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The C&WAS Zoom Meeting for the Dr Carlos Frenk talk

Dr Carlos Frenk, from Durham University gave an excellent talk to members of the society on Friday 13th November, on the subject of "How our Universe was made" via Zoom. This video sharing App has allowed members to keep in touch with the talks and Sky Notes during this year. While no-one can yet meet at Earlsdon, it is the best we can do until we can all meet again in person, let's hope early next year. Many thanks to Geoffrey and Mark for keeping the show on the road.

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Fred Hoyle and the Steady State theory

By Paritosh Maulik

We have recently read in MIRA 108 part of the biography of Fred Hoyle by Geoffrey Johnstone. Hoyle worked in many fields of cosmology, perhaps his name would be most associated with the Steady State theory of the Universe. Although the Steady State theory could not stand against the test of time, this article is not an attempt to demean Hoyle. I wanted to find out little bit about the theory, so here is a brief account.

A logical conclusion from Hubble's observations is, that in the past all the galaxies which are visible today, were touching each other in an infinitesimally small space. Following Einstein's theory, this means a high density and a high temperature, but there was no supporting evidence in late 1920s.

Hubble's law suggested the age of the universe to be two billion ($2*10^9$) years old. We now know that Hubble's observations were not corrected for the absorption by dust. Dimming of the light from far away galaxies are both due to distance and absorption by dust.

Also the origin of matter could not be explained.

According to Einstein, space and time are united; all space and time have equal properties (cosmological principle), hence in the infinitely small volume at the beginning, no space and or time is in the unique position to initiate the expansion.

Steady State

These are the objections which led Hoyle, Herman Bondi and Thomas Gold to look for alternative solutions to explain the state of the universe we see today. In Newtonian theory, time is same everywhere, whereas is to Einstein time is unique to the observer. As a simplification it has been postulated that the motion of the galaxies could assumed that all the galaxies move in their own path and do not interact with each other and they start from one position. The time line from the starting point is called cosmic time. At the beginning, the density is very high and the temperature is above 10^{10}°k. Once the temperature has dropped after the expansion, all the physical properties are expected to change, if measured in Newtonian time. Bondi and Gold argued that the universe would have same properties if we measure the properties cosmological time. It was called perfect cosmological principle. The universe does not change. This unchanging view was called the Steady State universe.

The major weakness of Bondi and Gold model was as the universe expands, the density drops and new matter has to be created to maintain the density. As a solution to this problem, Hoyle suggested a negative energy source; when a particle of given energy is created, a negative energy of equal amount is released. A mechanism for the of creation of matter is now established.

George Gamow and Ralf Alpher believed in the Big Bang. At the beginning the volume is very small and temperature is very high. As it began to cool, fundamental particles formed at the high temperature, will combine to form elements. The simplest element is hydrogen. Eventually hydrogen would form helium.

Hydrogen (1 proton) -> Deuteron (1 proton + 1 neutron) Helium (2 protons + 2 neutrons)

This reaction would occur as the initial heat is lost. There is a narrow window of time for the above reaction to occur. Gamow and Alpher calculated a time frame and temperature range for the above reaction; once the temperature has cooled down sufficiently, we can expect, for every 12 nucleus of hydrogen, there would be 1 nucleus of helium and a small amount of deuterium (molecular deuteron). This has been verified. Alpher and Robert Herman calculated the leftover heat from the initial creation would have dropped to 5°K by now and would be present in the form of microwave radiation. This theory came to be known as Big Bang Nucleosynthesis (BBN).

BBN explained the scheme to form 3 light elements hydrogen, helium, lithium but no further. Hoyle accepted that the above process is possible but he was not convinced by the concept of the leftover temperature. Later on when Herman used the age of the universe from the Hubble's model, i.e. taking into account of the time to cool down, the calculated leftover temperature rose from 5°K to 28°K. This uncertainty of the magnitude of the leftover temperature posed a serious question mark to big bang model.

Now Hoyle proposed a scheme to synthesise heavier elements in the stars. Carbon is widely present all around us and in us. Hoyle's theory proposed a mechanism to synthesise carbon in stars.

The first step of the process:

Alpha particle (a) in radioactivity is an helium atom, made from two protons and two neutrons, it is in fact helium atom or, nucleus

In a red giant or a red supergiant star (almost all of the hydrogen has been exhausted by fusion reaction), at a temperature $100*10^6$°K (100 million K) alpha particles can fuse to form a chain reaction to synthesise carbon.

a + a -> Be (beryllium)
Be + a -> C (carbon)

This reaction is called triple alpha process. In 1952 Edwin Salpeter showed that at $100*10^6$°K, synthesis of C from the above reaction is possible.

C + a -> O (oxygen) and so on.

For carbon to transform to heavier elements, carbon needed to have a special energy level. This was not known at that time. So Hoyle persuaded Willy Fowler in Caltech to look for this special energy level in carbon and it was observed. Further theoretical work suggested that other common elements can be synthesised in various stars. Elements up to iron would form. To form elements higher than iron, more energy is needed. But if the mass of the star is of the order of 1.4 or greater than the solar mass, the star would implode and a supernova explosion would result. The high temperature created by the explosion and the shock wave would provide the energy to synthesise elements higher than iron. Margaret Burbridge, the only astronomer in the group, provided the observational evidence. Based on these observations, in 1957 the seminal paper came out by Geoffrey Burbridge, Margaret Burbridge, William Fowler and Fred Hoyle on stellar nucleosynthesis, popularly known as BBFH paper. This paper showed that initial Big Bang is not necessary to form elements; conditions exist within the stars to form various elements.

Gamow, raised objections; nuclei formed before the formation of stars and massive stars die young; there may not be enough time to synthesise the heavy elements. According to Salpeter (1958) massive stars can synthesise heavy elements despite their short life. Hence from now on Stellar nucleosynthesis is the route for the formation of elements according to the BBFH process.

Cosmic Microwave Background (CMB)

Bell Labs had a 6 metre (20 feet) radio antenna for long distant radio communications. But by 1960s it became evident that the long distance communication is best achieved by satellites like Telstar, so the large 6 metre antenna was free.

In 1961, Edward Ohm from Bell Labs was using the antenna. He wanted to measure the background signal in the microwave range. Microwaves have a higher frequency than radio waves. A microwave reading represents the temperature of the source. Astronomical radio waves had already been observed. Ohm calculated that the noise level of the instrument alone, is 19.1°K. However his observation showed that the instrument is reading 22.2°K. He was certain that he was not pointing it to any known astronomical source. He could not account for this excess 22.2° – 19.1° = 3.1°K temperature. He concluded that the instrument was too noisy and so did not pursue with this instrument.

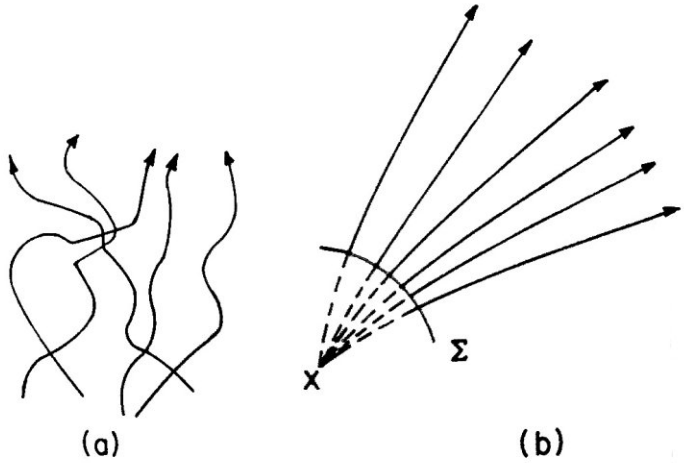
Robert Wilson and Arno Penzias used this antenna in 1964. They measured background microwave radiation to be 3.5°K. They were certain that the instrument was not pointing to any astronomical source. This radiation is present all around the sky as a background radiation.
Robert Dicke from Princeton University realised that this observed microwave background radiation is the leftover radiation from the Big Bang, the initial high temperature state as suggested by Gamow and co-workers. In 1965 Wilson and Penzias reported the observed radiation without mentioning the nature of the source. They invited Dicke to be a co-author, but Dicke thought that the credit should go to the discoverer of CMB and declined to be a co-author to the Penzias and Wilson paper. In their first paper Dicke and co-workers, did not mention the initial high temperature state to explain the observed CMB. In a following paper, Dicke etal suggested that the universe works in a cyclic fashion. Every new cycle reprocesses the matter of the previous cycle to hydrogen and hydrogen to stars. They omitted the question of the origin of the matter.

Up to this stage, no scientist mentioned the previous high temperature state which has cooled to near 3°K. Only the Bell Labs press release mentioned there was a previous high temperature state. Let us look back: Ohm did note the microwave background to be around 3°K, but did not believe it to be a true result. Wilson had attended Hoyle's lectures in Caltech and was impressed by Hoyle. Both Wilson and Penzias did not openly contradict the Steady State theory. Dicke etal were working with the idea proposed by Gamow and workers, but they also did not question the validity of the Steady State model openly.

The Steady State theory was still widely believed, however nagging questions were being raised. CMB results suggested the radiation is from a black-body with a pick temperature of around 3°K corresponding to microwave radiation at around 7.35cm. Being a black-body, we can expect a temperature to correspond to other wavelengths. But the technology was not there to verify the full spectrum of a black-body, hence the confirmation that the true nature of the source of the observed CMB, a previously hot state. Around this time Geoff Burbridge and Hoyle calculated that the stars could not make enough helium and helium is important for the stellar nucleosynthesis. In 1964 Hoyle and Roger Taylor reported that the observed helium is far in excess than that could have originated from the stars. Although Hoyle said earlier that there was no proof for the Gamow and Alpher model, in his 1964 paper he suggested either the universe is of singular origin or oscillatory. This is the first time Hoyle came close to mentioning the Big Bang.

Now Hoyle attempted to modify the original Steady State model. With Geoff Burbridge, he developed the concept of Quasi Steady State Cosmology (QSSC). Hoyle and Burbridge now suggested that the universe is cyclic; the time period is very long and the new cycle wipes out the remnants of the previous cycle.

Hoyle did not see any theoretical justification in the Big Bang model, or why the CMB temperature should be near 3°K. Could there be an alternative explanation apart from the cooling from a previous hot state. Stars radiate mainly in the visible range. It may be this visible radiation get changed into microwave radiation by the time it arrives on Earth. He proposed



a) Random motion of galaxies; b) simplification, assuming all galaxies cross the curved surface at right angle. Origin extrapolated to the origin X, the time line is cosmological time.

that the star light gets scattered by the dust particles and by the time it reaches the Earth it transforms to microwave range. There is plenty of dust between us and the stars in the interstellar space and the size of the dust particles is comparable to the wavelength of visible light. Astronomers found that the star light is polarised. In most of the cases light from a source is not polarised, it becomes polarised only after reflection from a surface, say dust or water. Light passing through a polarised filter gets polarised.

To transform the visible light to microwave light/ radiation, the dust particles had to be cylindrical in shape, less than a millimetre and should have metallic component. Presence of magnetic field in the cosmos would align the dust particles and all these could change the visible wavelength to microwave range. Laboratory made cylindrical shaped dust particles were shown to be similar to the dust in the interstellar space. Hoyle's group convincingly showed that the presence of dust can change visible light to microwave range and would be polarised.

The Cosmic Background Explorer (COBE) proved that the CMB is a black-body. QSSC model had answer to the results from COBE; the scattering by dust is the reason for the observed CMB radiation.

The final blow to the QSSC model came from the Degree Angular Scale Interferometer (DASI) experiment, based in Antarctica. It measured the polarisation of CMB. The measured polarisation was very minuscule compared to the prediction by the QSSC model, thus ended the QSSC model. Hoyle passed away in 2001 and DASI results came in 2002.

Hoyle did not receive the Nobel prize. He was awarded Crafoord Prize by the Royal Swedish Academy. In the citation Hoyle was praised for his work on stellar nucleosynthesis, "except" the lightest elements. About the later work the citation commented *"-- work is characterised by new interesting ideas and, sometimes, speculation"*. As a postscript, Geoff Burbridge, the joint proponent of QSSC published a paper in 2009, *"Facts and Speculations in Cosmology"* with Jayant Narlikar, a student of Hoyle. In this paper, there was no mention of the results from DASI.

Source

Loosing the Nobel Prize; Brian KEATING; 2019, W W Norton

The Structure of the Universe; Jayant NARLIKAR; 1977, Oxford University Press

Nobel-worthy astronomical discoveries of the 20th century

By Geoffrey Johnstone

If you were asked to make a list of astronomical Nobel Laureates of the 20th Century, I wonder who would be on it. In fact, you wouldn't find many as there is not a separate Nobel Prize for astronomy – astronomy comes under the umbrella of physics. There have been plenty of Nobel Laureates whose discoveries have had important repercussions for astronomy or have subsequently used to make discoveries.

In 1974 there was one Nobel Prize for physics that was completely astronomical. The citation read as follows:

"…for their pioneering research in radio astrophysics: Ryle for his observations and inventions, in particular of the aperture synthesis technique, and Hewish for his decisive role in the discovery of pulsars."

The strange thing is, that although Martin Ryle certainly developed aperture synthesis and Antony Hewish was part of Ryle's research group, neither actually discovered pulsars. It was their PhD student Jocelyn Burnell, now Jocelyn Bell Burnell, who made the discovery. So, here is the real story.

Jocelyn was born in Lurgan, Northern Ireland in 1943 (so is a bit younger than this author) and still speaks with the remnants of an Irish accent. The first school she attended did not allow girls to study science and, probably as a result, she failed her 11+ exam. She was already interested in astronomy by this time, as her father had astronomy books and was involved in building the Armagh Planetarium. Later, Jocelyn's parents moved her to a Quaker girls' boarding school near York where her interest in physics was encouraged. She followed this interest and obtained a Bachelor of Science degree in Natural Philosophy with Honours awarded by the University of Glasgow. While at Glasgow, whenever she walked into the physics lecture hall there were always catcalls and other sexist behaviour, because she was the only female student present.

From Glasgow, she moved to Cambridge where she attended New Hall College (now known as Murray Edwards) and worked with Antony Hewish and others to construct the Interplanetary Scintillation radio telescope to study Quasars, which had recently been discovered.

The first winter in Cambridge was particularly cold. If you don't know Cambridge, it is very flat area across which blow very keen east winds. She spent this winter building the telescope in a 4 acre field; the telescope consisted of 2048 poles across which were strung wires. Building the telescope was not a job for the weak or faint hearted, but she was determined to succeed.

In 1967, the telescope was operational and connected to a pen recorder. It wasn't long before a strong signal was received, which consisted of a few overlapping strokes of the pen at regular intervals. The signals were jammed into a quarter inch of paper, so Jocelyn ran the pen recorder faster when the signal was expected. However, the signal had disappeared. The first thing her colleagues asked was whether she had wired the telescope up correctly. Jocelyn said that she was used to such ribbing, partly because she was a student and partly because she was female. After a month the signal reappeared. She immediately got in touch with Hewish who thought the signal had to be man made as it was so regular. One possibility was a badly suppressed car, which was a common occurrence in those days and often affected television pictures. The first time she saw the signal was in August and by November it had kept pace with the stars, in other words appearing 4 minutes earlier each day.

Jocelyn called the signal 'LGM-1' for a joke;' LGM' stood for little green men. This presumably alluded to the Treens from the Eagle comic. It was possible to estimate the distance of the signal source to about 200 light years. This was well within our galaxy, but too far for radio signals from Earth to have reached whatever was producing the system.

A few weeks later, a second signal was received, and then another. It was hardly likely that many civilisations were all signalling on the same frequency at the same time from different parts of the galaxy. Instead, it must be a new object, and so Jocelyn and Anthony published a paper in Nature in February 1968 – *"Observation of a rapidly pulsating radio source"*. Nature was published on a Friday and two days before publication there was a seminar. Just prior to the seminar it became known that an important announcement would be made, so Fred Hoyle and others were invited. After the presentation, Hoyle was asked whether he thought it likely that the cause of the signal was a white dwarf star. Hoyle said he thought it was more likely to be a neutron star, which turned out to be the correct interpretation.

As soon as the press heard that the discovery had been made, not just by a student, but by a woman, the phone never stopped ringing. Most of the questions they wanted to know related to her vital statistics: whether she was a blonde or a brunette, her height, and whether or not she was taller or shorter than Princess Margaret. Photographers subsequently came to take pictures of her in all sorts of crazy situations. One even asked her to undo the top button of her blouse! Sadly, even in this day and age, these types of questions and requests are still put to intelligent women. In 1974, when Anthony Hewish was awarded the Nobel Prize for Jocelyn's discovery, the publicity started all over again. At the time, she said it was only right because Hewish was her supervisor, although she didn't entirely believe this. She thought that she hadn't received recognition because she was a student, and not because she was a woman.

Fred Hoyle publicly denounced the Nobel Committee's decision to not include Jocelyn Bell in the Nobel Prize with Antony Hewish. This got him in hot water with the Nobel Committee, which may well explain why he didn't receive a Nobel Prize for his work with William Fowler on the *"Synthesis of the elements in stars"*, for which he had done much of the research.

So, back to pulsars. There are between two and three thousand pulsars now known in our galaxy. They are very compact, very massive spinning neutron stars and as they rotate, which they do very quickly, they swing a beam of radio waves around. If that crosses the Earth, we receive a signal. The reason why they spin so fast, often measured in milliseconds, is because when the stars collapse to preserve the angular momentum, they spin up like an ice skater who is spinning while drawing in their arms. Jocelyn Bell was very astute to have noticed the original signal, as it could easily have been overlooked and she was equally astute to follow it up.

Jocelyn has had a distinguished career; she has been awarded 15 prizes for her discovery, and many honours. In 2018, she was awarded the Special Breakthrough Prize in Fundamental Physics, worth three million dollars (£2.3 million), for her discovery of radio pulsars. The Special Prize, in contrast to the regular annual prize, is not restricted to recent discoveries. She donated all of the money to fund women, and under-represented ethnic minority and refugee students, to become physics researchers.

In 1999, she was appointed Commander of the Order of the British Empire (CBE) for services to Astronomy and she was promoted to Dame Commander of the Order of the British Empire (DBE) in 2007. In February 2013, she was included in the BBC Radio 4 Woman's hour power list – a list of 100 women considered to be the most powerful in the United Kingdom. In February 2014, she was elected President of the Royal Society of Edinburgh: the first woman to hold that office. She held the position from April 2014 to April 2018 when she was succeeded by Dame Anne Glover (a biologist). In 2016, the Institute of Physics renamed their award for early-career female physicists the 'Jocelyn Bell Burnell Medal and Prize'.

Jocelyn Bell Burnell's contributions to astronomy continue to be recognised. Just this year, she was elected a Legacy Fellow of the American Astronomical Society and she was included in a list of seven important but little-known British female scientists, which was compiled by the BBC. Recently she has joined the male-dominated portrait collection at the Royal Society in London where she is one of the few women to have their portrait hung on its walls. The painting shows Bell Burnell at the Royal Observatory in Edinburgh, in front of a 36" Grubb-Parsons telescope. It was unveiled to mark the date 53 years ago when she discovered pulsars.

Decisions

A bit of Sci-Fi, By Irene Rogers

Comet gazed through the window of his ULLEO space retreat at the blue-green sphere of Earth. The fully automated ULLEO, as its nomenclature indicated, was positioned right at the upper limits of low earth orbit. It had been the ultimate in 21st birthday presents from his grandfather for the rich kid who had had everything else already. At first, he had thought it a ridiculous present, hadn't wanted anything that took him away from his friends. . . but the more he used it, the more he liked it. It was changing his life.

He rested his chin on his hands; he supposed he'd have to check available windows and arrange a flight slot to take the shuttle back to his father's private island just off the Bahamas. Some VIVIPs (very important very important people) involved with the bases on the Moon and Mars were coming to one of his father's special "networking" parties, and as heir apparent to the vast space telecommunications and exploration (exploitation, he thought, was more appropriate) empire, he was expected to make an appearance.

He loathed the very idea; he found he now hated the almost unimaginable wealth and power that resided in his father's hands, no one person should have that amount of both. People lived and died under it; not directly of course, his father could be quite benevolent at times but his business came first. If an offshoot of it wasn't profitable, he shed it. Never mind the employees who lost their jobs; their lives were their own responsibility, "re-skill or put up with the consequences" was his motto.

When Comet had been younger, (and he was only 23 now!) he had loved it. His father, remembering a much stricter youth, had denied him nothing. Fast cars, yachts, trips to space stations, gadgets, clothes – he had had the lot. . . sex, drugs, drink, even petty crime – he had tried the lot. His father had decided that he should sow whatever he chose to sow while he was in his teens and early 20s with no questions asked or consequences – he would pick up the pieces; pay people to keep silent, even pay people to keep people silent - but, by the time he was 30, he expected him to be as involved in the family business as he had been in his father's at that age. He dreaded it; he hated the ruthlessness of the empire; how tight control over global and now interplanetary communications enabled it to swallow, digest and eliminate business rivals – especially those in cable and terrestrial telecommunications. He had been very pleased to learn that a disastrous but thankfully brief flirtation with mind-controlling microchips had ended with expensive lawsuits on human rights issues. He hadn't been as pleased to learn that its experts had found other psychological methods to manipulate customers to unknowingly buy, do, live, even think the way it wanted just to keep pole position in the race for supremacy in the world of space telecommunications and exploration.

He stared at the Earth. It was a beautiful object but far more fragile than its appearance suggested. Masses of humanity on it were being urged to expect more, consume more, use more but never as much as the controllers of their pointless lives who, in turn, tripped and trod over each other in their determination not to lose their place in the wealth and status lists or their power! The whole process was unsustainable; niche extinctions were happening daily, someone had to find a way to take a step back.

Life on Earth and Earth itself really needed a breathing space but how to find it. He had heard of communities that had no modern communications technology – except, perhaps, a telephone for emergencies – and he had liked the thought of that, even toyed with the idea of joining one. After all, when you have had everything you ever wanted - and are faced with having more of the same – what was there to look forward to?

A bleep alerted his senses – a collision warning. There was a jolt as the ULLEO automatically adjusted its orbit so that the threat could pass by. It did, in a flash, but the on-board computer identified it as a Russian satellite and large by modern standards. He was puzzled, the majority of communications satellites were in their allocated orbits far below his retreat so where had it come from? It should never have been anywhere near his; allocation of orbits was an internationally-regulated and deadly serious business and incidentally, one of his father's, but then he remembered, the notorious "killer" satellites that were explained away as anti-collision systems testers. The explanation was met with the usual blatant scepticism of anything coming out of Moscow, and other such dynastic dictatorships, as the people in those countries were ruled by men almost as ruthless as his father. If things got in their way…

Comet was disturbed; a collision at their speed and altitude would have resulted in the complete destruction of both the ULLEO and the satellite and the resulting debris caused could have. . . would have crashed into other space vehicles and satellites destroying them too. A cascade reaction would follow - as theorised by an American NASA scientist, Donald J Kessler almost a century earlier. It could be bad enough to knock out all the communications satellites, and as constellations of them were being sent up all the time by his father's and rival companies, the chances of it happening were increasing by the day. "Another fine mess we've got ourselves into!" the phrase from an ancient black and white film came into his mind.

He'd read somewhere an adage that went on the lines of; "a man builds a business and makes a fortune; his son takes it over and makes another fortune; his grandson takes it over and ruins it."

Comet was that grandson; he made his decision, he over-rode the anti-collision software on the ULLEO and re-set it on a diagonal path that would cut a swathe through the orbits of his father's communications satellites. He knew he would be killed in the ensuing cascade of collisions but... it would step back progress and give life on Earth its breathing space!

Go Boldly

By Geoffrey Johnstone

WARNING This should not be read by males under the age of 50.

The only connection with this item of miscellany and astronomy or the society is, that I missed the last meeting that we had before the lockdown, because I was in hospital having an operation. The operation was laser treatment for a benign enlarged prostate.

I remember in the 1960's reading an article in a science magazine which described the laser as a 'device with no known application'. I tried to spout this nugget of information to every one I met, the surgeon, the anaesthetist and a few others, but for some reason they just thought I was a boring old f-fellow.

The operation was quite early in the day and I was first on the list. The last thing I remember before falling asleep was someone putting a large sign on the door of the theatre saying 'danger laser in use' and a very bright green glow emanating from the door.

On waking up I was aware of an oxygen mask on my face and glancing to the left there was a drip that was plopping away slowly into my arm. Adjacent to that was a much larger bottle that was slowly emptying itself into a tube the size of a garden hose that disappeared under the bed clothes. Ever curious I gently lifted the blanket and sheet to see where it went, as if I didn't know. Ow-ee! That's going to be painful when they remove it! From the same part of my anatomy a thinner tube curled into a receptacle attached to the side of the bed that seemed to be slowly filling with blood, my blood! Later I found that it was necessary to wash my bits and pieces out over the next 20 hours. The large bottle was changed several times until the colour of the effluent became sufficiently pale, which wasn't until the next morning.

So for the next 20 hours I couldn't move although the oxygen mask was removed within an hour and the drip about the same time. At least the refreshments arrived soon after, a cup of tea followed by lunch at the appropriate time. I was able to phone my wife who seemed quite pleased to hear that I was still alive, and my daughter phoned me which was nice. I did have a television, and it is amazing what rubbish you watch when there is nothing else to do. I watched a film until 11:45 pm which I would not normally have considered to have any entertainment value.

I eventually fell asleep in a semi upright position, although waking up whenever they came to change the large bottle. Morning eventually arrived, together with breakfast and coffee. The surgeon came to see if I was alright and tell me I could go home when I was disconnected, which a young doctor came to do. I was told to relax and then removing the tube would be less painful. Isn't it funny how being told to relax makes you want to do the opposite, but I obviously survived the assault!

Before going home I was given a booklet to indicate what to expect when I got home. I quote. *"Slight discomfort when you pass urine, and passing urine more frequently."* Clearly the person who wrote the manual had never had the operation. I lost count of how many times I had to down tools and run, not quite making it on occasions and as for the discomfort. I would describe it more like a red hot poker had er- suddenly been, well you know what I mean! This is very like the medical speak when a doctor or nurse advances towards you with a large syringe and says. "You will feel a slight prick". Prick indeed!

I am glad to say it all settled down until about two months later when on I got up in the middle of the night to relieve myself and I couldn't. I tried and tried, but couldn't. I cannot tell you how awful it is when you want to and you can't. After a while I woke up my wife to say I would have to go to A&E. She as usual ever helpful pointed out that it was a Saturday evening and A&E would be full of drunks. She forgot that we were in lockdown and the pubs were closed, so it would probably have been deserted at one o'clock in the morning. Instead she suggested I rang 111, which I did. I had a very quick response and explained my predicament. She didn't giggle, or titter, she was too professional for that, but I could hear her smiling, if you know what I mean. Anyway I answered her questions after which she said she would have to pass me on to one of her colleagues. So another young lady came on the phone, asked me all she same questions and I could hear her smiling too. Following a brief silence she informed me that she would need to get the duty doctor on the line. However at this point I decided to go and have another go, so with the phone in and hand and, you know what in the other I gave an almighty squeeze and suddenly I made a sort of ah-ah-ah noise and it was like Niagara Falls. I was ably to inform the lady on the phone that her services were no longer required and that I was much relieved, and we both laughed. One wonders what stories the people at 111 told each other and the people they lived with at the end of their shift. "Guess what, last night I had this chap ring in who said he couldn't pee". "Really what did you tell him to do?"

All's well that ends well and I am now full repaired, until the next bodily malfunction occurs. If there is a moral to this sorry tale it is to 'go boldly, where no man has gone before', well not you at any rate. Into the unknown and hope for the best at all times.

Big Bang Questions

By Ivor Clarke

We've all watched TV programs and read books and articles about the start of the universe and the Big Bang. We now know so much more than when the first ideas were proposed well over a hundred years ago. We now have theories of how we think it all started, how a tiny spark in the distant past produced the universe we see today. What do we really know about the start of every thing we can see. All of space and time. Every thing out there in the space that surrounds us?

In just over 100 years or so the known size of the universe has grown from just our galaxy with all its stars and misty nebula into a vast expanding – what? A universe with trillions of galaxies stretching across 100's of billions of light years? Just as the universe has got bigger, so too has our galaxy. It was once thought to be around 50,000 light years across, but its now getting on for 200,000+ly overall, just a little smaller than the Andromeda Galaxy, M31. But were did it all come from?

In the October 2020 issue of *Astronomy Now* is an article on the BIG BANG with an illustration of a very bright object with a few galaxies flying off. The Big Bang is always shown has a huge explosion which formed our universe and everything in it, both in films, on TV and in books and magazines. In TV programs on space and astro physics, the Big Bang is shown as an explosion in various ways, most times with lots of bits flying off in all directions and clouds of hot gas, a bright fireball getting from nothing too BIG very quickly. Scientists say we can never know what is outside of our universe because all radiation as well as light cannot leave our universe. So if we can't see outside and we can't see an edge, we have no idea were we are in our universe. Are we near an edge or near the middle? So if we can't know what's outside of our universe, how can you see the Big Bang? What are the artists and illustrators standing on to see the explosion? Is it safe? How far away are they? And where are they? Out side our universe? In a different universe? In a different reality? What are they? Does time exist for them?

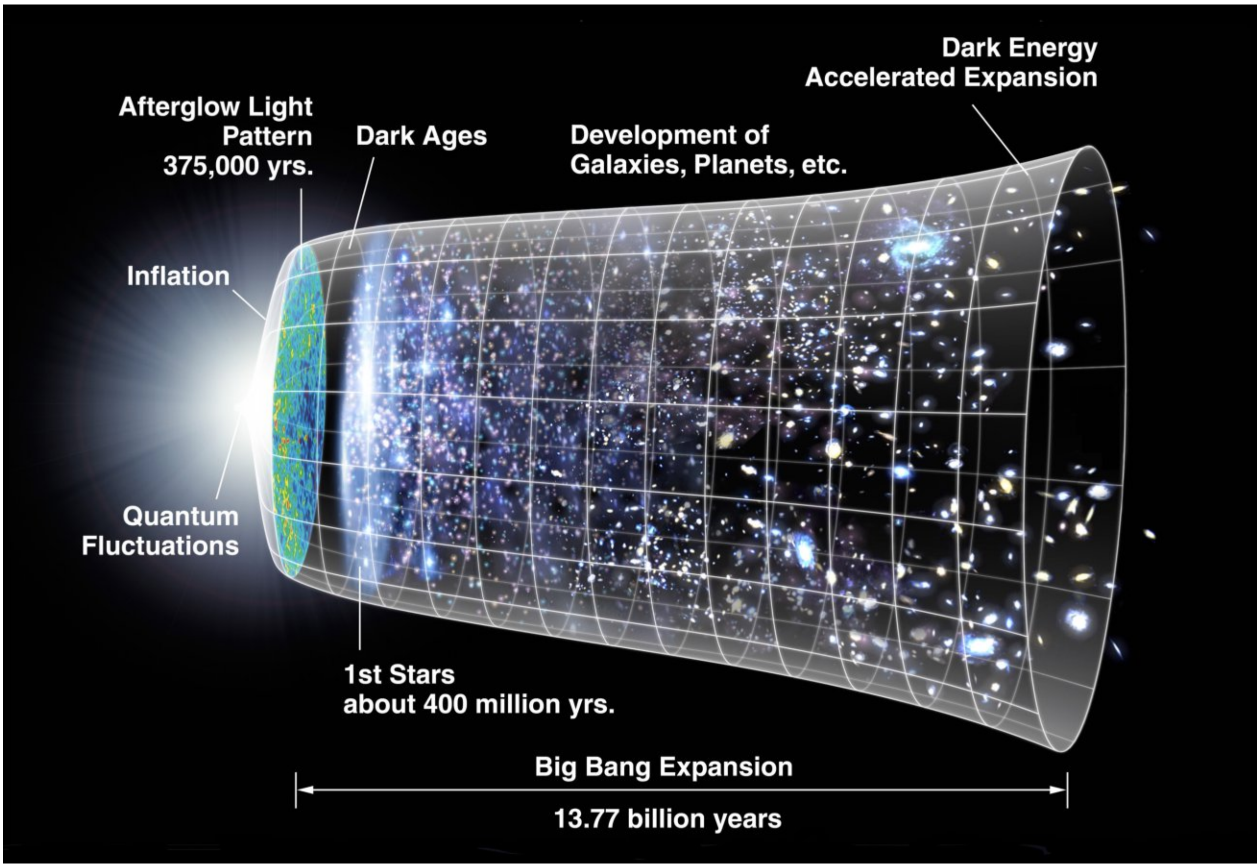
We know that our universe started 13.8 billion years ago from a ? (our physics at the moment can't tell us what happened at the very start of the process as the energy involved is infinite), and we can work out its size now to be roughly 90+ billion light years across and it's getting bigger all the while.

At the beginning there was an instance when our universe began, a spark, a point, a blip, a spot. The Big Bang. Whatever caused it to happen; it started the fireball which was expanding at the speed of light, then, after an unbelievable short space of time, something happened to caused a very rapid expansion, this is called the inflationary epoch. This was just 10^{-36} of a second after the Big Bang had started, when the universe was about half the width of a molecule of DNA, about 1 nanometer in diameter, 10^{-9}m in size and then it expanded in volume by a factor of 10^{78}. This number is a million followed by 6 trillions. The fireball was now a bubble approximately 10.6 light years across, about 10^{17}m or 62 trillion miles. This is an expansion of distance by a factor of a least 10^{26}. Then just as quickly as it had started, at about 10^{-32} seconds it, inflation, stopped! In an almost an instance of time the universe was now light years across. This tiny interval of time is just one of the mind boggling things about the Big Bang. Scientists can now time interval as short as an attosecond 10^{-18}, there are more than twice the number of attoseconds in a second then there have been seconds since the Big Bang. Some quantum processes take place in zeptoseconds 10^{-21}. Then the Big Bang continued to expand at a much slower rate, until 9.8 billion after the Big Bang, 4 billion years ago then it started to gradually expand faster and it is still doing so. That the universe should start to expand was a great surprise as it was thought it would slow down by the pull of gravity from all the mass in the universe.

Scientists have been trying to nail down the expansion rate for years; trying different methods and coming up with lots of differing results. In the late 1920's Edwin Hubble first estimated the expansion rate at a mind boggling 500km/s. During the second half of the 20th century the value was estimated to be between 50 and 100km/s. But now it's down to two numbers. It is expanding at a rate of 73.2 kilometres per second per megaparsec if you believe the results from the Type 1a supernova study by ground based and the Hubble Space Telescope or 67.4 kilometres per second per megaparsec if you believe the new results from the cosmic microwave background eBOSS results.

So let's say its expanding at 70kps per megaparsec which is an average. A megaparsec, which is 3,261,000 light years is a long way, further than the Andromeda Galaxy M31 at 2.5 million light years and is even further than the Triangulum Galaxy, M33 at 3 million light years. A light year is 9.46 trillion kilometres or 5.88 trillion miles. This makes M33 over 17 million trillion miles away.

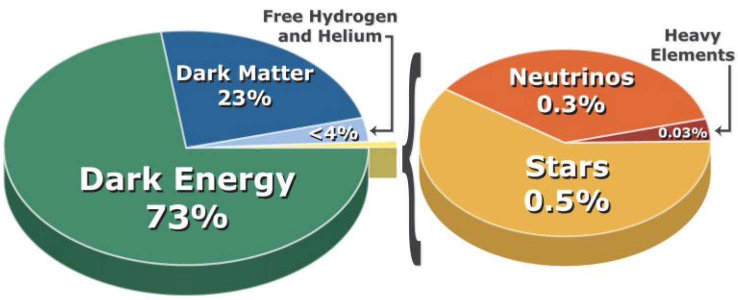
So somewhere in space far beyond the Andromeda galaxy is a point in space which is moving away from us at about 70kps or 43.5 miles per second or 156,585 miles per hour! This is a point at which, let's say a spaceship, is not moving under its own



Timeline of the universe. A representation of the evolution of the universe over 13.77 billion years. The far left depicts the earliest moment we can now probe, when a period of "inflation" produced a burst of exponential growth in the universe. (Size is depicted by the vertical extent of the grid in this graphic.) For the next several billion years, the expansion of the universe gradually slowed down as the matter in the universe pulled on itself via gravity. More recently, the expansion has begun to speed up again as the repulsive effects of dark energy have come to dominate the expansion of the universe. The afterglow light seen by WMAP was emitted about 375,000 years after inflation and has traversed the universe largely unimpeded since then. The conditions of earlier times are imprinted on this light; it also forms a backlight for later developments of the universe.

power and is at a standstill relative to its position, but it is still moving away from us because the fabric of space is expanding! Now this is a LOT quicker than any space craft we have yet built, from Coventry to London in about 3 seconds, Coventry to New York in less than 90 seconds, to Perth, Australia in less than 6 minutes, to the Moon in 2 hours, Mars at is closest about 10 days. But the Earth and its Moon are a small tiny part of our solar system but it is space that is getting stretched out.

So from our point in space, getting on for a million light years the other side of the Andromeda galaxy what can we see? The Andromeda galaxy nearly edge on to us filling most of the sky and in the distant our Milky Way galaxy, this would be some sight. Because the local galaxies are connected to each other by the pull of gravity and are in the process of a very slow crash, space is moving too slowly to have any effect on them and the pull of gravity is overwhelming the expansion. The gravity of galaxies overcomes the effects of the expansion so galaxies are not getting larger, they are like the currents in a cake which expands on cooking but the currants don't get larger. So from our vantage point, is the Earth is getting further or nearer? With the effect of the expansion it must be further as the space expands, but if a galaxy is already moving in the local area faster than the local expansion it will continue to do so. The local cluster of about 20 or so galaxies will, it is thought, always be near to each other as the local gravity is strong enough to hold them together.



So what's pushing the universe apart? Well it seems that it's the mysterious force called Dark Energy which makes up over 70% of the universe is the culprit, with Dark Matter at 23% and all the stars and matter we can see and touch and interact with at only 5% we are in a minority.

It is only when you get much further out to thousands of millions of light years that space is moving away from us at fantastic speeds. That is why the universe at only 13.8 billion years of age is 90+ billion light years across. Space has stretched that far in that time with the expansion.

Astronomical Highlights of 2021

By Mark Edwards

Meteor Showers

Quadrantids, January 2nd - 4th

Lyrids, April 22nd

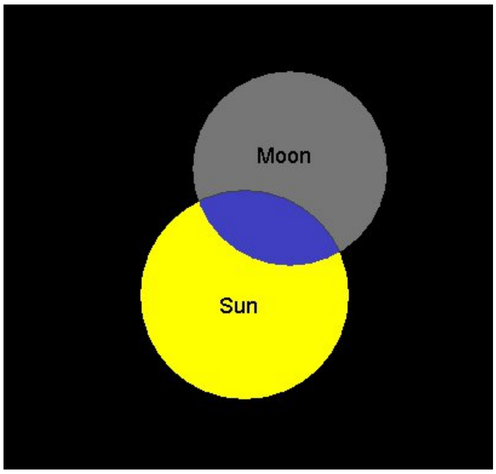
Eta Aquarids, May 6th

Perseids, August 12th

Aurigids, August 31st

Draconids, October 8th

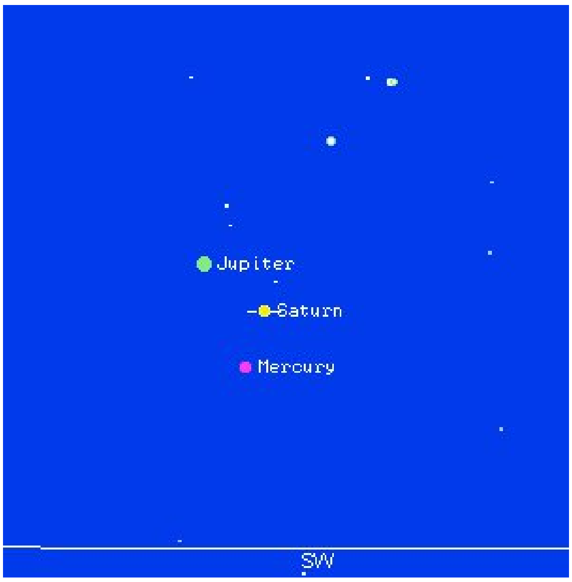
Geminids, December 13th



Eclipses

Partial Solar, 34%, June 10th 09:18 - 11:20

Partial Lunar, November 19th 06:02 - 07:30 moonset



Planetary Close Groupings

Mercury, Jupiter and Saturn, January 9th - 13th evening

Mars and Uranus, January 20th evening

Mercury and Jupiter, March 5th morning

Mercury, Venus and Uranus, April 25th evening

Mercury and Venus, May 28th evening

Venus and Mars, July 13th evening

Oppositions

Vesta +5.9, March 4th

Saturn +0.2, August 2nd

Jupiter -2.9, August 20th

Neptune +7.8, September 14th

Uranus +5.6, November 5th

Ceres +7.2, November 26th

Close Encounters

Moon near Mercury, Jupiter, Saturn, January 14th

Mars near Pleiades, March 3rd - 4th

Moon near Hyades and Mars, March 19th

Moon near M35 and Mars, April 17th

Moon near Venus, May 12th

Moon near Venus and Mars, July 12th

Moon near Venus, October 9th

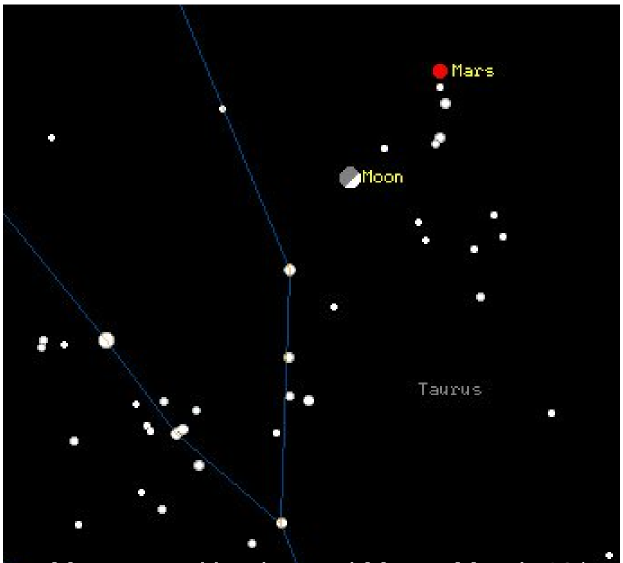
Greatest Elongations

Mercury, January 24th 18.6° east

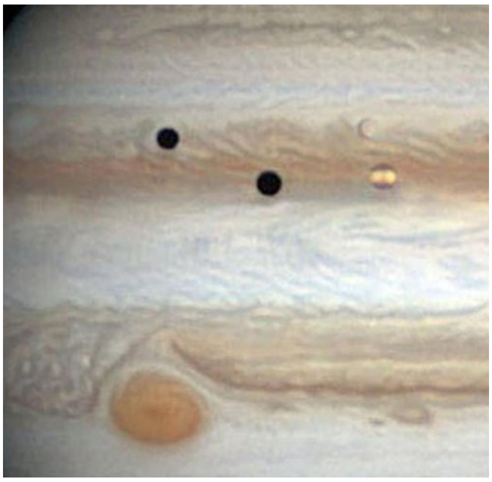
May 17th 22° east

October 25th 18.4° west

Venus, October 29th 47° east



Moon near Hyades and Mars, March 19th



Jupiter's Moons

Ganymede's shadow on Io, May 14th 03:43

Io and Ganymede shadows, June 5th 00:30

Io transit, Io and Ganymede shadows, June 12th 02:40

Io and Callisto transit and Io shadow, July 29th 21:00

Europa, Ganymede transit and shadows, August 22th 19:15

Ganymede and Callisto shadows, October 4th 18:50

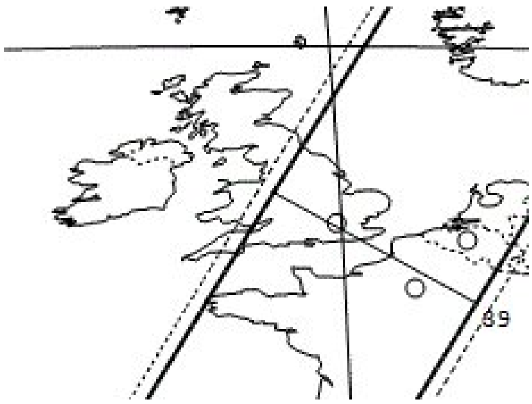
Occultations by the Moon

Epsilon Geminoram +3.0, September 2nd 00:12 - 01:45

Kappa Geminoram +3.7, September 3rd 02:41 - 03:38

Eta Leonis +3.5, December 24th 03:19 - 04:04
by Asteroid (2) Pallas +9.1

Star TYC 5240-00433-1 +9.2, October 12th 21:39



Path of Pallas' Shadow October 12th