TRANSIT

The November 2010 Newsletter of

Cleveland & Darlington Astronomical Society

NEXT MEETING

12 November 2010, *7.15 pm for a 7.30 pm start*
Wynyard Planetarium

30 years of The Planetary Society
Andy Fleming, *CaDAS*

Contents

Editorial

Andy Fleming

As guest editor, may I give you a warm welcome to this month's Transit, packed with observing and astro-imaging tips, letters,CaDAS news and of course, this month's quiz.

With the start of GMT we're right into the main observing season and the night sky is full of attractions for observers at every level. Orion will begin to rise mid-evening, containing that jewel in the Hunter's sword, the Great Nebula, M42. A host of other Messier objects are on view, including my favourites M51 the Whirlpool Galaxy, M81 Bode's Nebula and M82 the Cigar Galaxy in Ursa Major.

You can still catch the Ring Nebula in Lyra early in the evening, and don't forget the Andromeda Galaxy perhaps best viewed with binoculars. Don't forget to take a look at Jupiter and its Galilean moons high in the southern sky mid-evening and you should still be able to see Comet Hartley 2 with binoculars. Full details of all of these are included, as usual, in Rob Peeling's superb Skylights on page 5. For a superb image of the comet, turn to page 3 and appreciate Keith Johnson's excellent work.

I hope that you thoroughly enjoy this month's quiz on page 20. I've tried to make it of interest to everyone – I hope I've succeeded in obtaining the correct balance!

Finally, a big "thank you" to everyone who has supplied material for this issue. Thanks also to Rod and the committee for allowing me the honour of being guest editor of your magazine. Clear skies!

The copy deadline for getting material to Rod for the December issue is **Sunday 27 November**.

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Letters

Personal highlights of the last issue

from John Crowther

Personal highlights (an apt word) were Keith's and Rod's photographs of Jupiter along with the deep sky pictures by Rob of the scattered stars in the globular cluster M56. What was the aperture and magnification to take this beautiful photo?

Andy's article "The Lost World of Barnard's Star" included the sentence "The smart money is placed on the theory that suggests that such planets have migrated from original positions in their solar systems similar to that of our own Jupiter". So should we re-instate Immanuel Velikovsky with his book "Worlds in Collision" which predicted the retrograde rotation of Venus and planets migrating to new positions.

Ray's article "Out of this World" made me laugh out loud. Has he received any signed tenners yet? We look forward to his future articles.

A connection with Ray's book that was not published were our efforts some years ago in writing for a book which was to mark a CaDAS anniversary. But this wasn't completed either and it contained my bit on sundials!

Sorry to end with a moan after some positive remarks.

Best wishes, John Crowther

CaDAS member on the telly! *from Neil Haggath*

Recently, as some readers will have seen, astronomy got a very rare mention on the national TV news. On 21 October, ITV's News at Ten included a brief item, in the "And Finally" slot, about astronomers' discovery of a galaxy which breaks the redshift record – i.e. the most distant known galaxy, at a whopping 13.1 billion light years.

The astronomer whom they interviewed about it was one Dr. Mark Swinbank of the University of Durham – who is an Honorary Life Member of CaDAS!

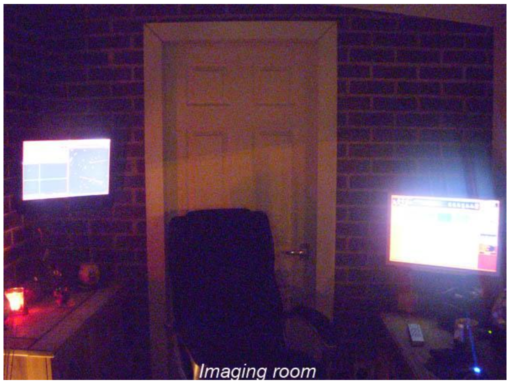
For those who don't know him, Mark comes from Stockton, and was a member of our society from about the age of 13. He later went to Stockton Sixth Form College, where he was taught A-level maths and GCSE astronomy by… none other than our founder, Dr. John McCue. He went on to obtain a Ph.D. in astrophysics from the University of Durham, where he now researches.

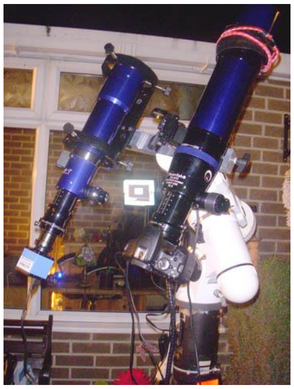
Mark is the third person who, after being a CaDAS member as a youngster, has gone on to a Ph.D. and a career as a professional astronomer. His predecessors are Dr. Carole Haswell and Dr. Dave Weldrake. All three have been honoured for their achievements, by being elected Honorary Life Members of our society.

Kindest regards, Neil Haggath

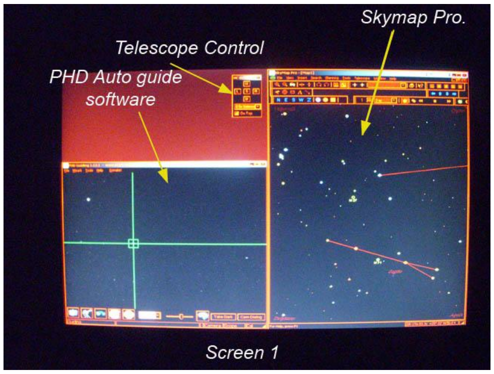
An insight into astro-imaging *from Keith Johnson*

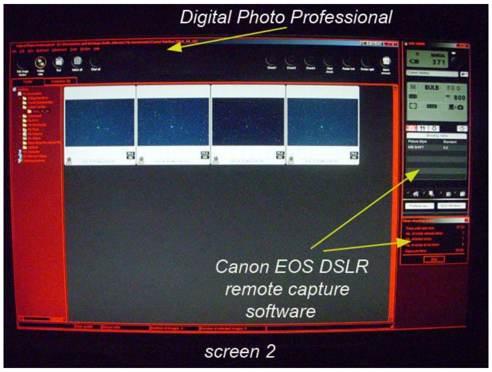
Here's a brief insight into some of my equipment and how it's all set up, including software and the imaging room.


Imaging room



The bunji strap around the front of the imaging telescope is to hold the dew strap in place... basically it's a heated strap to guard against dew and frost.





I've been waiting for a clear spot to allow me to image Comet 103P Hartley, clear skies in the early hours of Sunday October 13 allowed me to have a go.

Imaging equipment was as follows:
EQ6 Pro. mount.
80mmED Moonfish. (Imaging telescope)
Canon 1000D DSLR (Imaging camera)
William Optics ZS66 (Guide scope)
DMK Mono camera (Guide camera)
3min and 5 min.exposures captured @ ISO 800
Processed in Deepsky stacker.

OBSERVATION REPORTS AND PLANNING

Skylights – November 2010

Rob Peeling

The Moon

6 November	13 November	21 November	28 November
New Moon	First Quarter	Full Moon	Last Quarter

The Sun

The solar cycle is now getting more active with groups of spots frequently visible. If you fit your finder with a solar filter as well as your telescope then often the larger ones are visible at this low power**.** I also always look at the Sun through my filter before fitting onto the telescope. This is part of my routine for ensuring everything is safe before I look through the telescope, but every now and again you will spot a naked eye sunspot this way.

Don't forget that viewing the Sun without protective filters through the finder is every bit as dangerous as looking directly at the Sun with the telescope itself.

Planets

Jupiter dominates the sky. The missing southern equatorial band makes the planet seem off-balance somehow. It is only moving slowly retrograde during the month.

Uranus is relatively nearby to the north-east of Jupiter and again only moving slowly retrograde. This means its relative position to Jupiter will stay fairly constant throughout November. It forms the northern tip of a triangle with 20 and 24 Piscium which are of similar brightness to the planet. Slightly bright 27 and 29 Piscium are to the south-east of the group. 20 Piscium is a wide double, South 835.

Meteors

There are two showers to look out for in November. The first is the Taurids which peak on November 4th to 7th. The Taurids are slow and bright and derived from Comet Encke. The moon will be out of the way (new on the 6th) which will make them impressive.

The Leonids reach maximum on 17/18th November however the moon is waxing towards full and will be prominent in the sky at midnight on both nights.

Deep Sky

This month, the Pleaides and Hyades should be grabbing your attention. Also try to find M33, the Triangulum galaxy. It is a bit elusive with light pollution but the core can be quite bright. At a dark site see if you can spot the nebulosity to the north-east of the core. This is NGC 604 and is a star formation like the region around M42 in Orion. However to adjust your perspective, consider that M42 is ~1300 light-years away. NGC 604 is 2.8 million light-years away so in reality it is far grander than M42.

M33, the Triangulum Galaxy. NGC 604 is top right.

Also look for the open cluster NGC 752, lying between the short side of the triangle of Triangulum and the line between beta and gamma Andromedae. This is an easy binocular object and also bright enough to spot naked eye. I have seen it through the moderate light pollution at home. It is fairly easy from the planetarium as a cloudy, splodge with averted vision.

On a good, clear night try M31, the Andromeda Galaxy with binoculars. If you are not already familiar with this then you will be amazed at just how far the galaxy spreads across the sky. This won't be nearly as obvious with a telescope which is why I'm recommending binoculars.

GENERAL ARTICLES

The Wonderworld: We're 3.5 Billion Years Too Late

Andy Fleming

Evidence is mounting that Mars was once a wet and warm world, similar to the early Earth. What went wrong with the Red Planet -- is it possible that future explorers may find fossils from a more habitable time -- indeed did microbial life survive until the present time?

Once upon a time there were two adjacent planets orbiting a run-of the-mill star in one of the arms of an unremarkable spiral galaxy. Both were warm, both were wet, both had substantial atmospheres, both had vulcanism, both had oceans, seas and rivers, and both were in or on the edge of their star's habitable zone. Life, we are certain began on one, but on the other – well we're not too sure. The planets in question are of course the Earth and Mars.

Everyone is fascinated by Mars. From an earlier less-informed age, science fiction by Ray Bradbury and Edgar Rice Burroughs, or the imagined canals of astronomer Percival Lowell has fired our imagination, and has ensured that the Red Planet now has a special place in both our hearts and popular folklore. The real Mars is even more fascinating however, and the planet's formation and history can be the subject of some fascinating speculation. Mars is still one of the few places in the solar system that humans can think realistically about exploring on foot.

Did life arise on Mars in its early past like it did on Earth? Even more speculative, did life arise on one planet, only to be transported by ejecta to the other after an asteroid impact? Many scientists think that life, well microbial life at any rate, protected from cosmic rays and a fiery entry into the Earth's atmosphere inside a space rock can traverse the vast distances between planets. One of the meteorites discovered on the snows of the Allen Hills of Antarctica showcased by NASA in 1996, and confirmed as Martian by isotopic analysis, contains tantalising crystal structures that may be either chemical in origin or fossilised bacteria (albeit very small bacteria!). Meteorite ALH84001 may surprise us yet.

Will future geologists as they explore Mars discover fossils in the sedimentary rocks that are so indicative of the planet's wet and warmer past? Did creatures swim in the seas and rivers of ancient Mars – were they washed up on the now high and dry fossilised Martian beaches that we've identified with our Mars orbiters? Did they take the ultimate white-knuckle ride over waterfalls to dwarf Niagara in the Vallis Marineris, a gargantuan canyon the width of North America? As the late NASA astronomer and planetary scientist Carl Sagan (1994) speculated, "Now that would be a world to explore – unfortunately we are four billion years too late!"

Whether such speculation turns out to be confirmed, things started to go wrong about 3.8 billion years ago, about the time life got started on Earth. Mars is about half the size of the Earth so its interior began to radiate heat to space much more quickly and its core began to solidify. Without a molten iron core acting as a dynamo, any magnetic field surrounding the planet started to dissipate exposing the atmosphere and surface to the Sun's charged particles. Any tentative carbon cycle would grind to a halt too -- despite having the largest volcano in the solar system (Olympus Mons), vulcanism would cease, and with it any possibility of recycling the planet's carboniferous rocks.

In addition, with its gravity and hence escape velocity only 40% that of the Earth, and with no protective ozone layer, ultra violet radiation would pummel the Martian atmosphere disassociating water and carbon dioxide molecules into their constituent atoms with hydrogen and oxygen drifting off into space. With steadily decreasing atmospheric pressure, the Martian greenhouse effect would be thrown into reverse. Temperatures would plummet, the planet's remaining water would freeze either in permafrost or subterranean glaciers, and life, if it had existed would be forced to retreat into the last protected under- the-surface niches and habitats.

Is it still there, hiding in the caves of Mars or in the subsurface soils, clays and rocks, away from the desiccated, radiation-fried environment above? Is this the cause of the methane out gassing detected by NASA – or does this possible bio-signature have chemical or volcanic origins?

We know from a plethora of studies in some of the most inhospitable places on Earth such as Antarctica, deep in the oceans, in sulphurous volcanic springs, even in nuclear reactors and in solar radiation-saturated NASA hardware brought back by astronauts from the surface of the Moon that extremophiles are tenacious in the extreme! Once life has a foothold, extinguishing it is phenomenally difficult.

However, NASA/JPL's's two Viking spacecraft that touched down in mid-1976 gave inconclusive results in their analysis of the Martian soil. Gases were exchanged when a nutrient soup was added to the soil, but no organic molecules were found on the Martian surface. However, the Vikings were designed to detect only a small subset of possible life – that found on the Earth. There's no guarantee that extraterrestrial bugs will adhere to terrestrial rules.

NASA/JPL's Mars Science Laboratory, now named *Curiosity,* is slated for launch in 2011, and with a battery of on-board tests and equipment may start to provide some more substantial tantalising evidence of the signatures of life. Previous unmanned spacecraft have participated in NASA's "follow the water" initiative -- both the Spirit and Opportunity Mars Exploration Rovers have found abundant evidence of sulphate rocks formed in water and stratified sedimentary rocks exposed on the Martian surface. The Mars Phoenix lander found copious amounts of water ice underneath its landing site, and evidence of perchlorate-saturated water condensed on its legs.

Mars is still a fascinating, enigmatic and lovely world with wonders aplenty to keep our robot emissaries, and eventually astronauts busy for decades and centuries to come. Its river channels, waterfalls, lakes and seas may now be desiccated, and its warmest days may be barely above the freezing point of water, but finding life on the Red Planet has been a dream of humanity for centuries. And sometimes dreams come true.

Bibliography

Sagan, C., *Pale Blue Dot: A Vision of the Human Future in Space*, Random House, (November 1994)

I was Fred Hoyle's groupie

Ray Worthy

As I perused the book titles laid out before me on a bookstall in Cambridge market, I became aware of a man doing the same on the opposite side of the bookstall. I casually looked up and felt the adrenalin shoot through my body. I did a double take – surely not! Then the man spoke to the stall holder and I heard that deep Yorkshire voice. It was!

I stared at the man whose brain had worked out how the elements had been generated in the bodies of the stars. This was the man who stood, in my estimation, with such names as Newton, Einstein, Maxwell and Dirac. My eyes were as wide as saucers and my jaw was dropped as low as my belt.

Fred Hoyle broke the spell.

'You'll be catching flies in a minute', he said, smiling at me.

I was embarrassed.

'I'm sorry. Excuse me', I muttered and hurried to the next bookstall where my friends were mooching around.

'That's Fred Hoyle', I said reverently.

'Oh yeah? 'one said, 'Who's he?'

Then I remembered that my friends were all reading English or History or something.

'He's one of the greatest scientists on Earth', I answered.

'This place is full of them', was the retort.

Even after the lapse of more than fifty years, I can pinpoint that moment in time to within a couple of weeks – probably in October 1956. I had been working in Austria for the United Nations, helping refugees. With me in our work camp was a group of Cambridge students. This was the time when the Iron Curtain was rigorously being maintained but we young idealists were doing our utmost to break it down. One weekend, we had laid siege to the Hungarian Legation in Vienna trying to get visas for entry across their border. We were turned away, but later we got word that we could get permission to visit an agricultural exhibition in Budapest. This permission came too late for me, because I had to get back to ICI, but one friend had the opportunity though not the funds. I lent him what he needed and came back home. We were not to know, but a couple of weeks later the people of Hungary revolted against their Russian occupiers, and the British Government started a war with Egypt. So it does tend to stick in the mind.

Fred Hoyle loomed large in my education after I came out of the army. I became aware of his work just at the period of my life when I was most receptive. It began with a series of talks on the BBC which had been printed in their magazine *The Listener*. I must have read them at least five times. I was totally bowled over with his trains of thought and deductive reasoning. These talks were the forerunner of his book *The Nature of the Universe*.

What Fred Hoyle was leading up to was the exposition of his 'steady state' universe. As indicated in Einstein's famous equation $E = mc^2$, we know that energy can be converted into mass and mass back into energy. Fred envisaged the spontaneous appearance of mass at a rate equivalent to one atom of hydrogen in a space the size of St Paul's Cathedral in a year. It may not seem much, but Fred calculated that it would be sufficient to account for the expansion of the universe as described by Hubble and others. This would be a continuous process and would give rise to the 'steady state'.

In my mind, Fred Hoyle was Top of the Heap, King of the Mountain or any other expression that indicated that no one could match him; hence my unusual reaction when I realised that the man next to me was he.

Another factor that moved the situation on was that I had bought a motor cycle. For the first time in my life, I had a salary and could afford this luxury. What I had not realised was that the new means of transport would totally alter my life. I could reach Cambridge in three hours. My friends and I had every intention of going back to Austria the following year, so I was back in Cambridge the next spring. I heard of a public lecture Fred Hoyle was to give, so I turned up for that. All in all there were several occasions where Fred saw me en passant, as it were, though I never went so far as the girls who followed John Lennon around camped on the landing outside his London flat and even stuck chewing gum in his door lock to delay his getting inside and away from them.

It sounds stupid, I know, but there was one occasion when I contrived to get into a Cambridge lecture theatre before he did. He came in with a small group of friends when I was already seated. His group actually took the row immediately in front of mine. Wonder of wonders, Fred Hoyle was last to sit down and stood to look round the theatre. He nodded to me and even smiled, probably thinking 'I know I've seen his face before, but who on earth *is* he?'.

Over the next year or two, I devoured every book or article about Fred, or at least those I could understand, and then things began to change. Fred's utterances were not so confident. He was becoming beset by enemies, others who did not agree with his ideas, men who saw him practically every day.

I had one bit of luck – I think it must have been in 1958 or the following year. One lad amongst my UN group had a girlfriend who was a physicist. As I arrived late one evening, I caught him about to pedal off on his bike with a flask and sandwiches for his girl. When I found he was going out to Barton, where the new Mullard radio telescopes were, I offered to give him a lift on my pillion. In those days no one bothered with crash hats and things like that, so he dumped his bike and hopped on my pillion,

What a wonderland that place proved to be! The girl had to be on duty for several hours and welcomed our visit. As I remember it, there were at least five dishes that could be manoeuvred along rails, although today there are only two. When used together, they could simulate one dish of an immense diameter. I was going to write, 'with suitable software', but this was at a time long before computers as we know them had arrived. The word was that these telescopes were seeing further into the depths of the universe than ever before. They were the work of Martin Ryle, Fred's bitterest foe.

It was a slow process, but my relationship with Fred Hoyle, peculiar and one-sided though it was, began to wane. His opponents were offering evidence, whereas it seemed to me that Fred was sticking to his guns because his name had been irrevocably attached to the theory, and that because of this he refused to let go.

Ryle was beginning to get significant results. The radio telescopes could see through the dust of space. He was seeing images of distant galaxies far beyond anything managed before. One has to bear in mind that, because of the finite speed of light, when one sees further, one is looking at the universe as it was a long time ago. The farther he saw, the more closely packed the galaxies seemed to be. This observation was deemed to be decisive. The universe was more tightly packed the further back one went in time.

So, Martin Ryle came out with the statement that Lemaître's notion of the universe having originated in a singularity must be the correct idea. Fred was livid. He lost his temper in meetings as his world went sour. Years before, he had invented the disparaging term, the 'Big Bang'. Unfortunately for him, the world had taken the term and made it its own.

It was at this stage that I began to see my hero in a new light. He was a brilliant theoretician, but he had no ammunition with which to refute Ryle's measurements. He could not advance his cause without new facts, which were not forthcoming. Indeed, over the following years, his opponents gained more and more ground until one day in 1965, over in New Jersey, a couple of

Bell Telephone engineers made a discovery of an importance of which they were completely unaware. Penzias and Wilson were seeking to find the source of some annoying background noise that was interfering with satellite communication. Using a parabolic horn receiver, they found that they needed a super cooled detector. They found a signal emanating from everywhere in the sky, equivalent to radiation at three degrees Kelvin.

They hadn't got a clue as to what they had discovered, but as soon as they discussed it with some astronomers in nearby Princeton, they were informed that they had found the cosmological holy grail. They had discovered the long-sought cosmic background radiation. It had long been predicted and was held, if found, to be final proof of the Big Bang theory.

This proof was accepted by everyone except dear old Fred, who went into a private huddle and muttered imprecations. It was then that he lost me. The scales had fallen from my eyes. Fred was human after all.

Then came the saga of Jocelyn Bell. During the summer of 1967 Jocelyn Bell (now Bell Burnell) was studying for her doctorate. She was working under Professor Antony Hewish at those very same Mullard telescopes where I had carried my friend on my pillion. You have to appreciate that this was long before the advent of computer power. The data from the observations came in the form of pen records on unrolling strips of paper. They had to be scanned by human eye. After months of painstaking work, Miss Bell found something odd. At one point in the sky, there was a ticking signal. After eliminating all the other possible sources, she realised that she had a star-like entity that was ticking at about one tick per second. She called it her 'Little Green Man No. 1'.

This was absolutely astonishing and no one knew what it could be. Later, after a lot of work, they found they had discovered the first pulsar. Nobel Prizes were in the air and sure enough two were awarded. Professor Ryle got one and so did Professor Hewish, but Jocelyn Bell got nothing, even though her name was second on the paper. Penzias and Wilson got a Nobel Prize each for blundering into a discovery without knowing anything about the background, but Jocelyn got nothing after months of diligent application.

There was a rumbling in the corridors of Cambridge, and back into the limelight came Fred, spitting vitriol. He let the whole scientific world know what he thought of the 'great Injustice' perpetrated by the Nobel Selection Committee. It didn't do a ha'porth of good and it did himself a lot of harm. He would never get a Nobel Prize now, even if he came up with the solution of the Grand Unification Theory.

There is an epilogue to all of this, a personal one; but before you read it (if you are so inclined), there is a little anecdote I need to relate, to provide a little background and increase your understanding. It concerns the two engineers, Penzias and Wilson.

You remember that their detector had to operate at a temperature somewhere near to absolute zero. Well, the story goes that they were plagued by a pigeon that was trying to make a home inside their horn, a section of a parabola. The pigeon droppings were giving off a signal, because even a frozen dropping would be at more than 270 degrees above the temperature of the detector. Not wishing to kill the innocent bird, one of the pair took it on a trip some thirty miles away when he visited his mother, and released it. When finally he got back to his telescope, there was the pigeon cooing as if giving thanks for the exercise.

A few years ago, I had a spell of influenza and I had to take to my bed. A core of my brain was still operating and I found myself composing some verse. Here it is.

Lying in the Long Grass.

Lying in the long grass, staring at the sky,
A little boy is thinking of the mysteries on high.

The fear of Hitler's air force keeps the sky so clear and dark.
No glim of earthly light is seen from the long grass in the park.

What are these points of light I see? I know each one's a star,
But that word tells me nothing about what they really are.

I'm also told they're like our Sun, these tiny points of stars,
With families attending them, like Venus, Earth and Mars.

So does that mean that other folks are living there all free?
And is there someone else up there a-staring down at me?

Can I count them? No, I can't. There's so much work to do.
In between my finger and thumb, I've counted thirty-two.

I've been told about the atom, and how it's mainly space
With tiny points all buzzing round the centre in a race.

So what is it I'm looking at? Is there a pattern here for us?
Can it be each point of light is an atom's nucleus?

Are the planets moving round, with all their heavenly beauty,
Playing their part in the scheme of things and doing the electron's duty?

So what is it I'm looking at? Let's give this line a nod.
I'm looking at the insides of the body of our God.

Hang on! Hang on! Just half a mo! That strange idea has risks.
The 'cyclopedia tells us all the stars are grouped in disks.

OK then! Give this a whirl. This theory might be good.
The galaxies are corpuscles flowing in God's blood.

The student in the long grass, staring at the sky –
Still he's filled with wonder at the mysteries on high.

He's read his books so diligently and filled himself with knowledge.
He's studied this, he's studied that. He's been to school and college.

He's lying there and pondering; the answers still to figure.
His brain is filled with postulates (the words are now much bigger!).

There's constant cosmological and stellar evolution.
There's fermions and nucleons and of course there's light pollution.

He goes to Cambridge; studies hard. Sits at the feet of Hoyle.
Element manufacture set everyone on boil.

And now the topic's shifted ground. Excitement there is great.
The question of the moment: 'Big Bang' or 'Steady State'.

Hoyle, with Gold and Bondi, said they'd explained old Hubble;
Vacuum's not a vacuum. It's an energy soup a-bubble.

New-formed matter turning up in space to intercede
Caused accelerating galaxies to continually up their speed.

Hoyle's opponent Martin Ryle, with his radio array,
He put his aerials on rails and finally won the day.

He pinpointed radio sources with discoveries so heady,
Until he proved that Hoyle was wrong and the Universe not steady.

Poor old Fred. He took the huff and said the proof was not enough.
Retired hurt with new invention and tinkered with his first intention.

Our young man's let down, misled. His idol did betray.
The object of his worship had now got feet of clay.

Where to go now ? What to do? Panic almost frantic.
Investigates positions across the broad Atlantic.
.
Wilson and Penzias flying pigeons from their horn
Put the cap on steady state, leaving Fred Hoyle so forlorn.

Their accidental finding brought his theory to its knees.
Finding fossil radiation at a temp. of three degrees.

Murray Gell-Man, flying high, brilliantly made his mark,
Breaking down the proton into quark and quark and quark.

Alpher, Bethe, Gamow (I couldn't find a 'Delta'),
Everett with his many worlds, ideas all helter-skelter.

Josephson with his junction, and Wheeler, I suppose,
Dyson, Glazer, Baade -- and Higgs and Bell and Bose.

But standing head and shoulders over all these mentioned here:
Iridescent Richard Feynman with his diagrams so clear.

Not a chance of standing out in this company divine,
Our hero steadily plods along, quietly toeing the line.

Meanwhile, back in Cambridge, 'black holes' are making sense.
Event horizons gather round small points immensely dense.

Penrose and Stephen Hawking find their calculations click,
And Jocelyn Bell with Hewish find a star that makes a tick.

Disillusioned old professor, his ideas all ahoo.
Every argument he'd put down had met its Waterloo.

Instead of shining brightly, his colour was always grey.
Nobel Prizes gone astray; someone else had won the day.

We need new mathematics to support each new position,
For every thought put forward shows counter-intuition.

We live in three dimensions: at a pinch we live in four.
But now we work in nine or ten, or maybe even more.

To cap it all, new thoughts take wing,
And points aren't points, they're bits of string

Lying in the long grass, the professor so morose.
Have we got there? No, siree. We're not even close.

If that's the case, we pause and think and possibly we pray,
Some new-born Newton may arise and show us all the way.

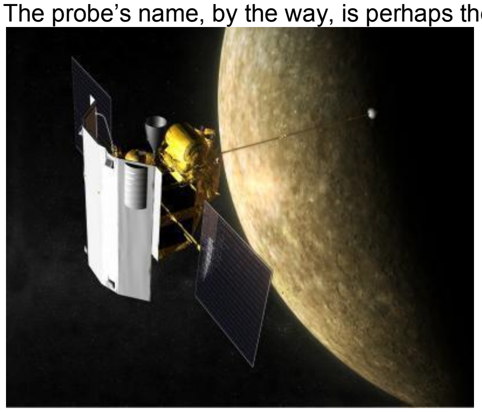
Not exactly as the crow flies!

Neil Haggath

As most readers will know, I'm a spaceflight enthusiast. I recently learned a quite astonishing fact – courtesy of my good friend Peter Rea – that I hadn't previously realised and that has inspired me to write this piece. Some of you will remember Peter from the Cosmos North-East conventions; he's quite possibly the UK's leading expert on the US space programme.

You may have heard of NASA's MESSENGER space probe, which is currently on its way to Mercury. It was launched on 3 August 2004; it has already made three close flybys of Mercury, and returned some fabulous images. But on 18 March 2011, it will finally rendezvous with the little planet and go into orbit around it, to begin a year-long period of intensive study.

The probe's name, by the way, is perhaps the worst example yet of an irritating phenomenon that has pervaded NASA in recent years – that of awful, contrived acronyms! Years ago, spacecraft were given names that were simple words, appropriate to their purpose; for example, planetary probes were given names connected with voyages and exploration, such as Mariner, Viking and Voyager. But in recent years, there has been a strange attitude whereby every name also has to be an acronym for a long-winded phrase describing the spacecraft's purpose. Usually, someone thinks up the catchy name first, then invents a horribly contrived 'long title' to fit it. And MESSENGER is no exception.



You would think that 'Messenger', as a simple word, would be a perfectly sensible and apt name for a probe to Mercury – the Messenger of the Gods, and all that. But no – NASA decided that it also had to be an acronym. It stands for – wait for this… 'MErcury Space and Surface ENvironment, GEochemistry and Ranging'. *Yuk*!!!

(In my opinion, NASA are not doing themselves any favours with this sort of thing. 'Romantic' names like Mariner and Voyager captured the public imagination; silly acronyms don't!)

But I digress; back to the point. Now, you may be wondering, as the probe is 'only' going to Mercury, which is pretty close to Earth in planetary terms, why it's taking six and a half years to get there! Especially as NASA has been sending probes to Venus and Mars since the 1960s, and they normally take a mere few months to get there. Well, that's a very good question – and now we come to the astonishing part.

The distance from Earth to Mercury is a 'mere' 91 million kilometres at their closest, and 206 million at most; yet by the time MESSENGER makes its rendezvous, it will have travelled a staggering *7.9 billion* kilometres – a distance greater than that from Earth to Pluto!

It was impossible to send MESSENGER on a direct trajectory; instead, it has had to follow an incredibly convoluted path, making sixteen and a half orbits of the Sun, and six close passes of the planets – one of Earth, two of Venus and three of Mercury itself, which serve as gravitational 'slingshots'. (It has already completed fourteen of these orbits, and all six slingshots.) I always knew that its journey involved multiple orbits and multiple gravity assists, but I hadn't realised how many. It has, of course, already returned some stunning images of Mercury, and carried out some important measurements, during those three flybys.

I'm assuming, at this point, that the reader is familiar with the technique of gravity-assist manoeuvres. For those who aren't, I'll try and explain it very briefly. To put it simply, when a space probe makes a close approach to a planet, it can make use of the planet's gravity to increase its speed relative to the Sun. Voyager 2 used this technique to great effect to visit Jupiter, Saturn, Uranus and Neptune in turn; each planetary encounter served as a gravity assist, or 'slingshot', to accelerate the probe onwards towards its next target. And more recently, the Galileo and Cassini probes, sent to Jupiter and Saturn respectively, each used a series of flybys of Venus and Earth to boost their velocity.

Think of a planet's gravity field as a dip in the curvature of space; picture the well-known analogy of a weight placed on a trampoline, and rolling a ball through the resulting 'well'. The ball gains speed as it falls into the well, then loses it as it rises up the other side; as it emerges, it's moving at the same speed as when it started, but in a different direction. The same applies in a gravity assist; the spacecraft leaves the encounter with the same speed as before, *relative to the planet*. But there's a difference; the planet, with its gravity well, is also moving in its orbit around the Sun. The spacecraft picks up part of the planet's orbital speed as well, which is added to its own original speed, *relative to the Sun*.

It can also work the opposite way; if a spacecraft approaches the planet from behind, it gains speed, but if it approaches from in front, it slows down instead.

A detailed explanation of gravity assists is at http://en.wikipedia.org/wiki/Gravity_assist.

Note that, of course, Nature never gives anything for nothing! When a spacecraft gains velocity, and therefore momentum, in this manner, the Law of Conservation of Momentum tells us that the planet must *lose* an equal amount of momentum (it's actually *angular* momentum that is transferred). That is, the planet is slowed down in its orbit, albeit by an absolutely miniscule amount. Someone at NASA actually calculated the changes in the velocities of Venus and Earth as a result of Galileo's gravity assists; in each case, it's equivalent to a few centimetres per second per billion years!

Note also that, while I'm using the words 'speed' and 'velocity' fairly interchangeably here, they are not actually the same thing. In physics terms, speed is a scalar quantity, and velocity a vector; speed is simply the rate of motion, but velocity is the rate of motion *in a given direction*. After a gravity assist, a spacecraft's *speed*, relative to the planet, is the same as before, but in a different direction; its *velocity*, relative to both the planet and the Sun, has changed.

To understand the necessity for MESSENGER's tortuous journey, you have to understand a little about orbital dynamics. It's all about the different speeds of the planets in their orbits.

Anyone with any knowledge of spaceflight knows that to launch a satellite into Earth orbit, it has to be accelerated to a speed of about 28,000 km/h, and that to leave Earth orbit and go to the Moon, it has to reach about 40,000 km/h. That's the speed – known as *escape velocity* – to which the mighty Saturn V rocket had to accelerate an Apollo spacecraft.

But those are velocities *relative to the Earth*. Meanwhile, the Earth itself (and the Moon with it) is travelling at a whopping *107,000 km/h*, in its orbit around the Sun! All the other planets travel at different speeds in their orbits; the further from the Sun a planet is, the slower its orbital velocity, in accordance with Kepler's Third Law.

To send a space probe to another planet, we have to launch it into an elliptical orbit around the Sun, which is calculated to intersect the planet's orbit at the right time and place. To go to Venus or Mercury, that orbit has its aphelion (furthest point from the Sun) at Earth's distance, and its perihelion (closest point to the Sun) at the distance of the target planet. To go to an outer planet, it's the other way around. This ellipse is called a *Hohmann transfer orbit*.

I said earlier that NASA has been sending probes to Venus and Mars since the 1960s and that they took a mere few months to get there. And in the 1970s, Mariner 10 flew by both Venus and Mercury – the only probe, before MESSENGER, to have visited the latter planet. But those early missions were merely flybys; each probe simply shot past the planet at some immense speed, and spent a hectic few days taking images and making measurements as it did so. Doing that is relatively easy; we simply need to accelerate the probe to Earth's escape velocity and a little more, and direct it into a transfer orbit that will meet the planet, as described above. (I'm using 'easy' as a relative term, and taking nothing away from the fantastic skills of the engineers who build the rockets and the mathematicians who calculate the orbits!) To go to an outer planet, the probe has to gain speed, to 'climb' outwards against the Sun's gravity; to go to Venus or Mercury, it has to slow down, to 'fall' inwards towards the Sun.

But to have a probe actually *rendezvous* with a planet, and go into orbit around it, is another matter entirely, and far more difficult. To do that, the probe has to change its orbital velocity relative to the Sun, from being equal to that of the Earth (which it shares before it even leaves the launch pad) to be equal to that of the target planet. To go to Venus or Mercury, it has to speed up, while to go to an outer planet, it has to slow down – relative to the Sun, that is! And that requires a *lot* of energy!

Putting a probe into orbit around Mars is still relatively easy; NASA has been doing that since the Viking probes in the 1970s. But to do it with Mercury is far from easy; I'll now explain why.

The orbital speeds of those three planets (rounded to the nearest 1000 km/h for simplicity) are as follows:

Mercury	171,000 km/h
Earth	107,000 km/h

Mars 87,000 km/h

(These figures can easily be verified, if you know the planets' orbital radii and periods. If a planet's orbital radius in kilometres is *r*, and its orbital period in days is *d*, then its orbital velocity in kilometres per hour is $2\pi r / 24d$.)

So we see that to rendezvous with Mars, the required change of velocity, relative to the Sun (known as delta V, or ΔV), is a quite modest 20,000 km/h – equivalent to only half of Earth's escape velocity. So with a probe weighing a few tons, and a pretty hefty launch rocket such as a Titan 3C, it's possible to use a straightforward Hohmann transfer orbit, and achieve the necessary ΔV using the rocket alone.

To rendezvous with Jupiter or Saturn, the required ΔV is somewhat more, and beyond the capability of even our most powerful rockets. That's why Galileo and Cassini had to go by those circuitous routes, with multiple gravity assists at Venus and Earth, to alter their speed in several steps, with their solar orbits becoming progressively bigger. Galileo used three slingshots (one with Venus and two with Earth) and Cassini four (two with Venus, one with Earth and one with Jupiter).

But now look at Mercury, which is positively racing around the Sun! As we can see, the required ΔV in this case is more than three times that for Mars – which means that to achieve it requires nearly *ten* times the energy! (Remember that kinetic energy is proportional to velocity *squared*.) Doing this in one go is far beyond the capability of any of today's rockets – even a Saturn V, if they were still being built (oh, how I *wish*!), couldn't have got anywhere near it.

Actually, it's not quite as simple as that. For a probe going to an outer planet, the Sun's gravity steadily slows it down, to a speed less than that of the target planet – so it has to use gravity assists to boost its speed. For a probe going to Venus or Mercury, the opposite happens; the Sun's gravity accelerates it to a speed greater than that of the target – so it has to use the gravity assists to slow itself down! But you get the idea; it's all because the required ΔV can't be achieved with the initial rocket boost.

So that's why MESSENGER has to travel by such a convoluted route, with its 16 orbits and six gravity assists! It's doing the opposite of what Galileo and Cassini did, with each successive orbit going further in towards the Sun at perihelion. At the end of it all, its velocity will have finally matched that of Mercury, and it will put itself into orbit and begin its studies.

So now you know why, despite Mercury being one of the closer planets to us, getting there is so much more difficult than going to those much further away. When it comes to orbital dynamics, closer doesn't always mean quicker or easier!

Time machines?

John Crowther

Some of us will have seen one or more of Channel Five's 'Stephen Hawking's Universe' series. Last month I happened to catch the one on time travel, with its clever simulations.

Professor Hawking says that theoretically a home planet and its inhabitants could be visited at some point in the future, given that time passes much more slowly as perceived by the crew of a very fast-moving spaceship. However, the resources needed to build such a vehicle and the energy needed to power it are problems that were not gone into!

The programme discussed 'wormholes'. Apparently holes of microscopic size do exist – for example, in the fabric of billiard tables and in the balls themselves. So are they in our telescope mirrors and in the vacuum of space? If they are, could one be enlarged to accommodate a spaceship? It seems extremely unlikely. Here, fiction and fact may merge, as in the book (and film) *Fantastic Voyage*, which describes a vehicle and crew shrunk so that a living human body could be explored – fiction that is now almost fact with the advent of body-exploring cameras.

Forgetting wormholes, we are left with two other similar methods that use the same principle.

The first one is, to our minds, another fantastic voyage. We need to journey to the large black hole that supposedly sits at, and is, our galaxy's core. Time will be slowed because of the near-light speed necessary to get there. Then the ship will have to orbit the central black hole. Its gravity would cause considerable time loss for the crew of a ship orbiting it in sixteen-minute circuits.

The second method makes use of acceleration almost up to the speed of light. When this is achieved, what happens when the spaceship makes a gigantic U-turn? Some speed may be lost, and then more will go as the ship has to slow as it nears its own star system. So will any of the time difference also be lost as the starship nears home?

The programmes didn't discuss these points and I didn't enter my own time machine by going to sleep! But clearly, gone is the simple time machine as described by HG Wells in his book.

(*Comments on and criticisms of this article are welcomed!)*

CaDAS NEWS

CaDAS workshop, 29/9/2010: Messier Bingo

A new format of CaDAS meeting, to supplement the monthly lecture series, had been suggested for some time. The general idea was to allow members to participate in the evening's activities, to make it as informal as possible and provide opportunities for members to become acquainted with one another. Ed Restall and Rob Peeling had devised and planned a session of "Messier Bingo". They had put a lot of effort, time and knowledge into providing a PowerPoint programme to project the pictures and the (random) bingo cards on which the numbers represented a Messier object. If that object was projected by the (random) PowerPoint, the card would be marked accordingly and, when complete, that person won the prize.

The other participation twist was that participants were asked to recognise the picture of the Messier object. Rob added interesting background information on each object, so we all learned about the objects, the history of the Messier Catalogue, where the objects were, as well as what they actually looked like.

Twelve members were present, as well as Ed and Rob running the whole thing. Barry Hetherington won the "bingo" and a prize. Ed had provided tea, coffee and biscuits to encourage some socialising. The evening closed at about 2100. It is hoped that a good time was had by all and that more members will attend the next informal meeting, to be held early in 2011. The format and general development of the "workshop" idea is continuing to be discussed by the Committee.

CaDAS Win Thomas Wright Trophy competition!

This was held on Friday, October 8th, 2010 as part of the CaDAS ordinary monthly meeting. The venue was Grindon Parish Hall, Thorpe Thewles. As usual, three teams were invited from neighbouring astronomy Societies, answering questions set by Neil Haggath in four different "rounds". Durham University, Durham AS and CaDAS had provided teams.

For most of the quiz, Durham AS held a slender lead, ahead of CaDAS with the University third. Only in the final round did CaDAS draw ahead to win by 59 points to Durham AS 51 and University 24.

Yorkshire Astromind 2010

Neil Haggath

On Saturday 16 October, CaDAS once again took a turn to host the prestigious Yorkshire Astromind competition. The contest took place at the Blue Bell Hotel in Acklam; five societies from across Yorkshire competed this time, and as has become the tradition for the last few years, Yours Truly was Quizmaster.

Rob Peeling again represented CaDAS, and upheld our honour by achieving his second win! The defending and multi-times champion, Marcus Armitage of Huddersfield A.S., came a creditable second; the other contestants, in finishing order, were Gary Gawthrope of Mexborough and Swinton A.S., Darren Swindells of Sheffield A.S. and Peter Clark of East Riding Astronomers.

While I was, of course, completely impartial as Quizmaster, I can take the opportunity after the event, to praise Rob’s performance. He took the lead in the first round, and held it throughout. In the final round, the two-minute speed round, Rob was first in the chair, and by the time he left it, the result was decided. He was so far ahead that Marcus, in second place, couldn’t have caught him even with a maximum score.

We all know that Rob knows his stuff – but on this occasion, he was simply brilliant! I doubt if *anyone* – including myself in my competing days – could have beaten him that day. Well done, Rob; you did us proud!

THE *TRANSIT* QUIZ

Answer to October's quiz

Last month's quiz was a history test, asking who made the following discoveries and when?

1. Mars has ice caps: *Christiaan Huygens, 1659*
2. Oberon and Titania, moons of Uranus: *Sir William Herschel, 1787*
3. Phobos and Deimos, the two satellites of Mars: *Asaph Hall, 1877*
4. Charon, the satellite of Pluto: *James W. Christy, 1978*
5. Each element has its own specific Fraunhofer lines in the electromagnetic spectrum:*Gustav Kirchhoff, 1859*

6. Infrared radiation: *Sir William Herschel, 1800*

7. Ultra-violet radiation: *Johann Wilhelm Ritter, 1801*

8. The first indication that a star could vary in brightness: *John Goodricke, 1782*

9. The Andromeda Galaxy (M31) is moving towards us: *Vesto Slipher, 1913*

10. Quasars have huge redshifts and so are extremely distant objects: *Maarten Schmidt, 1967*

November's quiz

Comment [AF1]:

Fill in the gaps.

1. The closest and brightest of the red long-period variable stars is ______________.

2. The greatest apparent magnitude of the planet Venus is ___________.

3. The ______ ______________ consists of two 10 metre telescopes, situated at the summit of Mauna Kea, Hawaii.

4. The bright and compact astronomical radio source at the centre of the Milky Way, thought to be a super-massive black hole is known as _______________ ___.

5. The constellation Horologium was originally named in honour of Christian Huygens. It is more commonly known as ___ __________.

6. The three chemical elements created at the time of the Big Bang were ___________, _____________ and traces of _____________.

7. As a distant galaxy recedes the frequency of the light received by an observer on Earth decreases. It is said that the light of the galaxy is ___________________.

8. Valued at approximately 72 km/s per megaparsec, this parameter is commonly known as the _____________ _____________.

9. The visually disappointing long period comet designated C/1973 E1observed by the crew of Skylab 4 and Soyuz 13 is commonly known as Comet _______________.

10. Discovered by William Herschel in 1784 and designated NGC 6992, this difficult to find deep sky object is otherwise known as the ________ ________________.