TRANSIT

The March 2010 Newsletter of

Cleveland & Darlington Astronomical Society

<u>NEXT MEETING</u>

15 March 2010, *7.15 pm for a 7.30 pm start*

Wynyard Woodland Park Planetarium

Astronomy at the End of the Rainbow

Dr Paula Chadwick *Dept of Physics, University of Durham*

Contents

Editorial

Rod Cuff

Recent weather has not been great for observing, as Alex laments in his article – perhaps Rob's 'Skylights' work can be put to better use this month, though. However, reflected in this issue are plenty of other things that an amateur astronomer can do: comparative research (Alex), reading (Andy and me), listening to astronomical podcasts (Andy again), exploring the internet for things to learn and share (Facebook) or get suitably indignant about (Neil), or putting together a presentation or article for other CaDAS members (Michael).

Andy's reviews are, I'm very happy to say, the beginning of a regular series from him – he says:

> *There are some fantastic books out there that are very user-friendly, with not too much math. I think everyone interested in astronomy has an obligation to learn about 'the giants' in our subject who made today's knowledge possible. Many of these superb books cost absolutely nothing.... they're all available from the local authority library! [And] I have a near-full iPod of science and astronomy podcasts …*

If you have books, broadcasts, programs, organisations … that you'd like to share your enthusiasm for, do please send them to *Transit*. I myself have a shelf of books suitable for review that I could add to the one I've covered in this issue.

There's another innovation this month – well, it's something I used to do in articles I wrote here before I started editing the mag – which is the inclusion throughout articles of web links that may be of interest. Mostly they appear just as clickable words, without an explicit URL, as readers of the PDF version can simply click, and those taking the printed version presumably can't access internet sites or else or can download *Transit* from our website and then click.

Many thanks again to all contributors. The copy deadline for the next issue is **Friday 26 March**.

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OBSERVATION REPORTS AND PLANNING

Skylights – March 2010

Rob Peeling

The Moon

7 Mar	15 Mar	23 Mar	30 Mar
Last Quarter	New Moon	First Quarter	Full Moon

A sidereal month lasts 27.3 days. You can roughly check this for yourself this month. Watch the Moon rise near Saturn on March 1st. Then watch it rise again in roughly the same relative position to Saturn on the 28th. On the 17th you can watch the Moon follow Venus as they both set in the evening twilight. A week later the Moon, Castor, Pollux and Mars will be grouped in the same part of the sky, with the Moon passing below Mars the following night.

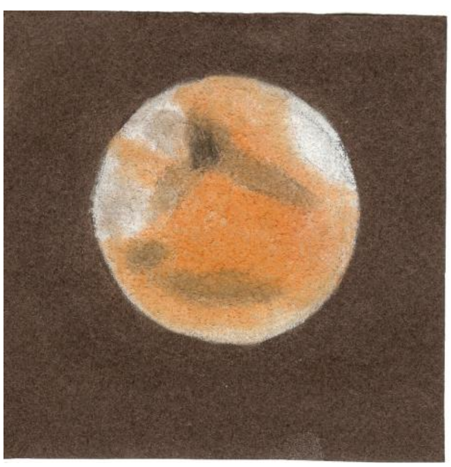
If the sky is clear and you don't mind being up in the early hours, then 4th-magnitude omicron (o) Leo to the west of Regulus will be occulted by the Moon on March 27th. *Very* roughly, omicron will disappear behind the dark limb at around 01:50 am and reappear somewhere around 02:30.

The Moon's libration in latitude is 7° at full moon on March 30th. This brings into better view obscure northern areas such as Mare Humboldtianum on the limb and the crater Endymion.

Sketch of the Mare Humboldtianum area of the moon. 30-01-10 at 21:42 UT. The mare is on the limb, with the crater Endymion above. The white specks beyond the limb are peaks illuminated by the Sun. 150mm f/5 Newtonian with 6.3 mm Plossl lens.

Planets & asteroids

Mars remains prominent but shrinking as our planet swings away. This is probably the last month for serious observation of any surface detail. Next chance is 2012!



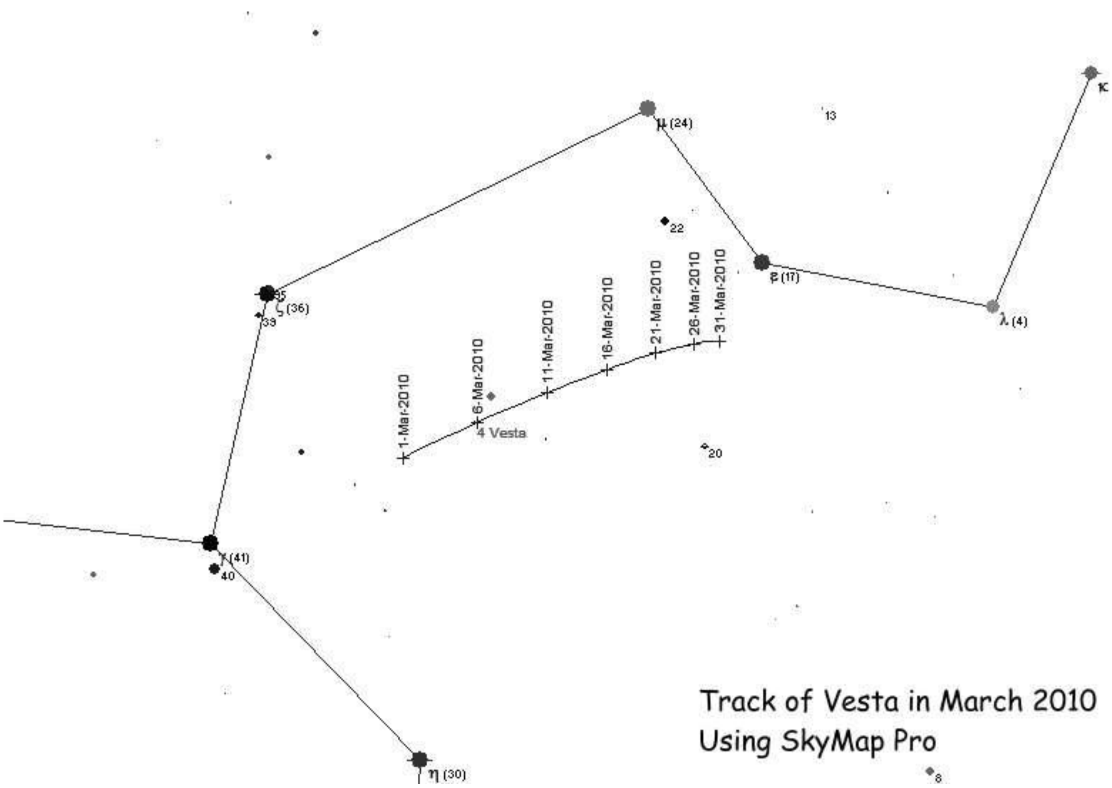
Sketch of Mars on 31-01-2010 at 21:28UT. Longitude of the Central Meridian is 353°. Using 150mm f/5 Newtonian with 6.3mm lens and 2× Barlow.

The darker area towards the top is Mare Acidalis.

Saturn reaches opposition on March 22nd. The rings are still quite thin, which means that the moons are perhaps easier to spot, as they stay fairly close to the line marked out by the rings. How many can you see on one night? **Titan** and **Rhea** are easy to track. The others are more elusive. A good total for one night is four, but finding five is certainly possible.

Venus appears as the Evening Star during March. Use Venus this month to track down the most elusive of the classical planets – **Mercury**. On the 26th Mercury can be seen soon after the Sun sets beneath Venus. The two planets will approach each other until the 29th. A search with binoculars in the quadrant below and to the right (west) of Venus should reveal Mercury as a bright 'star'.

The minor planet **4 Vesta** is nicely placed to track down during March because it spends the whole month in the hook of the sickle asterism in Leo. The sickle is easy to see and is well known as the backwards question mark stretching upwards from Regulus. Vesta is a magnitude 6.3 starlike object in this area. It betrays its true nature by the movement it shows relative to the stars night on night. The chart below plots stars down to mag 7. Once you've tracked Vesta down, check again in your finder. It is likely to be visible. Once you have the location, it should be easy to track with just binoculars.



Deep sky

Look out for the large open cluster **M44** named **Praesepe** or the **Beehive cluster** in Cancer. It is easy to find as a glowing patch in either your finder or binoculars just below the midpoint of an imaginary line between the bright stars Pollux in Gemini and Regulus in Leo. In the telescope it becomes a huge bright cluster. Try and discover if you can see it with the naked eye. I have been surprised at how visible it is through considerable light pollution. I have seen the Beehive with my naked eye both at home and at the Planetarium. Out on the North Yorks Moors you can't miss it. Once seen with the naked eye, the reason for its [translated] Chinese name, Ghosts, becomes obvious.

The pair of galaxies **M65** and **M66** in Leo should be fairly easy to spot with a low-power lens in a moonless sky. Look for the right-angled triangle of stars made up of Denebola, Zosma and θ Leonis that marks the hindquarters of the lion. Centre your finder on θ Leonis, which marks the right angle of the asterism. Now scan with the finder below (south) of θ to find a line of three stars, with 73 Leonis the brightest. Using the telescope, move left (east) a field width or two to spot the two galaxies. Can you detect a third galaxy, **NGC 3628**, which lies just to the north of Messier's pair?

An expedition to the North Pole

A continuing CaDAS project (started in the International Year of Astronomy 2009)
to collect observations, sketches, images and *any* kind of information about
any object with a J2000 declination ≥70 degrees.

Send your reports, lists, or whatever to Rod, Alex or Rob (contact info for all three is at www.cadas-astro.org.uk/contacts.html) or, if you prefer, bring them along to a CaDAS meeting.

Norton and the north

Alex Menarry

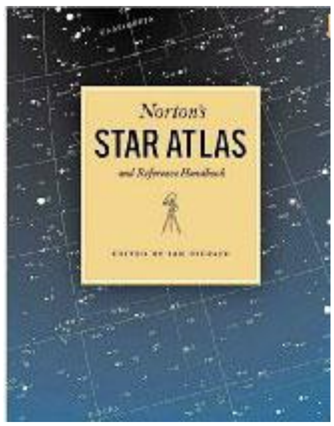
When I asked myself the question, 'Which astronomy book do you spend most time with and enjoy most?', the answer was *Norton's Star Atlas*, first published in 1910. It's a volume I go back to time and time again. It's a starter's book, I suppose, without great complication and dealing with basic astronomy. After a short extraction of what it has to say, it often leads me on to other tomes or the web, but there is always some starter or reminder information in good old *Norton*. There is a view that the later, Ian Ridpath, editions have departed too far from the original idea. To check that would require going back to an earlier edition, which I have given away to someone – maybe the Society library?

Which reminds me of when I bought that 1959 (14th) edition in 1963. We were living in Italy at the time. Somehow, *Norton* came to my attention and I ordered it through a British bookshop in Rome. I remember they were quite excited about it; no one had ordered a copy through them before and it had been dipped into by all the staff in the shop before I got it! I hope it inspired a few people to take up astronomy.

Observing in Italy was a doddle, compared with the conditions we have here – especially compared with the few observing nights we have had recently and the penetrating cold. The villa we rented had a flat roof in a holiday area by the sea. Very little light pollution, and blessed with warm evenings. Carry the armchairs onto the roof, set up the telescope (a pathetic 2-inch refractor), open *Norton*, pour out a glass of wine and there we were! The wine – red, of course –

we collected from the local trattoria in a jug filled from an enormous barrel, complete with wine flies but costing peanuts. It was a holiday area for Roman businessmen, who deposited their families in the villas for the summer holidays, when it was stiflingly hot in the city, and commuted to work. They thought we would perish if we attempted to live there through the 'winter', which was like our spring!

And so to the point of this piece (at last, I hear you say). Observing conditions (even marginal ones) have been so appallingly infrequent recently that I had nothing to report for the month.



Honestly, this is not just idleness and avoiding the freezing fingers and toes syndrome. My substitute was to compare the observing list (see *Transit, Sep 2009*) that Rob put together for the North Pole Expedition (NPE) with the *Norton* information on Maps 1 and 2. As with all star atlases, the maps are works of art. The limiting magnitude is 6, presumably to serve a readership of naked-eye observers, covering declinations from 50 degrees to 90. Lists of 'Interesting Objects, Maps 1 and 2' have three categories: double stars; variable stars; and clusters, nebulae and galaxies.

For the doubles, *Norton* uses the Aitken Double Star Catalogue designations. His list (or is it Ian Ridpath's now?) includes five doubles that don't appear in our target list: ADS 1598, 8682, 15719, 15764 and 16538, ranging from 0.9 arcsecs to 28.9 arsecs separation. Even those on Rob's list that are near to or brighter than magnitude 6 are missing. Not being an experienced observer, it raised the question in my mind, 'How does one choose the targets to go after?'.

So, I started looking into Catalogues, which was a major error. It's a subject worthy of a lifetime's study. I'm hoping some of our members have looked into Catalogues as a subject in itself and will write an article about it all. I quickly came across four double star catalogues – Aitken, Struve, Washington and the Index Catalogue of Double Stars. Of course there is a plethora of other catalogues, for all sorts of objects. Wikipedia has a massive list. There are lists of catalogues in Stellarium and, no doubt, in other planetarium software packages. Catalogues, I have decided, can take over your life – and probably have taken over lots of people's lives!

But enough of that little rant: onward to the other categories in the NPE. The lists of variable stars and eclipsing binaries were extracted from the BAAVSS binocular observers' recommended objects. In this category there appears to be little or no correspondence whatsoever with *Norton*'s lists, except for good old RZ Cas, the beginner's friend, which is just outside 70° dec anyway! More puzzlement to sort out sometime.

But the most puzzling category in *Norton* is for the deep sky – clusters, nebulae and galaxies. There are none in Norton's list above 70° declination! However, looking at the maps, there are at least 12, some of which are in the NPE list. Presumably Norton/Ridpath considered they were worth putting on the maps but were not 'Interesting Objects'. Does anyone know why?

Another armchair investigation, to fill those evenings blessed with ten-tenths cloud from horizon to horizon, was to have a detailed look at the NPE area in *Sky Atlas 2000.0*, by Wil Tirion and Roger W. Sinnott. This is another beautiful work of art as well as science. (Who said the two disciplines can't be reconciled?). You've probably already guessed that this only opened another can of worms – such as nebulae with B-numbers, galaxies with numbers like M-2-9-36 and M-3-10-42, and Cr objects. There may well be more mysteries to uncover. Stand by.

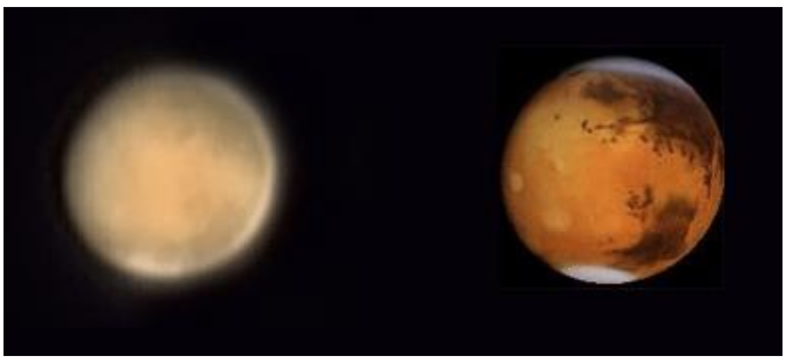
So, to finish, a little quiz. No cheating by looking it up on the atlases first! In which galaxy is the North Ecliptic Pole; and ii) in which galaxy is the North Galactic Pole? I briefly thought of suggesting a North Galactic Pole Expedition but the N(E)PE may yet prove to be a life's work.

Mars by webcam

Rod Cuff

There has been scant opportunity for observing or imaging work lately, as Alex says above; but I had a couple of goes at imaging Mars for the first time, the better (and later) result being shown below. In case you're in the remotest doubt, the image on the left is mine, and the one on the right, shown for comparison, is taken from the CalSky website, and displays a schematic view of Mars at that time.

Equipment was an 8" Meade LX90 with a 2.5× Powermate, and a Philips ToUCam Pro 2 webcam with an infrared blocking filter. Exposure was 1/33 sec, 10 fps, ~3000 frames in total, with the best ~850 stacked and processed with Registax 5, plus minor tweaks with Photoshop.



Mars at 2010 March 1, 20:50 UT.

The planet was then subtending an angle of about 12 arcsec. The Central Meridian is 78.57°. North is at the bottom.

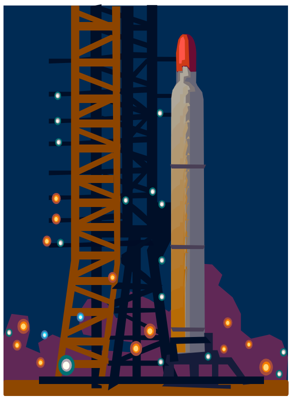
GENERAL ARTICLES

'Spaceflight is a waste of money'… NOT!

Neil Haggath

One of my perennial pet hates is people who whinge about spaceflight being 'a scandalous waste of taxpayers' money, which could be better spent on…' (insert whichever 'cause' they personally happen to support).

The most annoying version, which I've heard frequently, is 'could be better spent on solving environmental problems on Earth'. It obviously doesn't occur to those geniuses that the most important environmental problem we currently face was *discovered* as a result of spaceflight; the Greenhouse Effect was first postulated to explain the anomalously high surface temperature of Venus, before anyone imagined that it might be happening on Earth.



Those who emit such rantings obviously imagine that spaceflight accounts for gigantic amounts of (mainly American) public money – but how much does it *really* cost? This question has just been answered by an article in the *New York Times*, and in an article by Phil Plait on his Bad Astronomy blog, which links to it. Phil's piece is entitled 'Wait, how big is NASA's budget again?'; you can read it at http://tinyurl.com/CaDAS10Mar-1**.**

It appears that the average American lacks even the remotest comprehension of where their own taxes go, and how much their government spends on what. Of course, it's near-impossible for the man in the street to visualise what an amount measured in billions of dollars really means – still less *trillions* of dollars, in which the United States' overall government spending is measured! (That's using the awful and illogical American definitions of those words, which have annoyingly become the standard, i.e. billion meaning 10^9, and trillion 10^{12}.) But even so, the levels of ignorance revealed by a recent survey are quite astonishing. In particular, significant numbers of Americans apparently believe that NASA's budget accounts for anything up to *a quarter* of their nation's overall budget! Anyone with two brain cells to rub together can see that that's ridiculous – but you may be surprised to see how small the actual figure is.

The *New York Times* article breaks down the current year's government spending in a diagram in which various categories are represented by rectangles of proportionate sizes. The rectangle representing science research funding – in all fields – is so small that you have to look pretty hard to see it – and NASA's budget is just one subset of *that*!

In this year's budget, NASA was allocated a total of $12.8 billion. That might sound like a huge amount of money – but it's peanuts when compared to the total of government spending: a mind-boggling $3.7 *trillion*! Also compare it with the defence budget, which accounts for a whopping $738 billion.

So there you have it, folks – do the maths for yourselves. NASA's total budget is, in fact, a piddling *one third of one percent* of the US government's total spending! 'A scandalous waste of money'??? Think again; as Phil Plait points out, it's incredible to think what NASA has achieved, given how *little* money it has had available, in real terms. Even at the height of Apollo, the most expensive space programme in history, the corresponding figure was only slightly more than one percent.

I think I've made my point – but still, quoting figures such as $12.8 billion in isolation doesn't mean much to the layman. So how about some comparisons, to put it into context? As Phil says, Americans spend more per year on pet food than the government allocates to NASA. And right now, their government is spending $11 million *per hour* in Iraq!

Let's go back again to the Apollo era, when NASA had its greatest share of funding. The total cost of Apollo over 11 years (from JFK committing the nation to it in 1961, until the last landing in 1972) was $23 billion – an enormous sum in 1960's dollars. Yet during the same era, the US was spending $30 billion *per year* on the disastrous war in Vietnam. To look at it another way: that total cost was comparable to the amount that Americans spent *per year* on cigarettes!

Even today, when far fewer people smoke than in the sixties, Americans' annual spending on tobacco is five times the NASA budget.

Of course, when people whine about the supposedly 'scandalous' cost of spaceflight, they are usually referring to *manned* spaceflight. But apart from Apollo, many of NASA's greatest triumphs have occurred in its unmanned programmes, which generally cost vastly less.

In 1989, after Voyager 2 made its final encounter with Neptune, I was dismayed to read a letter in *The Sun* that applied the same 'scandalous waste of taxpayers' money' rant to the Voyager project. I wrote a reply, which the paper unfortunately didn't print, pointing out the sheer stupidity of this argument.

The total cost of the Voyager project was $850 million. That still sounds like a huge amount of money, especially as we are talking in 1970s and 1980s dollars. *But*… Consider first that that expenditure was spread over a period of 17 years – 5 years of research and development prior to launch, and 12 years of operation from launch to the Neptune encounter. Then divide it by the population of the United States, which at the time was about 220 million – and we find that the actual cost of Voyager was – again, please check the maths for yourself – all of *23 cents* per US citizen per year!

'A scandalous waste of money'??? I'd say that it was one of the greatest bargains in history!

I rest my case.

Comets and the Oort cloud

Michael Roe

[This is the text of Michael's presentation at CaDAS's Members' Night on 12 February. –Ed.]

Comets have been known to humanity for thousands of years, often bringing fear as those ghostly visions appeared in the heavens from nowhere, moved across the starry background, then faded away. The superstitious people of earlier eras often thought of comets as omens heralding the birth or death of local rulers or the coming of some great disaster.

After the Middle Ages, other people – astronomers – began to record these spectral objects, although the Chinese and Koreans had recorded them for over a thousand years by this time. In Europe, people such as Tycho Brahe, the great Danish astronomer, measured the positions of comets, trying to make sense of their movements. Since the time of the Ancient Greeks, comets had been regarded as inhabiting the upper atmosphere, perhaps being a special luminous kind of cloud much higher up than normal clouds. The word 'comet' actually means 'hairy star'. In fact Tycho calculated using parallax that a great comet was much further away than the Moon, and was not locked within the Crystal Spheres believed to hold the Moon, Sun and planets in place around a fixed Earth, rather like celestial goldfish bowls.

From the late 1600s onwards, Isaac Newton and Edmund Halley calculated orbits for comets, including of course one later named 'Halley's Comet', the first of many to be named after its discoverer. The orbit of Halley's Comet (*below*) was very peculiar: a long, narrow orbit, an

ellipse stretching 50 times further from the Sun than at its nearest point to it, taking 76 years to make one orbit and being visible for only about a year with early telescopes.

But this didn't explain what a comet was. Only its fuzzy coma, bright at the centre and sometimes with a faint tail, could be seen, even with a telescope.

More comets were discovered. Charles Messier was famous for finding many, but is better remembered now for his catalogue of fuzzy nebulae (objects for comet-hunters to avoid!), and not for his comets.

Strangely enough, William Herschel, who thoroughly surveyed the heavens with great telescopes, never discovered a single new comet. Yet his sister Caroline, who assisted him, found several!

During the 19th century, many more comets, mostly telescopic oval or round blurs, were found. One, Biela's Comet (*right*) split into two in 1846, and by 1872 had been transformed into a spectacular meteor shower. This got many astronomers thinking. Could a comet be some kind of concentrated meteor shower – a collection of dust or sand-sized particles held together by gravity?

Comets were definitely of different sizes, from ones smaller than the Earth to others as large as the Sun with tails many millions of miles long but so diffuse that stars were visible undimmed through them. Moreover, although planets – especially Jupiter – often altered cometary orbits through its huge gravity, comets had no measurable gravitational effect on any planet.

During that century, spectacular comets appeared quite often: in 1811, 1843, 1858, 1861 and 1882. Larger telescopes revealed the bright nucleus in some large comets to be tiny, even starlike, with curving sprays of bright vapour.

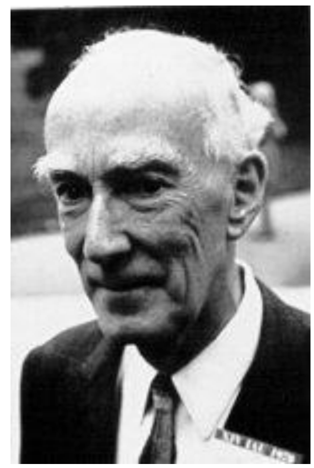
The new spectroscope revealed at long last what a comet was made of: often water plus gases such as cyanogen, methane and nitrogen, along with solids that included carbon, iron and nickel. These metals were found in comets that became known as 'sun grazers' because they do exactly that, approaching the Sun to within a fraction of its diameter, sometimes to be evaporated or even swallowed up.

Also, two types of tail were found, often on a single comet: one a gas tail, the other a dust tail.

Comets were now known to be of different orbital types. Some are periodic – comets that returned. Some are in smaller elliptical orbits going out as far as near Jupiter's orbit, while others such as Halley's Comet go out as far as the orbit of Neptune. Many of the periodic comets are faint objects without tails.

But there are others, sometimes very bright, known as long-period comets, with very long orbits that may take thousands of years to complete and take them to many times the distance of Pluto. When they come back into the inner Solar System, briefly going inside the Earth's orbit, they can become spectacular before fading again and vanishing into the dark gloom beyond the planets. For instance, Comet Hale–Bopp in 1997 was very prominent in a dark sky, while a few years ago Comet McNaught was visible just after sunset. I photographed both of these.

In the 20th century, astronomers began to have a better idea of what comets were. Many comets must spend most of their time at huge distances from the Sun. Some orbits were as near to parabolic as could be measured; a parabolic orbit would theoretically take a comet back out to infinity before starting to return. A very few cometary orbits are hyperbolic, which means that the 'orbit' is actually open-ended and the comet will never return. This situation sometimes arises, for instance, when the comet's previous orbit has been perturbed by a close encounter with one of the giant planets, usually Jupiter. Interestingly, a hyperbolic orbit of a comet thrown from another star system has never been observed, proving that such comets are very rare indeed!



In 1900 Jan Oort (*right) was* born, a man who made detailed study of cometary orbits. By 1950 he had concluded that comets mainly inhabit a roughly spherical region up to 50,000 AU from the Sun – over four trillion miles, not far short of a whole light year (5.88×10^{12} miles). These extremely long cometary orbits come from all directions in the sky, proving that the Oort Cloud (the name now given to this region) is roughly spherical.

This theoretical Cloud is believed to be very sparsely populated with comets of all sizes. Most of them have solar orbits taking millions of years – perhaps up to about ten million years in its outer regions, which are most likely to be very sparse indeed. Every few million years a star approaches the Sun to within a light year or so and by its gravitational pull stirs up the Oort Cloud. Some of the more distant comets must be captured by the approaching star, while others are perturbed into a shorter-period orbit (these are the comets we see), and yet others are flung out to roam the Galaxy (presumably not many, otherwise we would be seeing an occasional interstellar comet coming our way).

One important topic I've left until now is the mystery unsolved for centuries: what exactly *is* a comet? One idea from the past was that a comet is a kind of flying sandbank, a mass of sand and dust. But in this century better telescopic observations and spacecraft missions to comets have more or less solved the mystery.

A comet is a mass of icy materials, including frozen gases, with a small amount of dusty particles mixed in – the 'dirty snowball' theory. The Giotto spacecraft in 1986 revealed Halley's Comet to be a long, blackened object about 7 miles long, sending out sprays of vapour, its dark surface perhaps a crust of dust refrozen onto the icy body every time it moves into the outer part of its 76-year orbit. This has happened over and over again for thousands of years.

Possibly, comets that stay well beyond the planets – and these are the majority – have more icy surfaces but are darker, as there is little sunlight at such huge distances. The average comet will be an irregular block left over from the formation of the outer Solar System and will never develop a fuzzy coma or a tail, which are phenomena that occur only if the naked comet nucleus approaches the Sun closely enough. The water and gases then evaporate and the solar wind drives clouds of vapour away from the nucleus, thus building a fuzzy coma around the nucleus and sometimes a long tail too.

There is another region of closer-in cometary objects, the Kuiper Belt, named after Gerard Kuiper, one of the few professional planetary astronomers in the 1950s, when he predicted an inner ring of comets beyond the orbit of Neptune. This is of course where Pluto lies – some (like me!) classify it as a planet, others (such as the International Astronomical Union) classify it as a dwarf planet – perhaps it's a matter of personal preference.

Beyond Pluto is Eris, which I like to think of as the tenth planet. Eris has a very inclined orbit, moving between 3.4 billion and 10 billion miles from the Sun. Pluto and Eris are both much the same size – around 1400 miles in diameter. It's interesting to note that if Eris had been near perihelion in the 1930s, Clyde Tombaugh, the discover of Pluto, would probably have discovered Eris too, but in the 20th century it was far out near aphelion, and the same will be true throughout the current century.

Other worlds, from 1000 to 200 miles across and smaller, have been found recently in this region, which is 3–5 billion miles from the Sun and shaped into a vast ring, a bit like a fat car tyre. In this region, Neptune's gravity perturbs the comets and other small worlds nearer the Sun into short-period comets or out into the Oort cloud.

The Kuiper Belt merges into the Oort cloud at its outer, sparse edges. The total mass of the latter is unknown but probably amounts to several Earth masses. As for the size of the largest objects, who knows? Perhaps the largest Oort cloud object is a world as large as Mars. I'm sure a few are a thousand or more miles in diameter, but mostly they range from a few miles across down to pebble size.

Of course, the actual Oort Cloud is invisible to present telescopes even with the best CCD technology. Many of these distant comets are fainter than magnitude 40, although hopefully future surveys may track down the larger, nearer objects. The only real evidence of the existence of the Cloud is the long-period comets we observe.

I like to think of these tiny icy worlds permanently out there on their slow orbits so far out from the Sun, hardly illuminated by a star that would appear not much brighter than Venus does to us. They must have hard, frosted surfaces, as even hydrogen freezes out there. But whether their surfaces are smooth or rough we may never know. It would be such a vast expenditure of time, effort and money to send a spacecraft to such tiny distant objects that it probably will never happen. But still – I hope you'll all remember where its origin is when next you see a comet.

REVIEWS

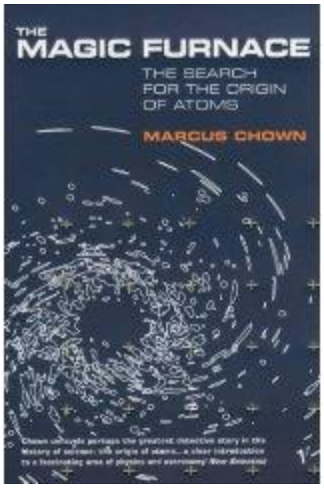
The Magic Furnace: The Search for the Origin of Atoms

By Marcus Chown (2000)

ISBN 978-0099578017 *paperback. £6.96 from Amazon (*http://tinyurl.com/CaDAS10Mar-2**)**

reviewed by ***Andy Fleming***

'If the atoms that make up the world around us could tell their stories, each and every one of them would sing a tale to dwarf the greatest epics of literature', Chown proclaims in the prologue of this book. The work is his attempt to chronicle humankind's efforts, commencing with Democritus in Ancient Greece over two millennia ago, to discover what the smallest constituents of matter are, and from where they came.



It's an enthralling, comprehensive history lesson in the development of astronomy and atomic physics, encapsulating key moments and discoveries in the search to answer the question of why 98% of the mass of visible matter in the universe is composed of hydrogen and helium, and where the remaining 2% of 'metals' came from.

In one of the greatest all-time detective stories featuring an all-star cast, the research of such notable scientists as Lavoisier, Hooke, Boyle, Dalton, Mendeleev, Davy, Faraday, Avogadro, Thomson, Curie, Rutherford, Chadwick, Einstein and Hoyle is all beautifully woven together to arrive at one inescapable conclusion: that all of the chemical elements from beryllium and boron to iron in the periodic table were exothermically cooked up in the cores of dying red giant stars and vomited into the interstellar gas once those stars died. The jigsaw puzzle was finally completed when the endothermic origin of the elements heavier than iron was identified as supernovae, the result of the detonations of high-mass stars, at the end of their short lives. It turns out that we, and everything we see were literally 'made in heaven'.

From the synthesis of hydrogen and helium in the Big Bang to the discovery of such helium in the chromosphere of the Sun, from star-forming regions of interstellar gas to white dwarfs, neutron stars and black holes, from Newton's prism to the development of spectroscopy and spectrometry, from the discovery of electrons, protons and neutrons to electromagnetism and the nuclear forces, from Becquerel's discovery of radioactivity to the nuclear fusion of hydrogen into helium and beyond, each step towards our contemporary understanding of astrophysics and atomic synthesis is both logically conveyed and clearly explained.

Chown's writing style is both inspiring and captivating, and you will have difficulty putting this book down. Indeed, on a re-reading I found it just as captivating.

It is essential background reading for anyone wanting to learn about the lives of stars, astrophysics and the reasons behind the abundances of the chemical elements.

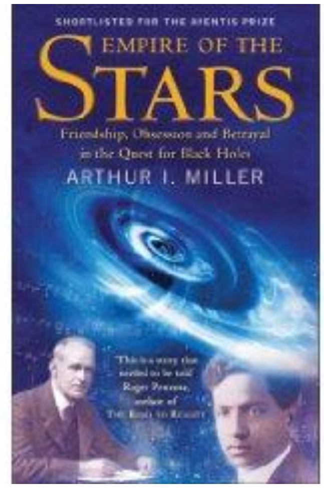
Empire of the Stars

reviewed by ***Rod Cuff***

By Arthur I. Miller (2005)

ISBN 978-0-349-11627-3 paperback. £8.99 from Amazon.

Although its title makes it sound like a science fiction novel, this book is an absorbing mix of biography and scientific detective story. It centres around the life of Subrahmanyan Chandrasekhar (always known as just 'Chandra'), the theoretical physicist who deduced that there was a maximum limit to the size of a white dwarf (the Chandrasekhar Limit, of about 1.44 solar masses). If a star, having burnt all its fuel, ends up more massive than that, his calculations implied that no known force in the universe can prevent it collapsing under its own gravity down to a tiny point – a singularity. Today we know this as a black hole.



Remarkably, Chandra came to this conclusion while an unknown 19-year-old, sitting in a deckchair on a ship carrying him from his native India to England in 1930 to become a graduate student at Cambridge. When he presented a more worked-out version to a packed RAS meeting in 1935, however, he was stunned to find that his presentation (and the very idea of a black hole – an as yet unnamed concept) was publicly ridiculed minutes later by the greatest astrophysicist of his day, Sir Arthur Eddington. Eddington was not only a colleague of Chandra's at Cambridge (and in and out of his office), but also a Fellow of the same college, Trinity.

This hour's events were to have a lasting and ultimately damaging effect on both parties, and delayed the 'discovery;' and later acceptance, of black holes by 30 years.

While it concentrates on Chandra and Eddington, Miller's very readable book also gives potted biographies of many of the other characters who were involved in practical and theoretical astrophysics and physics (including quantum mechanics, atomic physics and general relativity) in much of the twentieth century. Through them and their contributions, we see the greater understanding of stars and their lives unfolding, after twists and turns, false starts and leaps of intuition, over many decades. It's easy to take our present knowledge of such things for granted, as if it had somehow all been deduced logically and calmly and with general agreement. Ohhh no, it hadn't …

Podcast: The Planetary Society's Planetary Radio

reviewed by ***Andy Fleming***

In November 2009, Planetary Radio celebrated its sixth anniversary as a weekly space-exploration public-outreach podcast. Hosted and produced by Mat Kaplan, a seasoned radio reporter from Long Beach, California, each show features an in-depth interview with a scientist, engineer, project manager, advocate or writer, either in the studio or in the field. Each guest is specially selected to provide a unique perspective on the quest for knowledge about our solar system and beyond.

As it's a production of the Pasadena-based Planetary Society, the world's largest space-interest group and originally founded in 1980 by Carl Sagan, Louis Friedman and Bruce Murray, you know from the onset you're going to be listening to a quality and inspiring production.

An examination of the show's archive shows the range and depth of the space-related subjects covered. Whether you're interested in the popular NASA (and ESA) planetary science robotic missions such as Cassini, New Horizons, the venerable Mars rovers, Messenger at Mercury, or the more obscure missions such as the Dawn Discovery Mission to Vesta and Ceres, there is something for everyone.

Other programme subjects include the International Space Station, the Hubble and Kepler Space Telescopes, the Search for Extraterrestrial Intelligence (SETI), the space policy of NASA, the development of new ground-based telescopes such as the Thirty Metre Telescope, private space-exploration initiatives, and of course, the discovery of exo-planets. Most of all, as you may expect, the programmes heavily feature our planetary neighbours, with fascinating insights into such topics as our own Moon, Saturn and Jupiter's entourages of moons and rings, and of course Mars, with its ice, methane, possible caves, geology and meteorology.

Planetary Radio also sports an impressive list of guests, including Steve Squyres (of Mars Rover fame), Peter Smith (Phoenix Lander), and Linda Spilker and Carolyn Porco (Cassini – Dr Porco can fly you to Saturn). I've just been listening to the latest fascinating show featuring an interview with Apollo 11's Buzz Aldrin on President Obama's proposed NASA budget.

Each thirty-minute weekly show, available in both .mp3 and .wma Windows Media formats is available for download on a Tuesday. Along with the major interview, the show includes a news segment, with up-to-date details of major discoveries, Space Shuttle and unmanned mission updates, all provided by planetary scientist Emily Lakdawalla (*right*), famous for her fantastic blog).

Bill Nye, the science (and now planetary) guy, provides a weekly commentary on all things space-related and inspires the listener in his own potent way into the 'P, B and J' – the Passion, Beauty and Joy of space, and its exploration. Bruce Betts, Director of Projects at the Planetary Society, presents a weekly 'What's Up in the Night Sky' segment, focusing particularly on objects visible within the Solar System. Finally, Mat Kaplan and Bruce present a weekly Space Trivia Contest where winners can receive prizes ranging from membership of the Planetary Society to telescopes and T-shirts.

The location and number of participants in both the Q&A segment and the space trivia competition point to the fact that the show has a truly huge global audience (it broadcasts on many public-service radio stations both in the United States and around the globe, and was featured several times on the International Year of Astronomy's 2009's '365 Days of Astronomy' podcasts).

In conclusion, this show is indeed, as expected, a polished, professional production, originating as it does from the world's premier space interest and lobby group. I cannot recommend it strongly enough to *Transit* readers; indeed, if you didn't read, watch or listen to anything else concerning our hobby in the media each week, you'd be kept fully up to date in cutting-edge astronomy and space exploration by Planetary Radio.

Mat, Emily, Bill and Bruce and their guests ooze warmth and inspiration, the show is impeccably produced, and all segments are beautifully dovetailed together by the especially composed atmospheric Planetary Radio music.

To download the show, subscribe using iTunes or your favourite pod-catching software, or simply download the show direct and listen via your favourite media player, at:

http://planetary.org/radio/

For more information about the Planetary Society, its projects, its lobbying for more funds for space exploration, and how you can become part of the next age of space exploration, visit:

http://www.planetary.org/home/

THE PLANETARY SOCIETY
Making You a Part of the Next Age of Exploration

COMMITTEE NEWS

CaDAS on Facebook

Rod Cuff

Following a suggestion by Ed Restall, I've set up a page for CaDAS on Facebook. Ed and I are the formal 'admins' for it, but anyone with a Facebook id can add an item – a status update, a link, a photo, an event, a comment on someone else's addition, etc etc. Between us all, we've been contributing something once or twice a day throughout February, and now have 31 'fans' (OK, I don't like Facebook terminology much either!). The idea is to comment on something of astronomical interest for that day if possible (such as prominent constellations in the night's sky, where the Moon and planets are, what their satellites are up to, meteor showers, or announcements in the wider astronomical field), and/or CaDAS events (such as our monthly meetings), in order both to add to the general comradeship of the Society and to interest potential new members and/or those who just want to enjoy the sky.

Ed also has a great page for the Planetarium. If you have a Facebook id and haven't yet found both pages, do seek them out and become a fan – and feel free to contribute.

THE *TRANSIT* QUIZ

Answers to February's quiz

I gave brief descriptions and dates of some famous astronomers of the 20th century, taken from an appendix to Empire of the Stars *(reviewed above), and asked who they were.*

1. **Stephen Hawking**
2. **Sir Martin Rees** (now Lord Rees)
3. **George Gamow**
4. **Henry Norris Russell** (of Hertzsprung–Russell diagram fame)
5. **Edwin Hubble**
6. **Walter Baade**
7. **Sir Fred Hoyle**
8. **Maarten Schmidt**
9. **Cecilia Payne-Gaposchkin**
10. **Sir James Jeans**

March's quiz

There are all sorts of mnemonics – memory aids – for remembering various sequences in astronomy. For the order of the planets from our Sun, I was recently tickled by ' My Very Educated Mother Just Said "Uh-oh, No Pluto!"'. *Here are some more – but what are they for?*

1. All The Great Constellations Live Very Long Since Stars Can't Alter Physics.
2. "Oh, Be A Fine Girl, Kiss Me." "Right Now?" "Sure."
3. Sir Can Rig A VCR, Pa! (*think individual stars*)
4. My ingenious astronomy student remembers an easy light mnemonic (*count the letters*)
5. Met Dr. Thip (*think moons*)
6. I Easily Get Confused. (*moons again*)
7. Mispronunciations Afflict Uranus Too Often. (*more moons!*)