Heavens Above - A Chronicle: 01 All Year - Part 1

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PART 1

1. GETTING STARTED

(For 15th July 1998) Let's settle one thing from the start. This fortnightly column is about ASTRONOMY. So if you want to know if you should pop the question or if you'll win the lottery this week, you'll be disappointed. Try the Astrology columns.No, this column is going to explore the wonders of space as seen from backyards by ordinary people like you and me.

I'm the editor of Prime Focus, the Journal of the Macarthur Astronomical Society (I was up to end of 2006 -RB) and I've been studying astronomy as an amateur for over thirty years (Updated – over 40 years) . And I still don't have a telescope. (Well, now I do – two in fact.) However, I have been blessed with a beautiful pair of binoculars which have provided me with countless nights of awestruck stargazing. I have read shelves of astronomy books, increasing my understanding of the origin of the Universe, galaxies, stars, planets etc, and still, every Wednesday night about 10pm when I take the Otto bin out, I am struck dumb by the simple beauty of the starry sky.

We are living in exciting times for astronomy. Who hasn't been fascinated by the shots from Mars showing the rover Pathfinder crawling over the dry red dust, bumping from rock to rock? Or the recent passage of those two comets Hyakutake (Bless you!) and Hale-Bopp, their fan shaped tails hanging suspended over the western sky? Who hasn't marveled at the fantastic photographs from the Hubble Space Telescope revealing details of stars and galaxies that astronomers could only dream about ten years ago?

Every day some new fantastic discovery is published on the Internet, overturning old theories, setting the astronomers scratching their heads and going back to their computers to derive new theories. It helps keep them humble, recognising they don't know everything after all.

But for us, we can still marvel at the ordinary sky overhead, undisturbed by these far off discoveries. Macarthur area is blessed with dark clear skies, and we can see many more stars than most Sydney siders. I hope to be able to show you some of the exciting things to be seen 'up there'. There are much more than 'just stars.' And if I can succeed in getting you to put this paper down for a few minutes, step outside your house and look up into the sky to see for yourself, then I will have achieved my aim. So, I'll meet you again in two weeks.

Meanwhile, watch the skies.

2. THE COLOURS OF STARS

(For 2nd September 1998)

Twinkle twinkle little star

How I wonder what you are

Blue or white or red or gold

What mystery does your colour hold?

A quick check will show that not all stars are the same colour. Try it some time. You'll be amazed.There are white stars – the colour most people expect stars to be for some reason – blue-whites, even some blue stars. Then there are yellow-whites, yellows, oranges and cherry reds. It's an artist's palette out there (sorry, no greens or purples.)

But there is more to a star's colour than just pretty looks. Apart from the fact that it helps you tell stars apart (wouldn't it be boring if they were ALL white?), for astronomers, a star's colour reveals many things. It tells them the star's temperature and is a clue to its age and expected life span.

For example, our Sun is a yellow-white star, its temperature is 5,500$_{o}$C and is about half way through its 10 billion-year life. Now there's a strange thing about star colours. The redder the star, the cooler and older it is. And the more white or blue, the hotter and younger the star is. Seems odd, doesn't it? But think of it this way. Imagine the dying red coals of a fire. Hot? Then imagine the intense blue point of a welding torch. HOT!

As an example, the red supergiant Antares , found in Scorpius's spine near its head, is only about 3,000$_{o}$C, compared to the blue-white Acrab (middle of the scorpion's head) which is up to 25,000$_{o}$. Ouch!

So, stars can be big, small, young, old, hot or 'cool'. It's often fascinating to know which are which. The Southern Cross has three blue-whites and one red star. Can you pick the difference? Astronomers have a sequence of letters to classify star colours and temperatures. From hottest to coolest, it goes: O, B, A, F, G, K, M, N. Our Sun is a G class star, while Antares is Class M. To help them remember the correct sequence, they use a mnemonic "Oh Be A Fine Girl, Kiss Me Now".

You guessed it. Most astronomers are men.

3. TIME TRAVEL

(for 14th October 1998)

Have you ever wanted to travel through time? Back to the time of the First Fleet or even back as far as the ancient Egyptians?

Well, it's easily done and no fantastic science fiction machines are needed.Let's do it now. Step outside and look up at the Southern Cross. See the bottom star? You are now seeing that star exactly as it was (not how it looked from Earth) when Columbus discovered America in 1492. You are looking back about 500 years into time. That's Time Travel. A trick, you say? Not at all.Just as the sound of a starter's gun in the distance takes a finite time to reach us, so does light. Only light's a lot faster. It travels at 300,000 km per second.Look at the Moon sometime. That light is 1¼ seconds old. Look at the Sun (quickly). It's light takes 8.3 minutes to reach us. So if it ever went out, we wouldn't know for over 8 minutes. Look up at Jupiter when it's visible. If a 30 minute show has just ended on your TV, you are seeing Jupiter as it was just before that show started – 33 minutes ago.

Still not impressed? Okay, look south and find Alpha Centauri, the bottom Pointer Star. (It points to the Southern Cross). The light you are seeing left that star over 4 years ago during the 1994 Commonwealth Games. (That dates this particular column – RB.) We call the distance light travels in one year a 'light-year'. So Alpha Centauri is 4 light-years away. And that's the closest star. Everything else you see up there is much much older.So you can see that the night sky is one big and marvellous Time Machine.

The fascinating thing about staring at the stars is that the further away you are seeing, the further back in time you are travelling. Remember Scorpius and the two star clusters M6 and M7 near the scorpion's tail? Well, as Christmas approaches remember this. M6, the butterfly shaped cluster furthest from the tail, is 2000 light-years away. You are looking at M6 exactly as it was when Jesus was born. The light left M6 then but we are only just seeing it now.

H G Wells, eat your heart out.

4. THE NAMES OF STARS

(for 25th November 1998)

To paraphrase Shakespeare, a star by any other name would still shine. And just as well, because a lot of the stars you see in the sky have many an alias.

About 220 of the brightest stars have personal names they have been known by over the centuries. Names that roll off the tongue and conjure up images of exotic cultures. These names, difficult to grasp at first, but satisfyingly familiar after regular use, were given to the stars by the ancient astronomers – Arabs, Greeks, Babylonians and Romans.

For the more scientifically minded, the same stars (and the thousands of others that don't have personal names) have also been given scientific names that describe the star in order of brightness in a particular constellation, and is unique to that star. Like a house's address.For example, the brightest star in the sky which we affectionately call Sirius is also the brightest in the constellation of Canis Major (The Greater Dog) and it is called Alpha (α) Canis Majoris. (Alpha is the Greek letter for 'A'.) But we also call it 'The Dog Star', which leads us to another method of naming stars. This is more like a description than a name, and some of them can be quite amusing.

For example, one of my favourites is Betelgeuse (pronounced Beetlejuice by many, though its technically correct pronunciation is bet-el-gerse.) Its scientific name is Alpha Orionis (in the magnificent constellation of Orion). But its name means ‘The Armpit of the Giant.’ Delightful!

We will probably meet a number of these stars in this column in future weeks, and where possible, I like to use the star’s personal name. To give you a foretaste, some examples of other stars names are:

Canopus (the 2nd brightest star in the sky) is α Carinae; Arcturus is α Bootis, ‘The Guardian of the Bear’; Vega (the star featured in the movie ‘Contact’) is α Lyrae, ‘The Falling Eagle’; Rigel is Beta (β) Orionis, ‘The Ankle of the Giant’; Aldabaran is a Tauri, ‘The Eye of the Bull’; and Antares is α Scorpii , ‘The Rival of Mars’ and ‘The Heart of the Scorpion.’

After years of star spotting and familiarity with the sky, it is a great feeling to step out at night and see a bright star, and like greeting a close friend say, “hullo there Betelgeuse.”

5. SUNS ARE STARS, SOL

(For 25th January 1999)

Which star is so close to us, but you can’t see it at night? It’s easy to forget that the Sun is a star. And a very average star at that. But we should be thankful it is a boring, ordinary star. Because they live the longest. If it was a giant white star, it would blaze gloriously for a few hundred million years, then burn itself out, ending in a cataclysmic supernova. A bit rough on any planets around it.

But ever humble average Sol has burned steadily for 5 billion years and will continue to do so for another 5 billion years. Because our Sun is a typical star and is so close (an average 149.5 million km away), it is easy for astronomers to study to find out how other stars tick.

So, what is our Sun made of? Hydrogen and helium, the two lightest and most common elements in the Universe. That’s it! But a lot of it.The Sun has a diameter of about 1.4 million km. You’d have to place 110 Earths side by side to equal this, and you could fit 1.3 million Earths inside its volume. Its boiling surface of gas has a modest temperature of 5,500$_o$C which is hot by Earth’s standards but is like ice compared to its core. At its core is a 15 million degrees C furnace fueled by the fusion of hydrogen to helium. This is exactly the same reaction that occurs inside hydrogen bombs.

As the Sun generates heat and light, it loses mass at the staggering rate of 5 million tonnes per second. And it will lose that 5 million tonnes per second for the next 5 billion years. Try and imagine that.

What would our Sun look like from a planet around another star? Probably like Alpha Centauri, the First Pointer star. Though it is a double star, its brightest component is just like our Sun. And to them, we would be the brightest star. At night.

6. Life, Europa and Everything

(For 30th November 1999

While Jupiter is still shining brightly in the sky, let’s have a look at its second closest Galilean moon. They are the moons you can see in binoculars and a small telescope.

Europa is the smallest of the four moons and at 3,138 km diameter is just smaller than our own Moon. But it makes up for its size by offering astronomers both a puzzle and a promise. Namely, does it have life on it? Conditions on Europa are pretty rugged. Firstly, its surface temperature is a chilly –160°C. Unlike its close cousin Io which has a surface covered with sulphur from active volcanoes, Europa's surface is craterless and covered with jagged slabs of water ice. It looks like a glass ball with crazy cracks all over it.

But the discovery that caused astronomers to go into a frenzy was that beneath that craggy surface, there lurks an ocean of liquid water. It is liquid because, even at that immense distance from the Sun, heat is generated by the interaction of Jupiter's massive gravity with Europa's and the other moons. This ocean is thought to be up to 100 km. deep.The clues started to build up. Liquid water…heat…what else? Right, organic molecules deposited by colliding asteroids and comets. Taken together, these provide the ingredients that give a decent chance that Europa does (or did) harbour life.

Of course, nothing is for certain, but possibilities is what science and exploration have always been about. Future space probes will further study the extent and nature of this amazing ocean.So when you look at Europa, remember – ice, oceans and, possibly, life.

7. SHOOTING THE STARS (Meteorites)

(For 8th February 2000)

How many times have you looked up in the night sky and seen a faint but sharp streak of light whiz across the sky? A Shooting Star. Or sometimes it's a brilliant light, like a sky rocket that lasts for seconds before disappearing over the horizon? A UFO?

Meteors are so often seen but so often misunderstood. Despite popular opinion, the scientific term 'meteorite' applies to the chunk of speeding stuff in space before it reaches Earth's atmosphere AND after it hits the ground. 'Meteor' applies to the same chunk of stuff while it actually burns its way through our atmosphere. So you see the meteor and hope the meteorite doesn't demolish your house.

Meteors are usually seen when they are very high in Earth's atmosphere, up to 120 km high. The length of their flaming path may be up to 60 km. Typically, the speed of the meteor can be 60,000 km per hour. That's about 17 km per second. They are mostly made up of fragments of the stuff left over from the formation of our solar system, a mixture of carbon, silica and iron.

They can vary in size tremendously. For example, the streak of light we call a shooting star is probably the size of a grain of sand 100 km high, while the meteor that ploughed a 1.2 km wide crater in Arizona 20,000 years ago is thought to have started out weighing 250,000 tonnes. Thankfully that size meteor rarely hits Earth. In between, an exceptional fireball that for a few seconds outshines the Moon would weigh only about 5 kg.

However, some meteorites have been ejected from the Moon or Mars after they were hit by a large object (a larger meteorite or even a small asteroid) millions of years ago and it's taken them this long to eventually reach Earth. Most meteors we see never hit the ground. They are burnt out by friction with our atmosphere long before then, reaching the ground as an invisible shower of dust.

Go out any night and, with patience you'll see some. But one thing meteors are not…UFOs. There are no little green men riding those lumps of rock.

8. HOW FAR LITTLE STAR?

(18th April 2000)

How do astronomers measure the distances to stars and galaxies? Two good questions in one.

Firstly they must measure the distances to the nearest stars. Then, with these distances, they can use much more complicated methods to measure the vast distances to the edge of our galaxy and the galaxies beyond. But if they don't get the first measurements to the stars right, the rest collapses like a human pyramid.

Distances to nearby stars are measured using a basic geometry tool, parallax. Hold your arm out straight with your thumb up. Close one eye and see what your thumb lines up with. Then shut that eye and open the other. Your thumb will appear to have moved. That is parallax. Your thumb, which is fixed, seems to move against the background because your point of viewing changes.

Astronomers do the same with stars. When the Earth is on one side of the Sun, they measure the angle to the target star against the background of stars. Six months later, when Earth is on the opposite side of the Sun, they measure the angle again. The difference in angle is the parallax. Combining the angle with the 300 million km baseline gives the distance to the star.

A star with a parallax of 1 second (1") of arc (one 3600th of a degree) is said to be one parsec away. This equals 3.26 light years. But if the star is further away, its parallax is smaller. The closest star, Alpha Centauri, has a parallax of 0.76", or 1.3 parsec. This makes measurements very difficult. The most precise measurements cannot go beyond 0.01", or 100 parsecs.

It's a big jump from measuring 300 light years to Andromeda Galaxy's 2.2 million light years. How do they do it? That's another story for another time.

9. TAKING THE MICKEY OUT OF PLUTO

(For 30th May 2000)

Ask any science student the name of the 9th planet and they will answer Pluto. Correct? (Not now, hopefully – RB)

Recently, a number of astronomers have questioned whether Pluto, named after the Greek God of the Underworld (sorry, it was NOT named after Mickey Mouse's faithful dog) is really a Claytons planet – a planet you're having when you're not having a planet.

It is timely to consider this now, as on 2nd June 2000, Pluto will be in opposition. That is, at a mere 4,300 million km away (30 times further from the Sun that Earth), Pluto will be at its closest to us this year.

Don't bother to try and see it unless you have at least a 200 mm telescope. It is far too faint.

Why are they trying to downgrade Pluto from planet status? Mostly because of its size and position. At 2,300 km diameter and 1/500th the mass of Earth, Pluto is smaller than 7 of the other planets' moons, including our own. Its width would only reach from Sydney to the West Australian border.

Secondly, Pluto is located outside the orbit of Neptune in the vicinity of a swarm of 70,000 other fair sized objects called the Kuiper Belt. Many astronomers believe that Pluto is just the largest of them. They argue that if Pluto had been discovered today, and not in 1930 by American Clyde Tombaugh, it would simply be classified as a large Kuiper Belt object and not a planet. Planets are hard to define, and in many ways Pluto just doesn't cut it.

However, astronomers recognise that 70 years of tradition are hard to undo. Until they discover another Kuiper Belt object equal or larger than Pluto (and this is highly likely), Pluto can stay a planet. But watch that space!

10. SLIPPERY LITTLE SUCKER (Black Holes)

(21st November 2000)

A question I am often asked at star nights is: “Can you show me a black hole?” Invariably, the answer is “No.” Black Holes seem to capture everyone’s imagination, mostly because of their exotic and mysterious nature. Personally, I find the description “slippery little sucker” very apt. ‘Slippery’ because they are very hard to find, and ‘sucker’ because if you get too close, it will drag you in to a quick and messy end.

So, what is a black hole? It’s the left-overs of a star much bigger than our Sun, which furiously burns itself out and explodes in a supernova. The outer layers spread into space as a beautiful nebula. The centre of the star contracts under gravity to form an unimaginable dense ball, some times only kilometres across. Some black holes have the mass of a mere 10 Suns, some billions of Suns. These humungously larger one aren’t formed by an exploding star, though, but an entirely different process, too complex to mention here.

Here’s where the ‘magic’ starts. On Earth, the velocity a rocket needs to escape Earth’s gravity is 40,000 km per hour. As a planet or star gets heavier and smaller, the escape velocity needed increases. Eventually, you can get a body so heavy and small that its escape velocity is more than the speed of light (300,000 km per second.) Black holes are like that.

But nothing in the universe goes faster than the speed of light. That means nothing, not even light or any other type of electromagnetic radiation, can escape from such a body, so you can’t see it. That’s why we call them Black Holes.

Yes, they do exist, but thankfully they are ‘out there’, a long way away. What goes on inside a black hole no-one knows. But one thing they do know – they are best kept far away from.

11. THE WAY SOUTH

(For 6th February 2001)

If you were lost in the bush or desert at night with no compass and only the stars to guide, would you be able to find North or South?

Easy, find the Southern Cross, you say? Yes, that will help but believe it or not, depending on the month or the time, Crux can be up to 30_o East or West of South, so going by Crux alone, you could be up to 30_o off. For example, at 4.30am one day, Crux will be dead South but at 10.30pm it will be 30_o East of South. A big difference.

So how do you find it more accurately?

You need to find the two Pointer stars as well as the Southern Cross. These are the two bright stars that point towards the top of the Cross.

First draw an imaginary line from the top star of the Cross through the bottom star and extend it about five Cross lengths. Then find the mid-point of the line between the two Pointer stars and draw another line at right angles to it. Extend this line until it meets the line from the Cross. (Drawing lines in the sky with fingers of both hands is a perfectly acceptable technique. Amateur astronomers do it all the time.)

The point where these two lines (or your fingers) meet in the sky is very close to the South Celestial Pole, so if you drop a line from it straight down to the horizon – that is South. This is true no matter what month or time it is – as long as you can see the Cross and Pointers for the trees.

Of course once you have South, the other directions are easy.

12. SEEKING SISTER EARTHS

(For 24th July 2001)

Wobble, wobble little star

Now we know where planets are,

Huge and fast, close and hot,

Paradise they're clearly not.

But search they will,

until they find

A planet of the Earthly kind.

In case you haven't heard, astronomers have discovered over fifty planets orbiting other stars. (Update – it's over 300 now in 2008 – RB.) This is a spectacular achievement, considering that they haven't actually seen the planets. What they do is measure the size, period and speed of the minute wobble of the star caused by the orbit of the massive planet around it. It's like the movement of a hammer thrower swinging his hammer. He doesn't pivot on the same spot but in a small circle around a spot between him and his hammer.

The bigger the planet and the closer it is to the star, the larger and more detectable the star's wobble. Using very large telescopes and sensitive spectroscopes, they can measure the speed of the star as it momentarily approaches and recedes from Earth during its wobble. This will tell them the size, orbital period and distance of the planet.Most of the planets found have been much heavier than Jupiter, and also very close to its star. Some are so close, much closer than Mercury, they have been called 'hot Jupiters.'

All this clearly proves that other stars do have planets. The irony is that a planet Earth's size, even if it existed, would not cause the star to wobble enough to be detected with today's instruments. But better instruments are on their way, so – watch this space.

13. SIMPLE THE BEST

(For 7th August 2001)

A couple of my friends from Macarthur Astronomical Society and I had the pleasure of showing the southern sky to a group of young Japanese visitors out back of Kentlyn last week. Because of the untimely clouds and a very bright Moon, we were very limited in what we could show them through our telescopes.

But as I thought about it the next day, that was possibly a very good thing as it brought us back to basics.

Sometimes we amateur astronomers get carried away with exotic objects in the sky, what we often refer to as the faint fuzzies. There is a thrill in hunting them down, faint and elusive as they are, and a pride in saying "I found it," not to mention the awe in knowing you are looking at something that may contain hundreds of billions of stars many millions of light years away.

So when we have a public night, we are sometimes tempted to show one to an untrained casual viewer. The result is inevitable disappointing for them.

At Kentlyn all we could show the kids was Alpha Centauri – a double star, the Jewel Box – a colourful star cluster, and the Moon with its craters. But their reaction? "Wow, two stars!" they said. And 'Hey, look at those craters, they're so close." Add to that the red disc of Mars high overhead and our overseas visitors were thrilled.

So the faint fuzzies are great, and I'll still go chasing them, but we should never forget the awesomeness of the seemingly commonplace.

14. PLUTO DOGGED BY LUCK

(For 4th September 2001

I came across a piece of astronomical trivia the other day that tickled my funny bone and also reinforced my belief in one of the greatest forces in the universe – Serendipity.

I have always been fascinated by the mathematical brilliance of the astronomers who could, without computers, crunch zillions of numbers and predict the location of a yet undiscovered planet from the irregular movement (perturbation) of another observable planet.

So it was that Adams and Le Verrier calculated and found the position of Neptune in 1846 based on the observed perturbation of Uranus. And, so it was that the American Percival Lowell and his astronomer assistants, after endless calculations based on Uranus's other unanalysed perturbations, predicted two possible positions for yet another planet beyond Neptune – Planet X.

Ultimately in 1930, Clyde Tombaugh who was continuing Lowell's work, discovered Pluto on photographic plates very close to the second predicted position after the first came up planetless. This was brilliant history making stuff. All that mathematical effort had paid off.

But now we know what really happened. Latest calculations of Pluto's mass confirm that it could have had no meaningful effect on the orbit of Uranus. Those were Pluto-less perturbations. It was all a happy accident – serendipity – that a large Kuiper belt object, Pluto, just happened to be passing near the predicted spot at the time Tombaugh was looking. A year earlier or later and – no 9th planet. Like the overnight success actor or singer, Pluto happened to be in the right place at the right time.

Serendipity – don't you love it?

15. JUST AN ORDINARY STAR

(For 5th March 2002)

One of my favourite questions at a star night is: "Are all the stars the same?" It's my favourite because a simple (but not silly) question like this opens up so many facets of astronomy about the life cycle of stars – you could literally talk about it for hours.

Well, are they the same? No! The only thing they really have in common is that they are all made from the same basic stuff – hydrogen and helium. After that, the key word is 'variety.'

Look up into the starry sky. The most obvious differences you will see are colour and brightness. You will see white, yellow, orange and red stars. Through a telescope, some of the white stars would actually be blue. And brightness! Some are brighter because they are close, like Sirius and Alpha Centauri. And some are bright because they are big – no, make that gigantic.

Betelgeuse, the red supergiant star under Orion's belt is 400 to 600 times the diameter of our Sun. At the other extreme, Proxima Centauri, the nearest star to our Sun (it orbits Alpha Centauri) is a red dwarf and is one twentieth the diameter of our Sun. There are some stars bigger than Betelgeuse, and some smaller than Proxima, and everything in between.

To make it more interesting, some stars are millions of years old babies, like those in the Orion Nebula, and others, like our Sun are billions of years old. Stars in globular clusters are almost as old as the universe itself.

Are all the stars the same? I love that question.

* * * FOR MORE ARTICLES OF A GENERAL SUBJECT, CONTINUE TO NEXT SECTION: GENERAL PART 2.