Our Universe

A BRIEF INTRODUCTION TO OUR UNIVERSE BY CHRIS SARA

Foreword

I consider myself a person of both science and faith but the two are often seen to be at odds with each other. Through history people of science have not fared well in the presence of those with faith. This is bourn from fear and ignorance but we now understand more and have come to rely on science for our answers. Now that the reasoning as shifted people of science should not as quickly dismiss faith as those before dismissed science; after all, we need to consider all aspects of our existence, in a yet unravelled Universe.

When observing the Universe, it is hard not to wonder what lies out there awaiting our discovery. Are we alone? Is our course of evolution a course predestined by physics; our future no more in our control than was the past? In all the Universe so far explored or observed, we are – humans - by far the most complex thing to have been encountered.

For many centuries great scientists and philosophers have ponded the heavens, they have observed and recorded, theorised and quantified, but now more then ever, we are able to translate observation into knowledge. Today, much of our investment in astronomy focuses on life, the most complex arrangement of the elements that came from the death of stars. Whether we are looking for answers to explain how our world will evolve, perhaps looking for a new home for humanity, definitely tracking the path of objects able to destroy us all, or ultimately finding other life, that is what astronomy is to the inquisitive mind.

At times we must put the science aside and solely marvel in the immense beauty of space. A vast array of light, dust and gas combined in a chaotic structure. If you take nothing else form star gazing than images of awe then your time will be well invested. As we look deeper and deeper into the past, as it is the past we observe, the more we come to understand and the more we understand how much we don't. Physics and chemistry are our tools to understanding, with theory at the forefront of discovery. We must place faith in what we believe, faith in the science, as we are yet to actually observe many of the things we expect to find.

Introduction

Astronomy is the study of the Universe; a human study. We look out to understand both the past and future. Countless questions give rise to countless answers, in turn giving rise to countless more. We know more about the Universe now than ever before, but we will never know it all. We can never stop looking, seeking answers, pondering our place in the magnificent chaos of space.

The moment the first stars ignited, life within the Universe was made possible. Everything required for life to evolve has been created within the stars. Before stars, the Universe was a place of the simplest gases, dark and lifeless, unexciting compared to the complex Universe we now observe.

Earth may, or may not, be the only place life exists within the Universe, but we could very well be the most complex lifeforms that have so far evolved. Given the share number of stars, opening up the opportunity for an even greater number planets, there is every chance that many regions within the ever-expanding Universe have, or have had, or will, be home to life.

In what is to be a very long life the Universe can still to defined as being very young. In relation to our own human journey, we are required to comprehend an existence where time must be measured in billions of years, not millennia, distances in light years, not miles, and energy as factors of the Sun, not megawatts.

The concept of a “Universe” would not have played a part in the early stages of human development. Long before science began to explain the stars and objects of the cosmos, the night skies were the regime of myth and mystery; to the point that even today religions, cults and many other cosmic followers still base their faith around the stars.

Early conception of the Universe prescribed Earth as the most important component; we placed it at the centre. This Earth-centric belief has been debunked by science and sensibly we have stopped persecuting those who apply observation and physics to explain how the Universe works. I like to think that the science we have applied does not mean “faith” in the unknown is not a genuine path; moreover, it gets us closer to understanding our place in the cosmos. Afterall, the power to discover the “why” is at the heart of human progression.

Astronomy for most of us is simply observing; we don’t have to draw any conclusions from our observations as it is enough to simply enjoy the view.

The Beginning

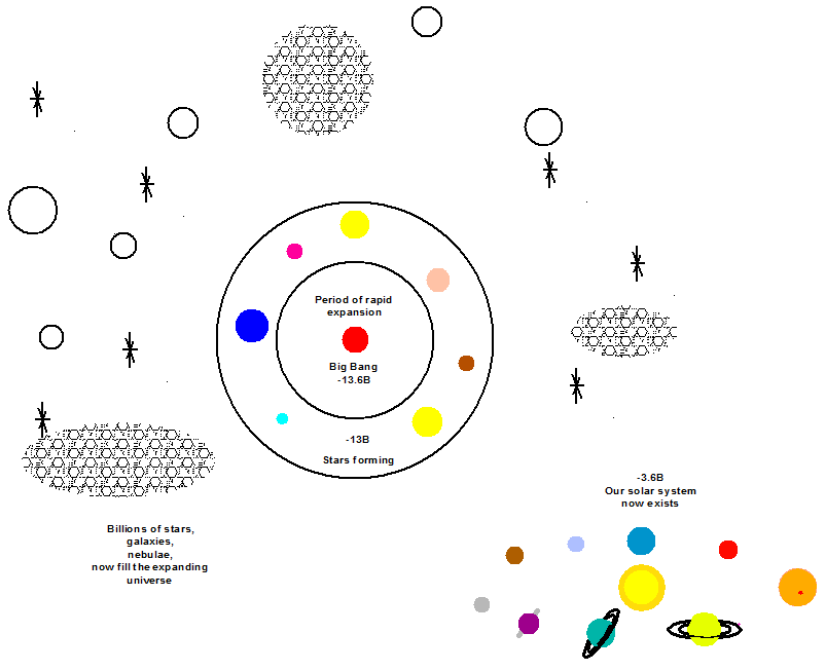
After many years of theorising the one thing that cannot be denied is the vast scale of space, so incredibly large that distances are measured in light years, that is 9.5×10^{15}m. What we are observing when we look at the cosmos is really events that occurred anywhere from seconds ago to billions of years past. History is frozen in a beam of light travelling from the start of time, to us, or perhaps, beyond to observers somewhere even further out in the Universe.

Our understanding will evolve as we reach further back in time and closer to the beginning of our journey. There are theories about cosmic webs and even multi-verses, but for as long as I have been contemplating the Universe it was about the "Big Bang", our most commonly perceived explanation of the start of our known Universe.

There is so much involved in this single moment that it could easily distract one from the simple enjoyment of astronomy. We can leave the finding of answers to the astrophysicists and for now be content with the resulting canvas we have been presented. However, we must take a moment to put context around what we are looking at, and our place within it.

So, a single point in time, some 13.6 billion years ago, a point incredibly hot and dense, ignited and started a chain reaction. An expansion of matter that lasted many millions of years releasing the building blocks for stars (suns). Suns formed only to consume themselves before releasing their matter to add to the ever-increasing matter that was to form the Universe as we know it today. Billions of years have passed and the process continues, as it will for many of trillions of years to come.

That gets us too now, our solar system, a place of life for some 3.6 billion years, sitting in the Milky Way, our galaxy; a vast collection of billions of stars spanning distances of many thousands of light years – a galaxy that accounts for merely one of billions of galaxies throughout the Universe, each potentially home to many *"Earths"* offering the hope of life.



The exact understanding of the science behind the origins of the Universe is not necessary for enjoying the pastime of astronomy. We learn the science to help explain why things are the way they are. With an understanding of physics, we can appreciate why things are, and combined with chemistry, we can understand why they look like they do.

Astronomy

Astronomy is the branch of science that deals with all the stuff in space, the physical Universe. For most of us amateur astronomers it is primarily about observing "stuff", and there are many ways to do this. Some stuff can be seen with the naked eye, some with the aid of binoculars, where some will require a telescope. However, all but the Sun and Moon are so far away, or small, that they only appear as dots, or maybe smuggles, of light in the night sky.

Objects that we can practically observe

There are many objects present in the night sky. The darker the sky, the greater the number of these objects that will be visible. For this reason, it is important to reduce and hopefully eliminate light pollution where ever possible.

The moon: a good starting point and it has its own importance. Excepting the Sun, the Moon influences the Earth like no other object in the Universe. It is the only other object man has stepped upon, and it is easy to see; hard to miss you could say.

The planets: the other objects in the near vicinity of us. Depending on where they are in their orbit around the Sun, some are visible with the naked eye, and show good detail with the right telescopic equipment.

Stars and Constellations: the naked eye is sufficient to view these star patterns in the sky. Stars form the zodiac signs that have their history rooted in time. As the Earth orbits the Sun on the ecliptic, (the apparent path of the Sun through the Zodiac), the constellations will appear in the night sky throughout the year, and aid us to navigate the night skies.

Milky Way: our home galaxy with a spiral arm that stretches across the night sky. A cloud of dust, tens of thousands of light years wide, that reflects star light presenting a highlight to any clear night observing.

Deep space objects: of the billions, only thousands are visible at the best of times. Light pollution means that in some locations, visible stars only number tens or hundreds. Their motion, brightness and colour are the basis of much of our scientific knowledge.

> **Star Clusters:** what may look like a single object in the sky may be a group of stars that are visually close to each other but are in reality still many light years apart. A good telescope can show these are indeed individual stars.
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> **Nebulae:** these clouds of cosmic dust are the nurseries for new stars and galaxies. They are visually incredible and great astrophotography subjects.
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> **Galaxies:** billions of galaxies exist outside our own. They are home to their own clusters, nebulae and objects of wonder. There are clusters of galaxies with gravitational dependency slowly diverging in the creation of a singularity. Our own galaxy is undergoing this process, and as more galaxies combine the distance between everything within the Universe will increase.

Transients: objects known and unknown constantly transit through skies. We can observe these fleeting moments as comets, asteroids, shooting stars etc, past through our skies, and who knows, you may even discover something new; so, keep looking.

Observing the Heavens

Whatever level of knowledge you start from, or whatever level of equipment you use, there is always things to learn. You could even be the first person to see an event that happened many years past. You must remember that the closest stars are still light years away. This means that what we are observing happened many years ago. We are even observing things that are no longer in existence.

Where to start looking is a bit overwhelming. There are billions of objects spread throughout the Universe. We can observe only a fraction of them but there is a life time of observations to be made.

For the purpose of observation, we can think of the stars as stationery and their movement as being a consequence of our rotation and orbit about the Sun. In reality the Universe is expanding and everything is growing apart, but, due to the distance separating us and the stars, from night to night, we can ignore this fact. If you are studying the history of constellations and how ancient societies used them this motion will need to be accounted for.

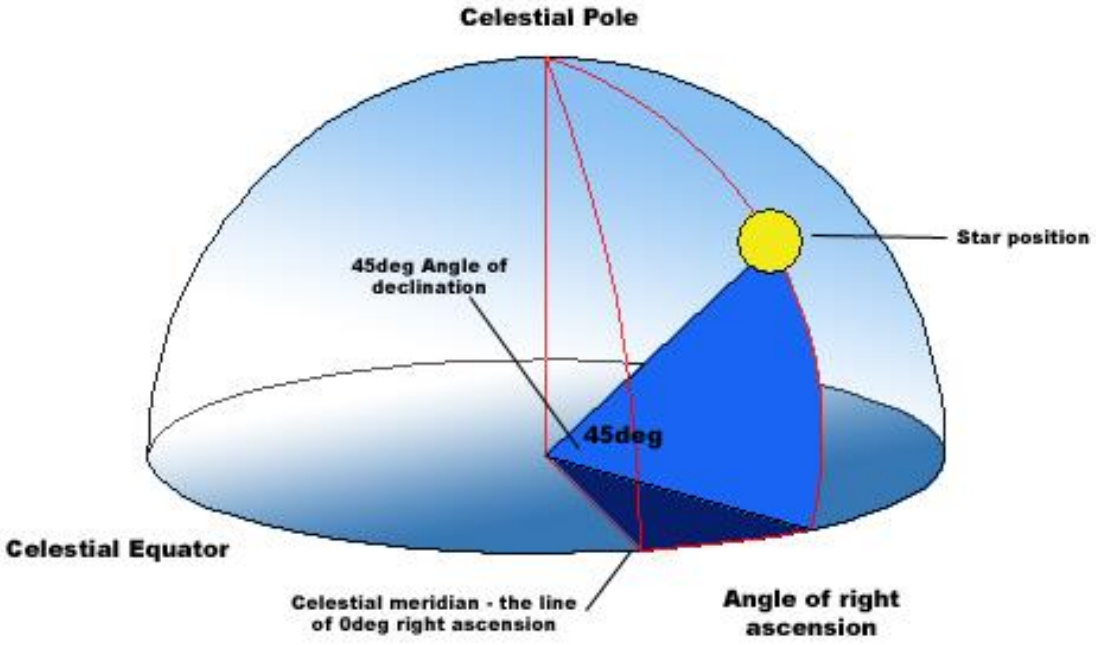
Fortunately, the stars have been mapped by the astronomers that have came before us. Learning to navigate your way using the collective knowledge makes astronomy a lot more fun. There are numbering system to prescript all the main objects observable. Learning the constellations is a good starting point. Once you know them you can star hop across the skies and in time your ability to translate the skies will make you a great astronomer.

Until your own skills get you to that point, the use of accurate mapping combined with smart equipment such as “GOTO” mounts means you can quickly and accurately be pointed to the more interesting objects.

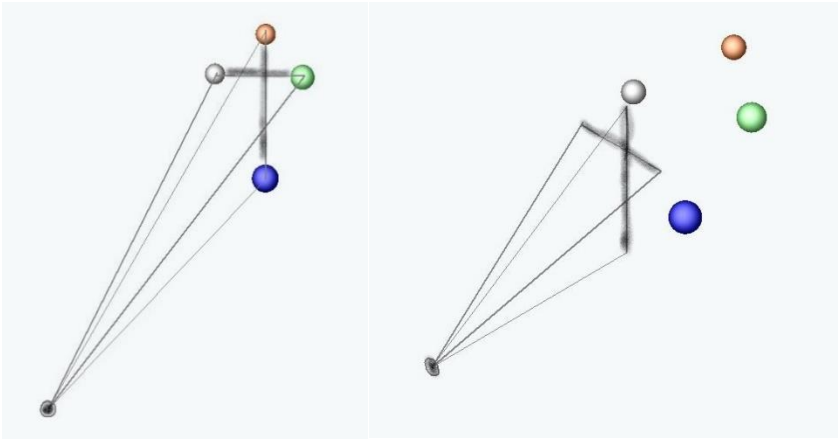
The planets and constellations have been an integral part of human knowledge for many centuries. Many cultures used them for planning their planting seasons and more latterly for navigation. Astrologists to this day still use the stars to predict events in the lives of those who follow the practise. Due to the fact that the Universe is ever-expanding, and the Earth has a wobble that takes 28,000 years to cycle, the Universe appeared different to those, such as the ancient Egyptians, who observed and recorded it thousands of years ago. Brief moments in time, such as supernovae explosions, have also been recorded in history. You may be lucky enough to be looking at the right time and capture these moments, finding something never before seen.

The Celestial Sphere

It would be fair to say that ironically to help simplify the mapping of the Universe we place the Earth at the centre and effectively project all the objects in the Universe onto what is referred to as the "Celestial Sphere". This allows objects in space to have two dimensional coordinates as we do for places on the surface of the Earth. On Earth the horizontal lines are "Latitude" and the vertical lines "Longitude". For the celestial sphere we call the horizontal lines "Declination" and the Vertical lines "Right Ascension (RA).



This map is only relevant to us on Earth as in reality the objects we observe are at many different distances from us. The following illustration of the constellation Crux (Southern Cross) illustrates how we observe objects versus the reality.



Crux as we observe it on the left, but in space the stars are at widely varying distances

Summary

Many years of observation and science has brought us to this point of understanding but much more is still to be discovered. We may be alone or maybe not, but as long as we glance skyward, we will never stop pondering what mysteries await us.

Technology is allowing us to venture further into space and undertake greater levels of science that leads to our greater knowledge of everything. For us Earth bound astronomers we rely on our ability to access space from where we are. For this reason, the protection of the dark skies is essential to astronomy. As populations increase and people spread further across the lands the threat to darkness increases. The Universe should be seen as part of nature, with all things within our internal world, and we need to show diligence when it comes to decisions about the night skies. Things once lost can be very hard to get back. We need to promote smart lighting with controlled lighting plans. As astronomers this responsibility is more with us than any other group, as we have the most to lose.

Rakiura is one of the most southern populated land points on the planet. Our small population and low level of industrialised commerce mean we are well placed to maintain a low level of light pollution - ALAN (Artificial Light At Night). This can not be taken for granted however. There are also the problems beyond our immediate control, such as, satellites and other space-based objects, that cast their light across the night skies. The impact on astrophotography is of concern given the proposed number of objects slated for delivery into our visible space.

Enjoy your journey into the universe of astronomy and share your passion as far and wide as possible. You will never stop learning and technology will continue to offer more and more to the amateur astronomer, and in turn, the amateur astronomer will offer more and more to the knowledge of astronomy, and thereby, our knowledge of our Universe.