planetary nebula phase and become white dwarves. However, stars having 8x solar mass will have a more extreme ending: first becoming a red super-giant then exploding as a supernova. Two possibilities can occur after this: a neutron star or a black hole. Black holes are notoriously hard to detect; until recently the evidence was based on the effect they had on matter. Then in April 2019 a very large team of scientists, using multiple imaging techniques captured the black hole in the elliptical galaxy M87.



The problem with SMBH's is how do they form? A subject that Len Mann tackled in November last year. Although mergers are the probable answer, this is still a puzzle. One of the other mysteries is the very distant quasars. Discovered in 1963, these look like ordinary stars but a spectrum taken of them looked indecipherable.



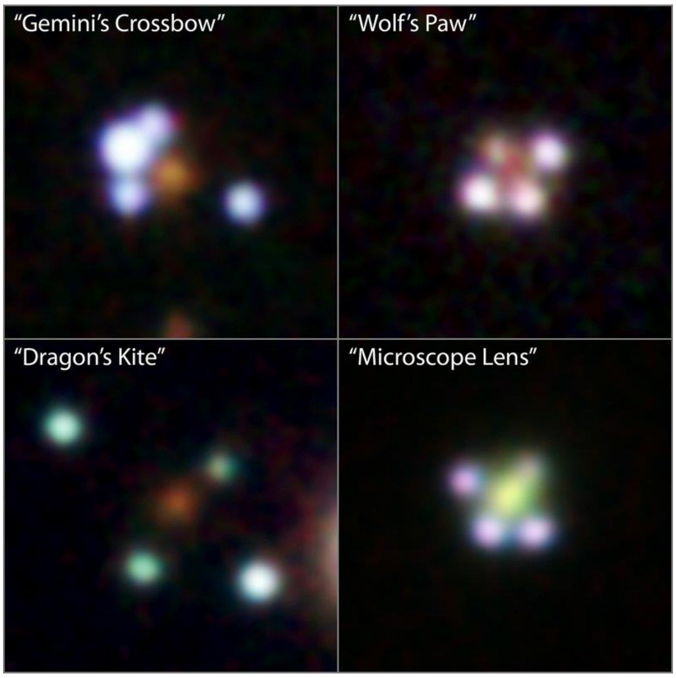
It wasn't until Maartin Schmidt in the USA realised that they had a very large redshift that they could be understood. The very great velocity in recession indicated a very large look back time. It was much later that it was realised that they are the SMBH's in early galaxies (Active Galactic Nuclei). In fact, the quasar is the jet of material expelled from the poles of the SMBH. These jets are extremely bright: each one is more luminous than 1000 galaxies.
The big question is: how did these extreme objects form in the early universe? And how did they change the universe today?
Fortunately, Aayush showed us the near future of this part of astronomical research: the James Webb Space Telescope, with its 6.5 mtr aperture with greatly add to the field by providing higher resolution images. It might seem counter-intuitive to use a telescope designed to detect infra-red wavelengths for high-energy sources; but due to the high degree of red-shift, the information is located in the red and infra-red parts of the spectrum.

Also, ELT in Chile (Extremely Large Telescope), working in the optical and infra-red wavelengths and the SKA (Square Kilometre Array) radio telescope based in Australia and South Africa are involved. In this multi-national research. It's good to know that UCL is very much part of this!
* *Metal poor and metal rich is how astrophysicists classify stars: 'metals' means elements beyond hydrogen and helium.*
We must Thank Aayush for a very interesting evening: he covered a very complex subject with great clarity and humour.

Observer's Corner

I'm sorry to say that we have had very few chances to observe the sky, cloud and lack of transparency has been a problem. Even clear, blue skies during the day have been spoiled by high cloud as the Sun sets. However, there have been a few clear patches, if you are not too fussy. I did manage to see ϒ Virginus (Porrima); as a pair, using a high-power eyepiece, and a fine sight it is too! I must say, the evening was very poor, misty and with a bright waning gibbous Moon in Libra.
Double stars are a great standby when skies are poor. Some favourites I have include ζ Cancri, sometimes called the 'spring Alberio' a blue/yellow pair, ε Boötis, similar colours, but much closer; α Herculis, a red giant paired with a pair of solar-type stars (they can't be resolved); The view in a small scope is of an orange gem and a close greyish companion. And lastly, from the northern sky, ζ Ursae Majoris – yes – Mizar and Alcor; look for the 8th mag star between them and also Polaris, the Pole Star is also a good double to look at – and you don't have to move the scope much to follow it across the sky.
As we are now in mid-spring the constellations of Hercules and Corona Borealis are high in the east, so the treasures of globular clusters are visible. M3 can easily be found on a line between Arcturus and Cor Caroli, (α Cvn) and I like to spot it with binoculars – but it's a fine sight in a small scope. M5 is harder to find, below and east of Arcturus. But is a real treat if you can find it: close to the star 5 Serpentis, it's full of individual points of light. However, it is low in the sky. A late evening in May is best.
Regarding planets. May offers the chance to see Venus in the evening sky. As it's very bright, it's hard to miss. Also in evening twilight, May brings us a chance to see tiny Mercury: on the 13th it will be close to the crescent Moon, a good sight in binoculars – but you'll need a unobstructed western horizon to view it. Jupiter and Saturn are still in the early morning sky. Better observing times will be later in the summer.
I doubt very much that many members also read *Heritage Railway;* a news note in the April issue mentions that the Dartmouth Steam Railway has a presence on Mars. A member donated money to NASA for the *Perseverance* spacecraft, so one of the chips on board has 'The Dartmouth Steam Railway' engraved on it! They also have a boarding pass. The comment was – 'From the red sands of Devon to the red sands of Mars'
More next time!

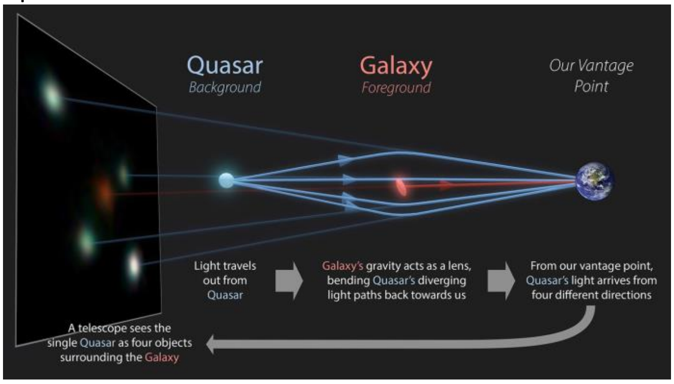
Colourful Quads



Gravitational lensing is a phenomenon resulting from the warping of spacetime near massive objects, as predicted by Einstein's theory of general relativity.

As early as 1704 Isaac Newton had predicted from his own theory of gravity that light might bend around massive objects. Einstein confirmed this in 1911, but then in 1915 his new theory of gravity based on general relativity showed that the bending would be double the amount suggested by Newton. Furthermore, Einstein's new theory showed that the path of the light did not 'bend' through space, but spacetime itself would curve near massive objects: the light continued on its straight-line path through non-Euclidean spacetime.

It was soon realized that the phenomenon could possibly be used to see objects hidden behind other more massive objects due to what became known as gravitational lensing. The name is somewhat misleading: it cannot be compared directly to the mechanism of ordinary optical lensing, since there is no focusing or any concept of a focal length comparable to optics.



Perfect alignment of symmetrical objects would produce a circular image of the remote object, known as an Einstein ring. Although hundreds of gravitational lens effects have now been discovered, only one perfect ring has been observed: this was discovered in 1998.

In most cases neither the remote object being observed nor the intervening massive object acting as the lens (usually a galaxy) are symmetrical. This, coupled with the complex mathematics of general relativity, means that the remote object appears as a double or a quadruple image: the mathematics suggests that the number of images will always be an even number, most commonly two or four.

Now a new study has been published by researchers at Caltech working on behalf of NASA. The study is based on data gathered by a number of ground-based and space observatories, including ESA's Gaia mission and NASA's WISE (Wide-Field Infrared Survey Explorer).

The research uses computer machine-learning algorithms to identify likely candidates, starting from the fairly coarse resolution of WISE and then using the sharp resolution of Gaia couple with ground-based observations to choose likely candidates for multiple-image sources.

Quadruple images are of particular interest to researchers, because they provide an important tool for solving one of cosmology's major puzzles: discrepancies in the determination of the Hubble constant, which determines the expansion rate of the universe. Measuring the Hubble constant using the cosmic microwave background radiation (CMB) gives a different value to methods based on galaxy observations, and the use of gravitationally lensed quasars as a new tool is a promising way of resolving the issue.

Graham

Society Notices

All Meetings at The Royal Masonic School are suspended until further notice.

Our Next Zoom Meeting - Friday 30th Apr. 2021 at 8pm

“The Evolution of Planetary Rovers” By Dr. Ezzy Pearson

We take a look back through the annals of planetary exploration and the amazing robotic machines that humans have landed on distant worlds of the Solar System to explore their surfaces

Dr Pearson’s talk begins with the Soviet lunar rovers of the 1970s that were piloted from Earth with nothing but a blurred black and white image, before moving on to the balloons that bobbed through Venus’s cloud-laden skies.

She will also look at NASA’s Mars rovers, which have spent over 20 years traversing the Red Planet’s surface attempting to answer questions about our neighbouring planet’s past climate and whether it could have once been hospitable to life.

These machines have scaled mountains and descended into craters to reach areas that would be far too dangerous to land in directly, weathering storms and enduring mechanical failure to bring us spectacular close-up views of unworldly terrain.

With NASA’s Perseverance and China’s Tianwen-1 rovers due to touch down on Mars early this month, Dr Pearson will take a look forward to what adventures could be waiting for the robotic explorers of the future.

Dr Ezzy Pearson is the news editor for **BBC Sky at Night Magazine** and presents its monthly podcast, **Radio Astronomy**.

A Zoom meeting link for the event will be sent out to all members two days before the meeting, but if you would like to put a placeholder or reminder on your calendars now, the meeting will take place **on Zoom.**

Meeting protocols

We will allow access to the meeting approximately 15 minutes before the start time of 8pm. This will allow members to “chat” beforehand if they wish to do so.

Once the meeting commences, all mics will be muted to avoid extraneous noises.

You can ask questions at any time throughout the presentation by using the chat function, but to avoid disruption, these questions will be not be answered until the end of the presentation.
You will also be able to ask questions using audio at the end of the talk.

The meeting will be recorded and made available to members on our YouTube channel afterwards.

SWHAS Contacts

Chairman: Sean Meehan
01923 228969
chairman@swhas.org

Membership: Peter Craft
07958 776028
membership@swhas.org

Webmaster: Andrew Lane
webmaster@swhas.org

Content supplied by Richard Westwood, Graham Marett and Sean Meehan
Editing and publishing by Sean Meehan