MACARTHUR ASTRONOMICAL SOCIETY Inc.

Journal

PRIME FOCUS

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President's Report

It happens tonight

It gives me great pleasure to introduce to you tonight our guest speaker Dr Doug Vakoch from the SETI Institute California. With Dr Vakoch is Carol Oliver from the Australian Centre for Astrobiology. It's been a while since we've seen Carol so this will be a great chance to catch up. To our special guests I extend to you a very warm welcome.

Recently.

What a past few weeks it has been. At last month's meeting we were bombarded with meteorites and had to deal with the explosive nature of Cosmology. On hand to record these happenings was Daniel and his video camera. Yes folks, it was our discussion group meeting and all went well. My appreciations go to Daniel Ross – Astro-computing; Ned Pastor and his collection of extraterrestrial rocks; and John Casey for his Cosmological expertise. Also on the night Peter Druery gave a quick run down of the latest news and had time to slip in a few slides from the darkest depths of the forest. Again well done to all!

You could have blown my socks off the other Saturday morning. Channel 9 did a live cross over to David Malin who was promoting the Festival of Astronomy North Sydney (FANS) night. Unfortunately I could not attend but by all accounts it was huge. The event, which was only a trial run, has required the involvement of not only our society but many others around the state. I'm sure you will find a full report elsewhere in Prime Focus.

Big things coming up.

Where do I begin? Due to a series of circumstances we find ourselves holding a whole bag full of Star nights and public events. We are obviously a popular society with a proven track record in engaging the imagination of all eager stargazers. In saying that, we need to carefully co-ordinate our resources. So here it goes.

06/08 Japanese exchange students Kentlyn
08/08 Combined Probus Club Camden, morning only
10/08 International House overseas students group.
13/08 St Patricks Campbelltown together with Broughton Anglican College, held at Menangle
16/08 Nepean Observatory open night, Dr Fred Watson speaking
17/08 Observatory Open night UWS Campbelltown.

To add to the above William Carey High school at Prestons has also asked for a night, which was be in August as well. Unfortunately, a later date (possibly in September) will have to be arranged. In order to assist the overall running of these events I will be co ordinating our efforts, so it's really important you see me later to indicate your involvement. As always, we rely on our members voluntary support and to this regard I cannot thank you enough.

At time of writing I'm hopeful of having a speaker from the Australian Centre for Astrobiology Department of Earth & Planetary Science visit us next month. This is a very exciting field in which Australia plays an important role. In closing I wish everyone here tonight clear skies and smooth sailing.

Kind regards
Noel Sharpe. ■

Vice President's Report- F.A.N.S. 2002.

On July next year approx. 2000 professional astronomers worldwide will descend on Darling Harbour for varied conferences on Astronomy.

Taking advantage of this rare massing, the amateur societies of greater Sydney have over the last 18 months sent their representatives to Sydney Observatory to form a committee to evaluate the possibility of holding a parallel event to this.

After many months of deliberation (especially over public liability insurance) an offer by North Sydney Council to hold the event at North Sydney oval under their administrative umbrella, has allowed the event to go ahead. It was decided to hold a dry run this year to smooth out any problems that could arise.

June 22nd was chosen as the date, the night was to begin at 5.30pm and conclude at 10.00pm. The many surrounding businesses were asked if they could switch off their advertising signs on the buildings that they occupied and, apart from a few, this request was carried out.

There were approx. 70 scopes on the night to cope with an anticipated influx of 2000-3000 members of the general public (the final number was just on 3,000).
M.A.S. was well represented with five members Dick Everett, Bob Bee, Lloyd Wright; Daniel Ross accompanied by the ever lovely Kate and yours truly. We were all allocated a position on the field, and given a sign to allow the public to know what object each scope was looking at.

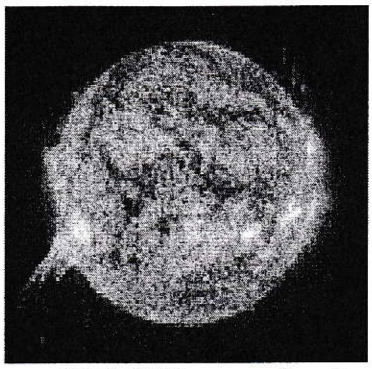
I was fortunate to be given the Moon, which was an easy object to find and track, unlike some of the other's around me. I had to revise my knowledge of the Moon to be able to give our guests as much general information as possible.

Up in the concourse area information stands were set up by some of the attending societies, publishers and general vendors. The conference room was filled most of the night by some very distinguished people. David Malin spoke about his exquisite astrophotos, and Fred Watson (A.A.O.) sent a message of congratulations for the night.

John Howard (no not that one) paid us a visit and spoke of his own passion for astronomy since his youth. Bob Evans spoke on his extraordinary feat as the worlds best and most prolific supernova hunter.

Everyone was well behaved and the questions asked were of a high level. Apart from a few minor details I feel that the night was great success. Congratulations to all the people involved from the inception of the idea, to the realization on June 22nd.

John Rombi. ■



(800,000km sun flare)

Strange Black Holes

Fourth in the series highlights some strange behaviours of these interesting but misunderstood objects.

Touring Black Holes

In July 2000 astronomers using 10 coordinated radio telescopes across the continental US tracked an X-ray object speeding through the galaxy at 145 kilometres per second.
It turned out to be a Stellar Black Hole (SBH) but two things were unusual. Most material including SBH reside in the disk of the galactic plane, this was in the halo, a balloon like area surrounding the central part of the Milky Way where hot gas, globular clusters and very old stars continue to exist.

Secondly this SBH is travelling on a looping path, dipping in and out of the galaxy disk, as if on a galactic tour. In addition it has its lunch with it! The black hole is orbited by a star every 4 hours and is tearing it apart atom by atom. Moving along together above or below the disk this 'tourist' never goes hungry.

Upon checking old sky survey photographic plates taken during the last 43 years, the object has been accurately plotted following the same path.

Explanation for the strange looping path is that it was formed by the collapse of a massive ancient primeval star within a globular cluster and then ejected by interaction within the cluster. GCs are mostly in the halo of our galaxy and follow similar paths. The original star of our wandering tourist was probably shining brightly and powerfully long before the Milky Way disk was formed.

Whirling Black Holes

Black holes have no solid surface where we can detect movement. We know that inflowing material orbits around the event horizon of a black hole, moving at almost the speed of light giving off large amounts of X-rays before being sucked across the line. However it now appears that at least one stellar black hole is itself rotating, causing an interesting result.

Using the Rossi X-ray Timing Explorer (RXTE) astronomers aimed it at a micro quasar about 10,000 light years from our Sun called GRO J1655-40. X-rays of a type called Quasi-Periodic Oscillations (QPOs) were detected at a very high wavelength cycle coming from a point much nearer the event horizon than thought possible.

It is believed that QPOs come from material orbiting at the 'inner edge of stability', or the last possible stable orbit that material can maintain before plunging over the event horizon. The very high frequency rate indicates the material is moving in an orbit closer than where QPOs have been detected before.

Black holes distort the space and time around themselves. A spinning black hole pulls the edges of space around in the same direction as its spin, allowing material to orbit closer before losing stability. The closer matter can orbit to the event horizon the faster it can spin before disappearing

It is believed the spin is started by the rotation of the original star before it collapsed. Because all stars and planets spin, it's more than likely that most black holes rotate rather than not.

Black Holes that 'Chuck Up!'

This rotation causes other results also. Some black holes of the super massive variety are so greedy they cannot digest, or 'keep down' all the matter they consume.

Astronomers in Germany have been looking at the core of a galaxy 100 million light years away. They have found a luminous fountain of super hot gas coming from the inner edge of an accretion disk surrounding the black hole. Something is causing the material (identified by X-ray as iron atoms) to shoot out of the accretion disk faster than it went in.
According to the Blandford-Znajek theory first made 25 years ago, rotational energy can be extracted from a spinning black hole if it is slowed down or braked by

magnetic fields. The laws of physics dictates that energy lost must be transferred somewhere else.

In this case what seems to be happening is that collision with magnetic lines somewhere between the inner edge of the accretion disk and the event horizon is slowing the spinning energy of the black hole. The energy loss is powering up the disk and throwing some matter out as streams of particle jets, perpendicular to the edge of the accretion disk.

Material does escape once caught by black holes!

Black Holes Vanish Into Their Own Orifice

Even as black holes swallow mass and grow they are also slowly fading away. This is particularly true of small black holes.

By a process called Hawking Radiation, (written about by Attila K. some months back), we understand that all black holes lose mass continuously and given enough time could eventually evaporate. The theory is named after Stephen Hawking who had the idea when he was left to get cold in his bath. Nothing like a cold bath or shower to make you think about loss of radiation and things shrinking!

Empty space is not really empty. A vacuum is a froth of virtual particles of every type. We know they exist because they have been observed in particle accelerators. Quantum mechanics says that you can always borrow energy from a vacuum, but you must pay it back quickly to keep everything in balance. Virtual particles are always created in pairs, a positive charge and a negative.

They annihilate each other in such a short time that they do not violate any law of physics. These particles are being created and annihilated all the time, completely unnoticed by us. The energy to make an electron and its anti-particle, a positron, must be paid back in one zepto-second. I'm not very familiar with zepto-seconds, but I reckon it's got to be faster than a Jedi can spit.

A fast moving real particle striking a pair of virtual particles before they annihilate each other will cause them to split and become real particles. If this happens just outside the event horizon of a black hole, the particle, which is nearer, will always fall in, but the one farther away will become real with enough outward boost to escape from the black hole completely.

The gravitational energy used to make the particles real comes from the mass inside the black hole. When it passes outside the event horizon it shrinks the black hole by two masses. When only one particle falls back in, it only gains half what it lost. So it shrinks!
As it decreases, the event horizon gets closer to its centre and the evaporation gets faster. A black hole should disappear in a final huge burst of Hawking Radiation. In fact there is a thought that 'Gamma Ray Bursters' might be the death throes of small black holes.

Ian Cook

The Moon, Planets and the Constellations.

The people who are searching history think that more than 2000 years ago, three planets Saturn, Mars and Venus formed the triangle, thought to be the Star of Bethlehem. Recently five of the planets have been in close alignment. The only one I could not see was Mercury because of its closeness to the Sun.

On the 5th May I saw Saturn, Mars and Venus in a triangle like predicted. I observed the planets over the next few nights. On the 11th all the planets were aligned in a row. On the 16th the Moon was under Jupiter. They were only 2° apart.

The stars Castor and Pollux were on the right side of Jupiter and the Moon on the 17th. I looked in *Astronomy 2002* and saw that the twins must be right under the moon. I did not use my telescope or my binoculars. Gemini, my birth stars, are setting earlier each day, and will soon have the Sun in the constellation. Orion is still visible for a short time after sunset.

Ursula Braatz. ■

Longitude – Part 2
By John Casey

This is the conclusion of John's story. Part 1 was in the June issue of Prime Focus.

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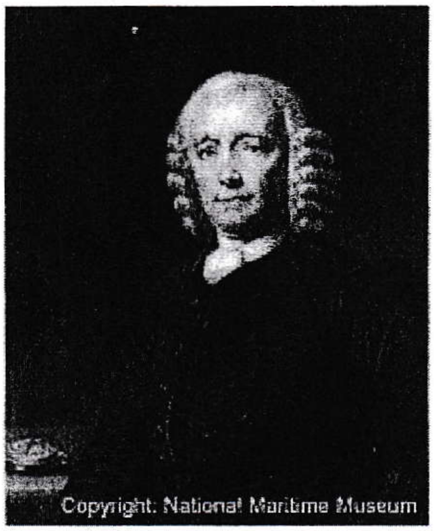
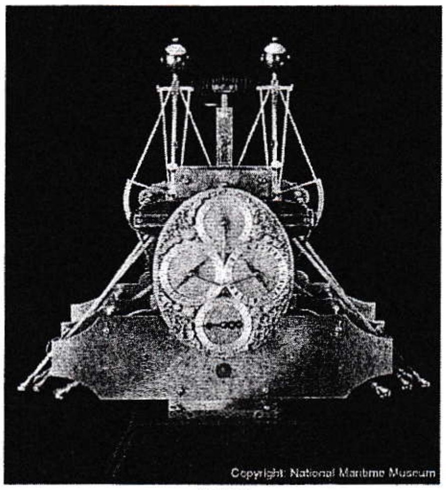
Then a carpenter called John Harrison came onto the scene.



He was born in 1693 in Yorkshire, and in 1713 made his first pendulum clock - made completely in wood, with oak wheels and boxwood axles. He had made himself a reputation as a clock maker by 1720 and then built the tower clock for Brocklesby Park manor house in 1722. It has run continuously for more than 270 years, with only a short break in 1884 when some components underwent refurbishment. It never needed lubrication, as he used lingnum vitae, a tropical hardwood that self lubricates.

From 1725-1727 John Harrison, and his brother, James, built two long-case, or grandfather clocks that incorporated novel new devices. They used a pendulum consisting of alternating strips of two different metals, chosen so that the pendulum neither expanded nor contracted with temperature changes. The other device was called a grasshopper escapement, which counts the beats of the pendulum, but does so without the friction that previous mechanisms did. Their clock, on firm ground, was accurate to within one second per month.

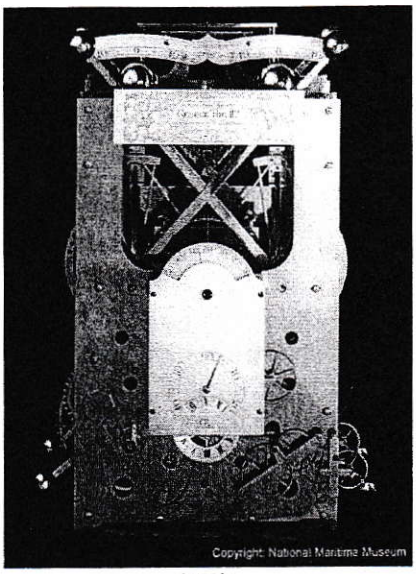
In 1730, John Harrison went to London to see the Board of Longitude, but the only board member he could find was Dr Edmund Halley, in the Royal Observatory at Greenwich. Halley suggested that he see the well-known watchmaker George Graham, who could best judge the fine points of his design. Graham encouraged Harrison, and gave him an interest free loan to help him develop his clock further. John Harrison then spent the next 5 years developing his first sea clock which he called H-1.



(H1)

H-1 had wooden wheels in the going train, as in his previous designs, but was highly ornate and built of shining brass, with rods and balances, and large coiled springs, and was housed in a glazed cabinet - a four foot per side cube that weighed 75 lbs. The Admiralty took one whole year to arrange a sea trial, and then set Lisbon and not the West Indies as the destination [as required under the act]. With strong winds, the trip only took a week. Harrison accompanied H1, but was sea sick all the way, and the captain died as they reached Lisbon before he could write his report. The ship returned to London, with H1 delivering errors of less than 2 seconds per day for both trips. On the 30th June, 1737 the Board of Longitude convened for the first time. Instead of demanding the trip to the West Indies to win the prize, Harrison sought funding to make improvements, and to make the time-piece smaller.

The Board gave Harrison half the 500 pounds he asked for to complete his modifications, on the provision that he surrender both his new model, and H1 " for the use of the Public". He presented his H-2 clock to the Board of Longitude in January 1741. H-2 weighed 86 lbs, but was smaller. H-2 embodied many improvements, including a mechanism to ensure a constant drive, and a more responsive thermal compensation device. The Royal Society subjected H-2 to many rigorous tests including heating and cooling and agitating it for many hours with greater violence than it would receive on a ship in a storm, and it passed with flying colours.



(H2)

But again Harrison decided that it was not good enough, and went on to make his H-3, in spite of the Society giving H-2 its full support, and assurance that it would easily meet the requirements of the Act.

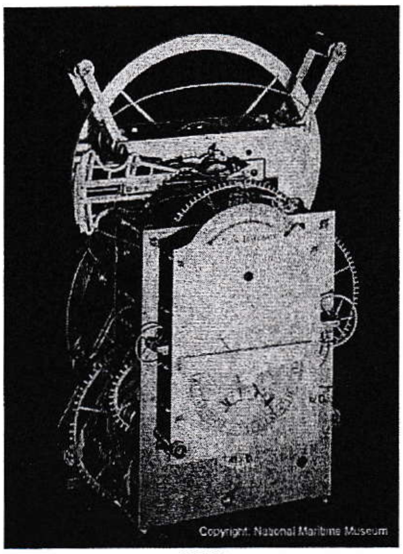
Harrison then spent 19 years developing H-3, and in this time again asking, and receiving 500 pounds, to continue his quest. Over this period, the Board of Longitude gave Harrison several extensions on deadlines, and a total of five 500 pound payments. Whilst he worked on H-3, two inventors - one English, the other American, independently developed the long sought after instrument that used the lunar distance method of providing the longitude. This was the reflecting quadrant, and it could help sailors determine both latitude and longitude. By using paired mirrors, the instrument allowed direct measurement of the elevation of two celestial bodies, as well as the angular distance between them.

The Englishman, John Hadley demonstrated his instrument to the Royal Society at about the same time that Thomas Godfrey displayed his in Philadelphia. Hadley's version also had an artificial horizon that allowed its use in darkness or fog. By now, star positions had been fixed and tables compiled that used these readings, but uncertainties in the Moon's orbit kept the prize out of reach. Then a mapmaker Tobias Mayer provided the precise Moon locations with the help of the Swiss mathematician Leonhard Euler, as a series of elegant equations.

The new Astronomer Royal, after Hayley's death, was James Bradley, and he compared Mayer's projections with hundreds of his own Greenwich observations and found the error was consistently less than 1.5 minutes of arc, which would provide the longitude to less than half a degree. But testing at sea showed up new problems, such as the steep changes in refraction of light near the horizon, that moved the apparent position of heavenly bodies. There were also errors in parallax, as the tables were formulated for an observer at the centre of the Earth, not on a ship at sea level, and sailors perhaps twenty feet above that. The mathematics involved was certainly above what a navigator at sea could perform.

Meanwhile, John Harrison struggled on, now with the help of his son, William. Harrison incorporated a new device, the bimetal strip, which like his gridiron pendulum of H-1, compensated immediately, and automatically for any changes in temperature. He also developed anti-friction caged ball bearings to give smooth operation.

H-3 weighed in at 60 lbs, and was two feet in height and one foot wide. He considered it small enough to fit in a captain's cabin, and reliable and accurate enough to try for the prize.

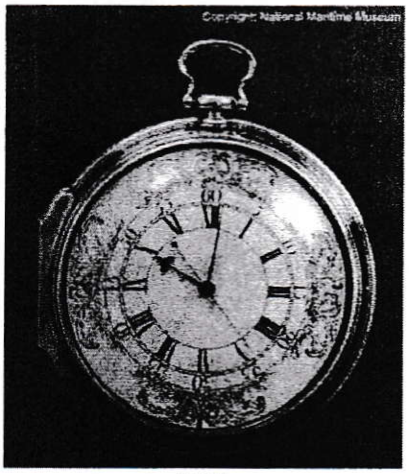


(H3)

As luck would have it, the Seven Year War prevented H-3 being trialled at sea for the prize. However, in 1753 Harrison was presented with a pocket watch by John Jefferys, a freemason of The Worshipful Company of Clockmakers, who had followed many of Harrison's designs, and he found that this watch was remarkably dependable.

Thus Harrison went on to making H-4, and completed it in 1759. It looked much more like Jeffery's watch than his earlier models. It weighed only 3 lbs, and was five inches in diameter, and used tiny jewels and diamonds as the pivot point bearings, and ran for 30 hours without winding. However, he was unable to miniaturise the anti friction wheels and caged roller bearing, and had to lubricate the watch. This then required the watch to be cleaned and disassembled every 3 years.

In the summer of 1760 Harrison presented his H-4 to the Board of Longitude, and the Board opted to trial both H-3 and H-4 together on the same voyage. The Astronomer Royal was still Dr Bradley, who had a conflict of interest, in that he was also a contender for the prize. There were long unexplained delays in starting the testing of Harrison's time-pieces. William Harrison had to wait at Portsmouth with H3 for 5 months awaiting a ship, and it was November when HMS Deptford departed. John Harrison had decided at that stage to only take H-4 for the sea trials. It took 3 months to arrive at Port Royal, Jamaica, arriving on January 19,1762. The Board's representative, John Robinson set up astronomical instruments and established local noon there. H-4 was found to have lost 5 seconds after 81 days at sea.



(H4)

After a week in Jamaica, the party and H-4 returned to England aboard the Merlin. Very rough seas were experienced on the return journey, but on March 26, H-4 was still ticking, in spite of up to six inches of water in the Captain's cabin at times. The total error of H-4 for the outbound and return journey was just under two minutes, so Harrison should have been given the prize immediately, for all the conditions of the Longitude Act had been satisfied.

However, the Board withheld the funds, and were suddenly dissatisfied with the time determinations both in London and Jamaica, and required a further trial under stricter scrutiny. He was paid only 1,500 pounds in recognition of the fact that his Watch " tho' not yet found to be of such great use for discovering the Longitude....... is nevertheless an invention of considerable utility to the Public." Then Maskelyne, defender of the rival lunar distance method, arrived back in London and published "The British Mariner's Guide", an English translation of Mayer's lunar tables. Mayer died of a virulent infection in February, 1763, aged 39. Then Bradley, the Astronomer Royal, died in July 1763, and his place was taken up by Nathaniel Bliss. Bliss insisted that H-4's accuracy was mere chance occurrence and wanted a retrial.

In March 1764, the next trial began aboard HMS Tartar. The astronomer sent to Jamaica to determine local time was none other than the Reverend Nevil Maskelyne, who had boasted that he would secure the prize himself for his lunar distance method. Maskelyne then botched the astronomical observations. The Board of Longitude allowed months to pass after this trial without saying a word. Eventually, and reluctantly, it was admitted that H-4 had "kept its time with sufficient correctness". In fact H-4 was three times more accurate than the terms of the Longitude Act demanded. That autumn, the board offered to hand over half of the prize money- on condition that Harrison hand over ALL of his sea clocks, plus a full disclosure of the details of H-4. To receive the full amount, Harrison would have to supervise the production of two duplicate copies of H-4. Then, to cap things off Nathaniel Bliss died after only 2 years as Astronomer Royal - and the new Astronomer Royal was Nevil Maskelyne !

At the next meeting of Board of Longitude, Maskelyne read a long memorandum extolling the lunar distance method, and brought in four captains from the East India Company who used this method and commended it. Then, in 1765, a new longitude act was introduced into parliament, which put caveats and conditions, including stipulations that applied specifically to Harrison, naming him openly, and describing his " contrariety with the board".

On August 14,1765 a watchmakers tribunal arrived at Harrison's residence, with three watchmakers, two Cambridge maths professors, and Nevil Maskelyne. Over the next six days, Harrison had to disassemble H-4, piece by piece, and describe, under oath, how each of his innovations worked. Then the board insisted that Harrison had to reassemble it, place it into a locked box, where it would be held for ransom by the Admiralty until the two replicas were built. They even removed his original diagrams and descriptions so Harrison had to build them from memory. At the same time Maskelyne had these diagrams and descriptions published and sold to the public.

Then in April 1766, the Board decided to subject H-4 to even more rigorous testing at the

Royal Observatory, over a period of 10 months. Then Maskelyne arrived unannounced, with a warrant for the arrest of Harrison's other sea clocks. In removing these, H-1 was dropped. They were carried by cart on the rough road to Greenwich.

H-4 failed its 10 month trial at Greenwich - Maskelyne simulated six voyages to the west Indies, each of six weeks duration, with the watch bolted down to a window seat in the Observatory. According to Maskelyne, "the watch cannot be depended upon to keep longitude within a degree in a West Indies voyage of six weeks".

There were a few flaws in the lunar distance method - for about 6 days every month, the Moon is so close to the sun it disappears from view, so no measurements of longitude can be made either. A good clock might be useful for such periods, Maskelyne admitted.

Harrison was now 74 , and his memory was failing, so the board allowed him to use the book recently published by Maskelyne to help in the making of the two copies of H-4. The board decided that the watchmaker Larcum Kendall should make one of these from the same book. He delivered his copy, K-1 in January 1770, and this was given to Captain Cook for use on his second voyage, aboard HMS Resolution. Cook was glowing in his praise for the timepiece, which helped him make highly accurate charts of the South Sea Islands. He took K-1 with him on his third expedition in July 1776. He died when attacked by Hawaiians at Kealakekua Bay, and according to the ship's log, K-1 stopped ticking at this same time as Cook's death.

John Harrison completed his second copy of H-4 in 1770, and called it H-5. It took three years to build, and then he spent 2 years adjusting it. At this time King George 111 took an active interest in science, and followed the trials of H-4, and granted an audience to both John and William. In January 1772 William wrote to the King about the history of the hardships his father had with the Board of Longitude. The King then arranged for H-5 to be given a six week indoor trial at his private observatory at Richmond. Initially it performed badly - until the King remembered that he had stored a few lodestones in a closet near H-5. After removing the loadstones, H-5 was accurate to within one third of a second per day. The King appealed to the Prime Minister, Lord North for "bare justice", and in June parliament awarded Harrison 8,750 pounds, nearly the amount owing to him. Another act of parliament laid out the terms by which the longitude prize could still be won, with duplicate time pieces, and very strict conditions, including one year testing at Greenwich, and voyages in opposite directions around Great Britain, and a further 12 months at sea - so the prize was never claimed.

The Board of Longitude disbanded in 1828, ironically, after years of having to supervise the testing and assigning of chronometers to ships of the Royal Navy. The world's primary meridian, passing through Greenwich, seven miles from the heart of London, is due to Nevil Maskelyne, the fifth Astronomer Royal. From 1765 to his death in 1811, he published 49 issues of the comprehensive Nautical Almanac, with all distances measured from the Greenwich meridian. Even French translations of the Nautical Almanac retained the calculations from Greenwich meridian - even though all other French tables showed the Paris meridian as the prime. In 1884, the International Meridian Conference in Washington, D.C. declared the Greenwich meridian as prime. The French recognised their own Paris meridian until 1911, but then referred to Greenwich mean time as Paris mean time retarded by nine minutes and twenty one seconds. But as this story has shown, not only the French can be pig headed!

John Casey ■

A Glance at the Year.

10/8 – The Oaks
10/8 – Int/House Students
13/8 – Broughton College
16/8 – Nepean Open Night
17/8 – Obs. Public Night
18/8 – General Meeting

7/9 – Belanglo Forest
14/9 – The Oaks
16/9 – General Meeting

5/10 – The Oaks
12/10 – Obs. Public Night
21/10 - General Meeting

2/11 – The Oaks
9/11 – The Oaks

18/11 – General Meeting
7/12 – Belanglo Forest
14/12 – The Oaks
(Whew!!)

What IC This Month
July 15 – August 18, 2002

Diary

Saturn creeps up on M1
Best views of Mercury now
Mercury meets Regulus
Venus high and handsome
Good views of Neptune and Uranus.

The Moon

17/7 First Quarter
24/7 Full Moon
1/8 Last Quarter
9/8 Dark Moon (New)
15/8 First Quarter

Evening Sky Planets

Venus is the only planet easily visible through this month. Setting 8.20pm in July and 9.00pm in August it will show a full half disk in a telescope and shine at mag. – 4.3

Tonight (15/7) it is very near Regulus in Leo and will climb higher each night. Next month on 12/8 the crescent moon will be closer to it and on the 22nd Venus will close in on Spica and the Virgo galaxies. It will dominate the north-western sky for the next couple of months.

Mercury is too close to the Sun for the last half of July but will climb out of the glare early August and rise higher each night. From 6/8 - 10/8 it will be about 10^{o} above the horizon and rubbing shoulders with Regulus in Leo, and a thin crescent moon.

Neptune in Capricornus is at opposition and will be at its brightest for the year on 2/8. From Neptune the Earth and the Moon will transit across the face of the Sun. This will occur each year till 2006. If you look with a telescope near Upsilon υ **Capricornus** you will see Neptune.

Uranus will start retrograde motion and move back to Capricorn from Aquarius over the next months. Look near iota ι **Aqu** for it.

Morning Sky

Saturn will rise in Taurus about 5 am in July. On the 21-30/7 it will be $\frac{1}{2}^{o}$ of M1 the Crab nebula. On 25/7 the moon Titan will sandwich M1 between itself and Saturn. Good photo op for early risers or dirty stop outs! A last crescent moon will be near Saturn on the 5/8 but you will have to be out at 2-3 am

Mars will be lost in the daylight till October and **Jupiter** will set before the Sun till early August before re appearing in the morning.

Comets

7P/Pons Winnecke is in Sculptor during July and August. Fading from 11 to 13 mag it is in the area of NGC 55 and 300.

46P/Wirtanen mid July will be passing across the Hyades in Taurus. Best to look for it in the dawn, it may reach 10th mag and be found between Orion and Gemini.

P/1992/Q1(Brewington) is supposed to reach 11th mag and be in Sagittarius during August.

Constellations of the Month

Just a bit to the west of north and high overhead this month you can find:

Scutum -The Shield
Invented by the Polish astronomer Johannes Hevelius, and listed in his catalogue of 1690, the *Prodromus Astronomiae*, it became better known after being published in 1725 by John Flamsteed.

Its full name is ***Scutum Sobiescianum***, Sobieski's Shield, as the constellation honours Jan Sobieski, (1629-1696) who was the saviour of Europe, and the eldest son of the lord of Crakow.

A brilliant military leader and the field commander of the Polish army he defended Poland from the Turks. Even though he was winning the fight, the elected Polish king (a politician?) gave all the Ukraine away to Turkey. In November of 1673 the king died.

Sobieski left the front lines and presented himself as a candidate for the throne back in Warsaw, and was elected in May of 1674 as King Jan III. He remained in charge of the war and personally led the

Polish cavalry in September 1683 to break the Turkish siege on Vienna. After nearly a ten year struggle, he was able to sign the Treaty of Warsaw with Leopold I, and liberated Hungary at the same time.

Seven years later Hevelius commemorated these events with *Scutum Sobiescianum* in the heavens. The faint asterism does resemble a simple shield.

Double stars:

Delta Scuti has a rather faint companion (4.5, 12;) separation 15". An optical component is sometimes also given as part of this system (C: 10th mag; sep.52.5").

Deep Sky Objects:

M11 (NGC 6705), **"Wild Duck Cluster"**, is a fine open cluster of perhaps four hundred stars which fan out like a flight of startled ducks. The cluster is one degree SE of R Scuti. Another nice binary, Struve 2391, is found between R Scuti and M11: 2.6, 9; sep. 38".

***M26** (NGC 6694)* is another open cluster of about thirty stars that resemble a miniature horseshoe, one degree SE of delta Scuti.

Our next constellation is further north from Scutum marked by one of the brightest stars in the sky.

Lyra – The Lyre

Is the musical instrument of Orpheus rescued from a river after his death. In Greek mythology, the lyre was invented by Hermes when he pulled a cow-gut across a tortoise shell. Hermes gave this lyre to his half-brother Apollo the god of music.

When Orpheus was only a child he was given a lyre by Apollo and the Muses taught him to play it like nobody else. Even Nature herself would stop to listen, enraptured by his music. The Lyre brought both delight and also pain to Orpheus. In later years when his wife Eurydice, died from a snake bite he followed her body to the Underworld hoping to revive and bring her back with his music. His playing convinced Hades to release his wife providing Orpheus did not look back at her during the journey home. Just as he emerged into the sunlight Orpheus turned and looked on Eurydice and you guessed it, he lost her forever.

Orpheus dies rather dramatically himself when Dionysus invades Thrace and the female followers called the Maenads tear Orpheus limb from limb. His head is thrown into the river Hebrus, where it floats to Lesbos, singing all the way. The Maenads must have hated good music, or his singing was very bad

The lyre of Orpheus was also thrown into the river, and floated to Lesbos, beaching itself near the temple of Apollo. Greatly moved, Apollo convinced Zeus that the instrument should be placed where all can see it. Zeus agreed, and placed the Lyre of Orpheus between Hercules and Cygnus.

The constellation is small and rather faint, but it is home to the mighty Vega. The asterism resembles some multi-legged creature more than it does a lyre, with Vega at the head. Only three stars are brighter than fourth-magnitude. Still, there are some very fine objects.

Vega - "Falling Eagle" or "The Harp Star", is only the fifth brightest star, but it dominates the summer skies in the northern hemisphere, crossing the meridian on 1st July. About 12,000 years ago Vega was the Pole Star, and it will be again in another 12,000 years.

Beta Lyrae, sometimes known as "Sheliak" (Tortoise), is a prototype of a variable star in which a close companion is transferring matter to its gigantic primary. Beta Lyrae is receiving matter very quickly and will eventually become an Algol variable.

Double stars in Lyra:
Delta^2-Delta^1 Lyrae form a wide binary that may be gravitationally bound despite the great distance. The two have a nice colour contrast, orange and blue. Note that

delta^2 is the primary: 4.3, while delta^1 has a visual magnitude of 5.6.

Beta Lyrae is a fixed multiple binary, with a primary of 3.5. AB: 3.5. 8.6; sep 46"; AE: 9.9, sep 67"; AF: 9.9, sep 85".

Epsilon the Famous "Double-Double." All four stars are fifth-magnitude ***Epsilon^1-Epsilon^2 Lyrae***: The two principal stars form a very wide binary separated at 208". Each star is itself a double: ***Epsilon^{1A}-Epsilon^{1B}*** is a slow binary with 1165 year orbit: 5.0, 6.1; and separation 2.6". ***Epsilon^{2C}-Epsilon^{2D}*** orbits about twice as fast, with a period of 585 years: 5.2, 5.5; sep 2.3".

Zeta Lyrae is another multiple system. The brightest components are AD 4.3, 5.9; sep 43.7". The other stars are too faint.

Struve 2470 and ***Struve 2474*** form another fine double-double, that some say is equal to epsilon^{1,2}. *Struve 2470*: 6.6, 8.6; sep 13.4" and *Struve 2474*: 6.5, 8.6; sep 16.4". The two binaries are found two and a ½° NE of gamma Lyrae, which is the brightest star in the region. It's a sight well worth the detour!

Deep Sky Objects:

***M56** (NGC 6729)* is a globular cluster, very condensed. It is found 8° due south of theta Lyrae.

M57 (NGC 6720) known as the *Ring Nebula*, is the finest planetary nebula in the skies. The ring itself should be clearly visible in medium scopes, while the 14 mag. central star will be harder. Burnham gives an excellent discussion on this object. Located between beta and gamma Lyrae (slightly closer to beta), it is about 4,000 light years distant

Music and shields of battle; just the thing to keep you warm on a winter's night!

Good seeing IC

Star Clusters and other Stars

Globular clusters once ruled the Milky Way. Back in the old days, back when our Galaxy first formed, perhaps thousands of globular clusters roamed our Galaxy. Today, there are perhaps 200 left. Many globular clusters were destroyed over the eons by repeated fateful encounters with each other or the Galactic center.

Surviving relics are older than any earth fossil, older than any other structures in our Galaxy, and limit the universe itself in raw age. There are few, if any, young globular clusters in our Milky Way Galaxy because conditions are not ripe for more to form.

But things are different next door - in the neighboring LMC galaxy. Take for example NGC 1818. Recent observations show it formed only about 40 million years ago - just yesterday compared to the 12 billion year ages of globular clusters in our own Milky Way.

Globular clusters are gravitationally bound concentrations of approximately ten thousand to one million stars. They populate the halo or bulge of the Milky Way and other galaxies with a significant concentration toward the Galactic Center.

Spectroscopic study of globular clusters shows that they are much lower in heavy element abundance than stars such as the Sun that form in the disks of galaxies. Thus, globular clusters are believed to be very old and formed from an earlier generation of stars (*Population II*).

More recent estimates yield an age of 12 to 20 billion years; the best value for observation is perhaps 14 to 16 billion. As their age is crucial as a lower limit for the age of our universe, it was subject to vivid and continuous discussion since decades. The age of globular clusters is determined by investigating their H-R diagrams.

The disk stars, by contrast, have evolved through many cycles of starbirth and supernovae, which enrich the heavy element concentration in star-forming clouds and may also trigger their collapse.

Our galaxy has about 200 globular clusters, most in highly eccentric orbits that take them far outside the Milky Way. Most other galaxies have globular cluster systems as well, in some cases (e.g., for M87) containing several thousands of globulars!

Open (or galactic) clusters are physically related groups of stars held together by mutual gravitational attraction. They are believed to originate from large cosmic gas/dust clouds in the Milky Way, and to continue to orbit the galaxy through the disk. In many clouds visible as diffuse nebulae star formation takes still place at this moment, so that we can observe the formation of new young open star clusters (composed of young *Population I* stars).

Open clusters populate about the same regions of the Milky Way and other galaxies as diffuse nebulae, notably spiral arms in disk galaxies, and irregular galaxies, and are thus found along the band of the Milky Way in the sky.

Most open clusters have only a short life as stellar swarms. As they drift along their orbits, some of their members escape the cluster, due to velocity changes in mutual closer encounters, tidal forces in the galactic gravitational field, and encounters with field stars and interstellar clouds crossing their way. An average open cluster has spread most of its member stars along its path after several 100 million years; only few of them have an age counted by billions of years. The escaped individual stars continue to orbit the Galaxy on their own as field stars: All field stars in our and the external galaxies are thought to have their origin in clusters.

White Dwarfs, unlike most other stars that are supported against their own gravitation by normal gas pressure, are supported by the degeneracy pressure of the electron gas in their interior. Degeneracy pressure is the increased resistance exerted by electrons composing the gas, as a result of stellar contraction.

The application of the so-called Fermi-Dirac statistics and of special relativity to the study of the equilibrium structure of white dwarf stars leads to the existence of mass-radius relationship through which a unique radius is assigned to a white dwarf of a given mass; the larger the mass, the smaller the radius. Furthermore, the existence of a limiting mass is predicted, above which no stable white dwarf star can exist. This limiting mass, known as the Chandrasekhar limit, is on the order of 1.4 solar masses. Both predictions are in excellent agreement with observations of white dwarf stars.

The central region of a typical white dwarf star is composed of a mixture of carbon and oxygen. Surrounding this core is a thin envelope of helium and, in most cases, an even thinner layer of hydrogen. Only the outermost stellar layers are accessible to astronomical observations.

White dwarfs evolve from stars with an initial mass of up to three or four solar masses or even possibly higher. After quiescent phases of hydrogen and helium burning in its core - separated by a first red-giant phase - the star becomes a red giant for a second time. Near the end of this second red-giant phase, the star loses its extended envelope in a catastrophic event, leaving behind a dense, hot, and luminous core surrounded by a glowing spherical shell. This is the planetary-nebula phase.

During the entire course of its evolution, which typically takes several billion years, the star will lose a major fraction of its original mass through stellar winds in the giant phases and through its ejected envelope. The hot planetary-nebula nucleus left behind has a mass of 0.5-1.0 solar mass and will eventually cool down to become a white dwarf.

White dwarfs have exhausted all their nuclear fuel and so have no residual nuclear energy sources. Their compact structure also prevents further gravitational contraction. The energy radiated away into the interstellar medium is thus provided by the residual thermal energy of the non-degenerate ions composing its core. That energy slowly diffuses outward through the insulating stellar envelope, and the white dwarf slowly cools down. Following the complete exhaustion of this reservoir of thermal energy, a process that takes several additional billion years, the white dwarf stops radiating and has by then reached the final stage of its evolution and becomes a cold and inert stellar remnant. Such an object is sometimes called a black dwarf.

Because of their intrinsically low luminosities, white dwarf stars can be observed only within a few hundred parsecs (1 parsec = 3.26 light-years) from the Earth. They are occasionally found in binary systems, as is the case for the white dwarf companion to the brightest star in the night sky, Sirius. White dwarf stars also play an essential role in the outbursts of nova and of other cataclysmic variable stars.

(The above article was gleaned from commentaries given in various 'Astronomy Pictures of the Day' on the net.)