NEPTUNE

Edition 2013-2014

On the occasion of the 2014 Annual Dinner of the

CUAS

CAMBRIDGE UNIVERSITY ASTRONOMICAL SOCIETY

CUAS Senior Committee:

President:	Dr. Michael Irwin
Senior Treasurer:	Jonathan Shanklin
Vice-Presidents:	Prof. Anthony Hewish
	Dr. John Murray
	Prof. Lord Martin Rees
	Dr. Roderick Willstrop

CUAS Executive Committee:

Chair:	Oliver Pambos [ojp25]
Vice-Chair:	Sean Guggiari [sg631]
Secretary:	Sarah Bosman [seib2]
Treasurer:	Indranil Banik [ib310]
Membership Sec.:	Samad Arshad [sa667]
Observational Sec.:	Rok Nezic [rn313]
Webmaster:	Alex van der Wateren [imv22]
Advisory:	Judd Harrison [jgihh]

List of contributors to this edition of Neptune:

Indranil Banik - Treasurer 2013-2014
Shannon Bohle – Member
Peter Hatfield – Chair 2012-2013
Brian Josephson - Member
Rok Nezic – Observation Secretary 2012-2014
Oliver Pambos – Chair 2013-2014
David Purchase – Treasurer (1962-1963), Chair (1963-1964)
Jaya Savige - Member
Oliver Tattersall – Member
Robert Townsend – Member
Alex van der Wateren – Webmaster 2013-2014

Editors of this edition of Neptune:

Alex van der Wateren – Webmaster 2013-2014 (issue editor, design)
Oliver Pambos – Chair 2013-2014 (obs. report editor, proofreading, printing)
Rok Nezic – Observation Sec. 2012-2014 (proofreading)

Message from the editor

This year we were very keen to get another edition of Neptune out. I was very lucky to get this task, and am grateful to the CUAS members who gladly contributed to this edition. You will find some great images of the night sky, an observation report, anecdotes from 'back in the day', a short article on gravity, a book review and even poetry. As this edition is released at the annual dinner, it includes a slip with the list of members attending the dinner as well as the menu. I do hope you enjoy reading these wonderful contributions and if you are keen to contribute to a next edition, please contact me, or the Webmaster of the next committee. *Alex van der Wateren (Webmaster 2013-2014)*

CUAS in 2013-2014

The refurbishment of the Northumberland dome started in summer of 2013 to commemorate the 180th anniversary of the historic telescope housed within. The dome itself was clearly in dire need of repair or replacement for a while, but the foundations of the buildings have also been strengthened, drainage improved, a permanent entry ramp made. The main changes - apart from the complete replacement of the dome with a new, copper one - include additional security in the form of a security alarm system (mainly due to the new dome), a telephone and the log book are now situated in the dome, along with changes to the storage spaces (all CUAS equipment has moved from the crowded south annex, which will be left for the IoA to store it's own telescopes, to the western alcove in the dome). *Rok Nezic (Obs. Sec. 2012-2014)*

The new dome on the Northumberland telescope, by Alex van der Wateren

Missile

I wake to my machine
unzipping the Sunshine Motorway
at a hundred and fifty.
Arabic numerals bloom on the dash
like bacteria in a petri dish
lit with firefly luciferin.

In two million years Pioneer 10
will rendezvous with the bullseye:
Aldebaran, patrolling the eastern
horizon, a hundred and fifty times
more luminous than our sun.

To ride this missile to Pleiades,
return with fistfuls of blue
jewels: the trick to finding them
is to avert your vision, look off
to one side, allow a less abused
section of the retina to drink
in the distant emanation.

JAYA SAVIGE

Jaya Savige was born in Sydney, Australia, and is the author of two prize-winning volumes of poetry Latecomers (UQP 2005) and Surface to Air (UQP 2011). He is a life member of CUAS and a Gates Scholar at Christ's College, where he is completing his PhD in English Literature, titled Underwriting Modernism: James Joyce and the Risk of Literature. He is the Poetry Editor of The Australian newspaper, and is currently writer-in-residence at the Cité Internationale des Arts, Paris.

The reference to the 'Sunshine Motorway' in this poem is to a motorway in Queensland, Australia, where the poet lived before moving to Cambridge.

Reminiscences of a past Chairman, by David Purchase

Your current Webmaster invited short contributions for this edition of Neptune, and I was rash enough to volunteer!

I came up to Sidney Sussex in 1961, joined CUAS immediately, and was elected as Treasurer for 1962-63 and Chairman for 1963-64. Although I hoped to continue in astronomy, the Tripos examiners decided, quite rightly, that that would not be a good idea! What do I recall of those distant days … ?

One thing I know is that CUAS was founded in late 1942. Some may wonder why an astronomical society was founded in that year. My own theory is that the wartime blackout was the last time that anyone could actually ***see*** the stars from Cambridge. I was born in February 1943, and so each time that CUAS reaches a significant anniversary, I realise that mine will soon follow. I hope to make at least the 75th anniversary dinner, and perhaps even the 80th.

Among my best recollections were the observing sessions. I took many sky photos using the Thorrowgood purely for guiding. On one occasion someone came out from the Observatory building and told me to stop immediately, because the humidity was very high. I did as I was told, but was a bit surprised: he looked like a gardener. Only later did I learn that it was Prof. Redman, the then Director of the Observatories.

(At that time the Director lived at the east end of the old building, where the Institute Library now is. He didn't hold it against me, as he gave the concluding lecture in my year of office.)

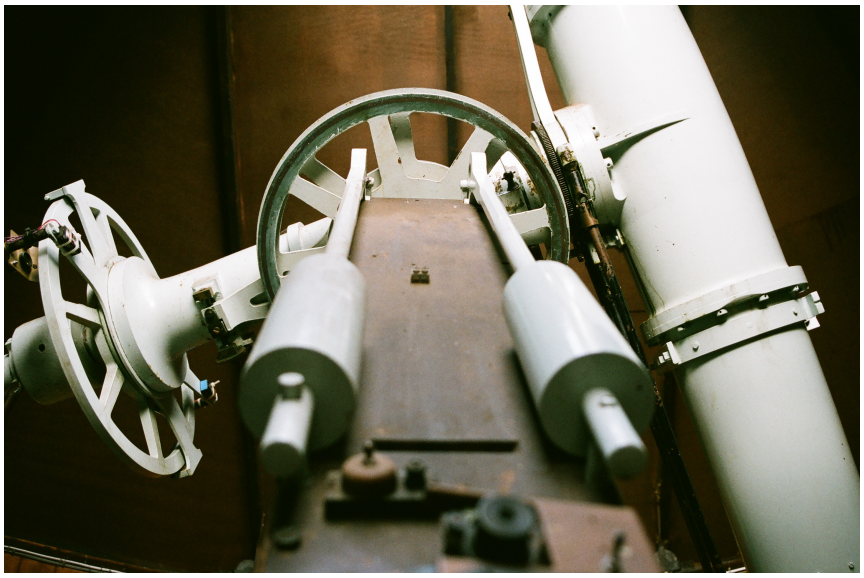
There was always a problem for a member in his or her first year on the Committee. Much though you wanted that year to be splendid, if you hoped to be (or feared that you might be) elected Chairman, you didn't want all the prize speakers to be claimed by your predecessor. (In those days there were fewer prize speakers than there are now.) My predecessor had secured both Martin Ryle and Patrick Moore for his year. Who was left ?

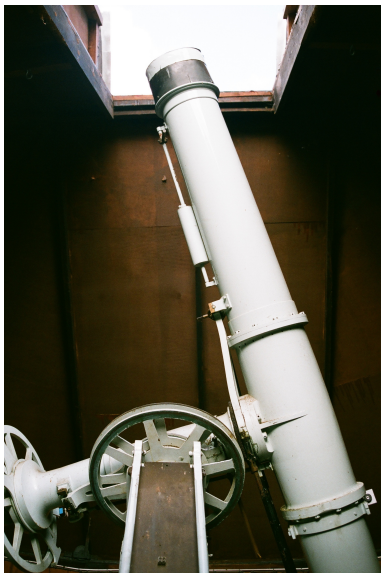
I was lucky. I got Prof. Blackwell from 'the other place', and Prof. Brück, the Astronomer Royal for Scotland, to speak to us. But my real coup was to persuade Fred Hoyle to address CUAS. In the 1960s it was the practice that the Committee entertained the speaker to dinner before the meeting, at the restaurant opposite the Corpus Clock which was then called Millers. (I think it cost 25 shillings.) When I got to the Mill Lane Lecture Rooms, I realised that if I had not been the Chairman, and so obliged to introduce the speaker, I would have been listening to Fred's lecture sitting in the corridor outside the lecture theatre!

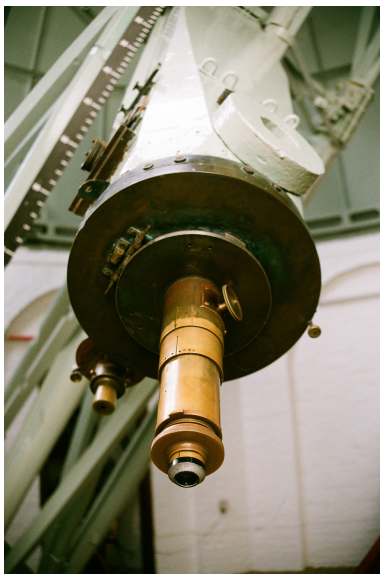
For a few years after I came down, I was able to return to Cambridge for the occasional CUAS lecture. The one that I recall most vividly was that given by John Glenn. He had a model of the rocket, and demonstrated just what a tiny proportion of what went up came down again. (I am talking of 50 years ago: this is better understood now.) But during the question session, someone asked him, "what were you thinking during those final few minutes before lift-off"? His reply (no doubt well-rehearsed) was, "Well, I remembered that all the half-million components of the rocket below me were manufactured by the company that submitted the lowest tender".

A few readers of this will recall David Dewhirst. He became Senior Treasurer of CUAS in the same year that I became (Junior) Treasurer, and we remained close friends ever since until he died in 2012. I recall that, many years ago, he said that 'you knew that you were getting old when you found that the apparatus with which you got your PhD was now on display in the Whipple Museum'. He also said that he 'had reached his anecdotage', a stage which readers of this will no doubt conclude that I have also achieved.

The Thorrowgood and Northumberland in 2014 by Alex van der Wateren







Astrophotography, by Oliver Tattersall

One can spend a small fortune on every conceivable piece of equipment for astrophotography but all you need to get started, and all you may ever need, is a DSLR camera, sturdy tripod, cable release, and some dark skies. There are countless 'how-to's and guides online but I'll give a brief description of the two photos taken here.

One of the simplest and most effective night sky shots one can take is that of star trails, as shown in the photo at our very own Observatory Building at the IoA. This is where the movement of the stars across the sky due to the Earth's rotation is captured by a long exposure time (minutes or even hours). You can achieve this effect either with one single long exposure or by taking many consecutive shorter exposures and stacking them together. I prefer the second technique as longer exposures can become washed out very easily and one mistake halfway through an hour-long exposure (shaking the camera, for example) ruins the entire exposure, whereas when taking multiple exposures one ruined frame can just be left out of the end result.

The photo of Orion was taken with the aid of a camera mount that rotates along the axis of the Earth, thus allowing long exposures to not be affected by trailing and more intricate detail brought out in the night sky.

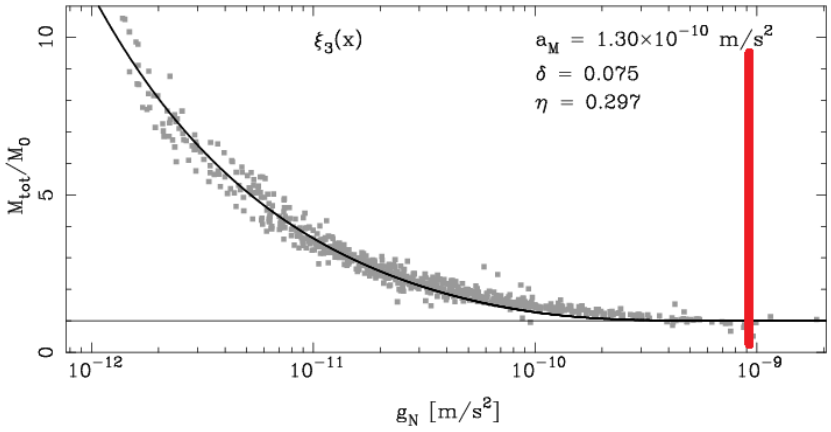
Photographs taken of the IoA (left) and of Orion (right), by Oliver Tattersall.

Dark Matter in Galaxies: A Mirage?, by Indranil Banik

Numerous observations on galactic scales reveal a systematic discrepancy between the accelerations predicted by Newtonian gravity and the actual values. But the gravitational fields are very weak (about 10^{-9} m/s^2). So weak that the energy in the field is below the vacuum energy, a minimum energy to space imposed by quantum mechanics (roughly, because spacetime can't be perfectly flat and curvature carries energy). This means quantum effects are likely to cause systematic deviations from classical gravity theories at accelerations below 9×10^{-10} m/s^2, to prevent the energy density falling below the minimum allowed value [1, 2].

The figure shows data from rotating galaxies, where the rotation speed tells us the true acceleration (v^2/r). The accelerations are well below those in the solar system, where it is known the theory fares well. More importantly, they go deep into the range where quantum gravity effects should be important. The data indeed show a systematic deviation from classical gravity which is larger the weaker the gravitational field (i.e. the lower the energy density in it).

If classical gravity were to hold at such low accelerations, then the discrepancies are due to hypothetical dark matter, which must dominate some galaxies. 100 galaxies with different formation histories and environments appear to show a tight correlation between the amounts of visible and dark matter. Given their fundamentally different behaviour, this seems unusual. Given also the lack of a compelling reason to trust classical gravity in galaxies, perhaps it simply fails because it ignores quantum mechanics.



The ratio of true to predicted accelerations is shown as a function of the acceleration expected with Newtonian gravity. Quantum gravity effects should become important left of the vertical line. Relativity Living Review (Volume 15, 2012) – B. Famaey & S. McGaugh.

[1] http://math.ucr.edu/home/baez/vacuum.html
[2] http://en.wikipedia.org/wiki/Gravitational_energy

Stephen Hawking's 'My Brief History', reviewed by Shannon Bohle

Stephen Hawking's autobiography *My Brief History* reveals a wonderfully uplifting story about Hawking, the man, but it also conveys a surprising tale while he was studying to be a cosmologist.

As it happened, Hawking was deeply disappointed he was not accepted by his first choice of supervisor at Cambridge. "I had applied to work with Fred Hoyle, the most famous British astronomer of the time," writes Hawking. "However, Hoyle had enough students already, so to my great disappointment, I was assigned" to someone "of whom I had not heard" (p.41). Hawking even goes so far as to say he "had been cheated out of working with Hoyle" (p.44). However, he relays the following devious tale of trickery to obtain his revenge on Hoyle during his third year.

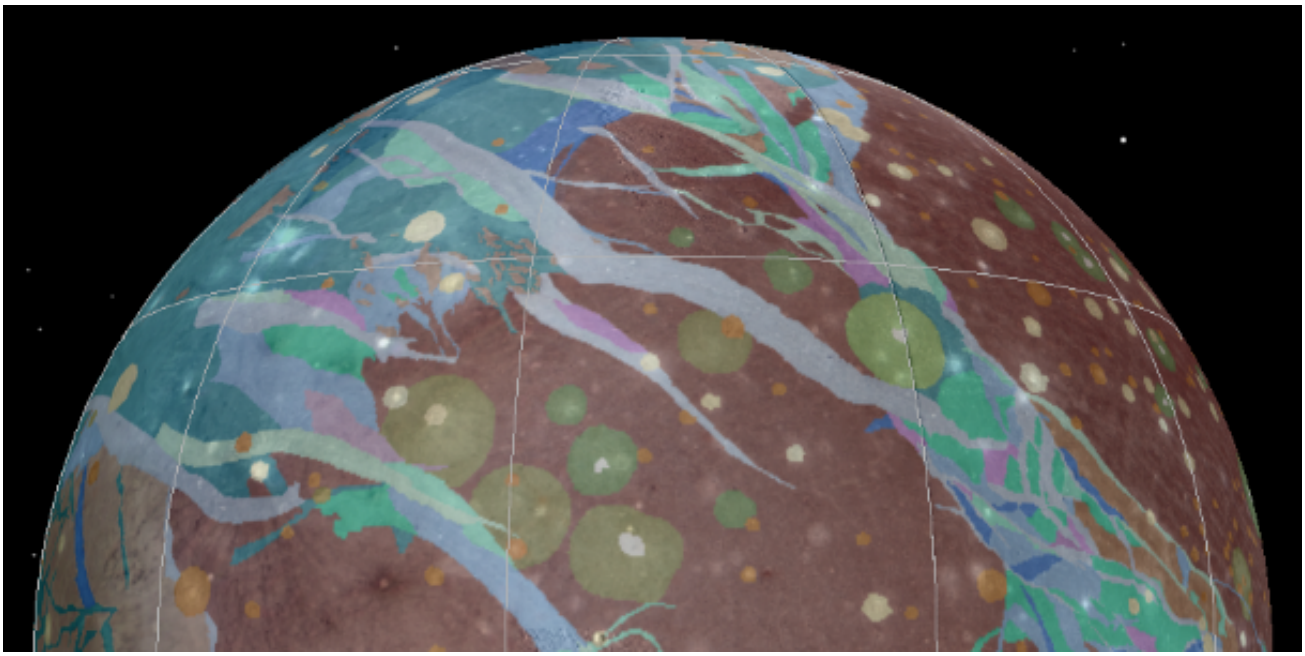
Hawking shared an office with Jayant Narlikar, one of the graduate students selected to study under Hoyle, the same individual for which the Hoyle-Narlikar theory of gravity is named. One day, Hawking says he gained access to the draft of this now-famous paper, which supported the steady state model of the universe, ahead of Hoyle's first presentation of the paper at the 1964 meeting of the Royal Society and its subsequent publication in November of that year in the *Proceedings of the Royal Society of London, Series A, Mathematical and Physical Sciences*. Seeing a "draft of the paper," says Hawking, "allowed me to do the calculations ahead of time." Hawking uses the opportunity to challenge Hoyle publicly, or at least to appear to know as much or more than the great Hoyle in front of the Royal Society. "I was at the lecture," he says, "and in the question period I said that the influence of all the matter in a steady-state universe would make his masses infinite. Hoyle asked why I said that, and I replied that I had calculated it. Everyone thought I meant that I had done it in my head during the lecture … Hoyle was furious." In the end, Hawking got his way, because, he laughs, "Hoyle later gave me a job" (p.44-46).

Hawking's abbreviated narrative proves him not just an erudite mathematician and science communicator, but also an adventurous and humorous man capable of clever interpersonal calculations with those who populate the universe with him.

Blog: http://www.scilogs.com/scientific_and_medical_libraries

Ganymede: What's going on at the surface?, by Alex van der Wateren

On February 12, 2014, a detailed single view of Jupiter's moon Ganymede was published by the USGS Astrogeology Science Center (see image for a detail) [1]. This view was assembled using data obtained with NASA's Voyager 1 and 2 and NASA's Galileo spacecraft, where Galileo's imaging aimed to fill gaps of the Vogayer coverage of Ganymede's surface, and to obtain high-resolution data of features and terrain type [2]. This single view complements the 'Global geological mapping of Ganymede', published in 2010 [2] which sheds light on the roles of cryovolcanic and tectonic processes in creating light materials. The authors recognized four fundamental types of material based on their visual appearance: dark-, light-, impact- and reticulate material, with further subdivisions of the first three material types. By the density of craters, the authors can suggest the sequence of formation of these types of materials, with older materials having a higher crater density (only craters with a diameter of 30 km or more are included in the map). In addition, they determined age of the craters. For this, the state of degradation of the crater rim has previously been used, but due to imaging issues, the authors were not confident this characteristic could be determined across Ganymede.



Selection from the single view map of Ganymede [1]: The colours indicate different types of material (blue/green is light material, red is basin material of Gilgamesh and yellow, crater material).

Therefore, they focus on relative albedo ('reflection') contrast (with respect to surrounding materials) and presence/absence of rays and continuous ejecta deposits [2]. In this way, the authors state the history of Ganymede can be divided into three phases: before, during and after the formation of light materials. These phases are named the Nicholsonian -, Harpagian - and Gilgameshan Period [1]. Dark cratered material is recognised as the oldest geological unit on Ganymede's surface, whereas dark lineated material and light material units have a similar crater density. This supports the view that dark lineated material is a transition material; from dark material to light material by tectonization [3]. "This geological map provides a post-Galileo synthesis of the history of this important icy satellite that will be extremely useful as a frame of reference for the future exploration of the jovian system." [2].

* *Many thanks to Tenielle Gaither for providing me with the information needed to write this brief summary.*

[1] G. Collins et al. 2014, Scientific Investigations Map 3237
[2] G.W. Patterson et al. 2010, Icarus 207, p. 845-867
[3] R.T. Pappalardo et al. 2004, Jupiter, p. 363-396

Please visit these sites for more information, full images, and a rotating map:
http://pubs.usgs.gov/sim3237/
www.usgs.gov/newsroom/article.asp?ID=3802&from=rss_home#.UxXt4KUpHwJ

The IoA at night, by Oliver Pambos

Observation report February 1st, 2014, by Robert Townsend

On the evening of Saturday 1st of February I returned to our observatory with my two dedicated companions at 3:40 am and together we had the roof down and the 14-inch telescope up and running just after 4 am. During this time, as if by magic, large breaks had appeared in the clouds above.

I used the bright orange star Arcturus in Boötes to align the computerized GOTO system and turned the telescope swiftly onto the galaxy M82 in northern Ursa Major. The sight of Supernova 2014j was absolutely breathtaking; I can honestly say that it is the brightest supernova I have ever seen. It was showing a very noticeable red tint, caused by a great deal of interstellar reddening from huge clouds of nebulae, or HII regions, within M82 itself. Through an eyepiece producing an 82 degree apparent field with such amazing eye relief, it looked even more superb.

As for M82 itself, we observed its lumpy cigar shape, and it appeared very 'blotchy', with a very noticeable dark pinch on both sides of the nucleus. You might think that after seeing 2014j any other supernova and its host galaxy would be a bit of an anti-climax; but not so! I quickly located NGC3448. This spindle shaped galaxy is smaller and a lot fainter than M82. So was its supernova. At first I couldn't see any obvious sign of a vast stellar explosion, but after much staring and using averted vision, I caught sight of a very faint but obvious 'dot' of light on the very tip of the galaxy.

The third supernova and host galaxy lay much further south, in the constellation of Coma Berenices, which borders onto Leo and Virgo. M99 is a face on spiral galaxy near to the fifth magnitude star 6 Comae. It was during this time, at around 5:40 am, that a lot of hazy white cloud started drifting across the entire southern half of the sky. In the clearest gaps we think we saw supernova 2014l just off to one side of the brighter nucleus and in the main galactic disk.

Despite the weather, the mud and the short observing 'window', it had been a thoroughly satisfying observing run nevertheless.

Please visit the CUAS website for the full-length version of this observation report

How the First World War let us explore space and Romans are teaching us about dark matter, by Peter Hatfield

For people all around the world, the Centenary of the First World War is a sombre occasion marked by reflection and remembrance. Hopefully, this occasion will be used as an opportunity to strive for peace and to learn from past mistakes – however here I offer a very small story about how WWI indirectly helped us learn about the Solar System and our Universe.

In 1918, after the armistice, Germany handed over its naval fleet to the Allies. The fleet was to be docked at the Royal Navy base at Scapa Flow, Scotland until the negotiations finished. As the terms of the armistice became clearer, Admiral Ludwig von Reuter, unable to tolerate handing over the ships into the enemy's hands, made a final act of defiance: he ordered the sinking of the entire fleet. Ten battleships, five battlecruisers, five cruisers, and 32 destroyers sank to the bottom of the ocean.

Turning the clock forwards fifty long years to the 1960's, the planet was a completely different place. The devastation of the Second World War had come and gone, omnipresent Cold War nuclear stand-off had replaced the pre-WWI Imperial world. There will, however, be one feature of the era that stands out to CUAS members: the Space Race! During the Space Race, scientists who were racing to develop new high-tech satellites and spacecraft, discovered that - because of Hiroshima and nuclear tests - steel made since 1945 was much higher in certain radionucleides. This made post-atomic steel unsuitable for many high-precision purposes. However, satellite engineers and scientists in many other fields finally found a solution: the Imperial German Fleet.

Pre-atomic steel from Scapa Flow is said to have been used in the Apollo programme, the Galileo probe and Pioneer, now far beyond Neptune. So the next time you're out gazing at the night's sky, consider what Kaiser Wilhelm II would have thought of his fleet, barely used in actual combat, now above our heads and far beyond the outer planets.

In practice, it is difficult to find sources confirming precisely what materials were used in particular spacecraft. But it seems certain that some steel from the fleet will have made it into space at some point. This story is not even the most extreme example of the use of historical artifacts in high-precision instruments. 2000 year old lead ingots from a sunken Roman

ship, for instance, are frequently needed for radioactive shielding (because of their age), for example in the Cryogenic Dark Matter Search experiment in Minnesota. I conclude by leaving you to imagine what uses people in the distant future might find for current day artefacts…

References:
- "E=mc~2: A Biography of the World's Most Famous Equation" by David Bodanis
- 'Ancient Roman Metal Used for Physics Experiments Ignites Science Feud', Clara Moskowitz, Dec. 18, 2013, Scientific American

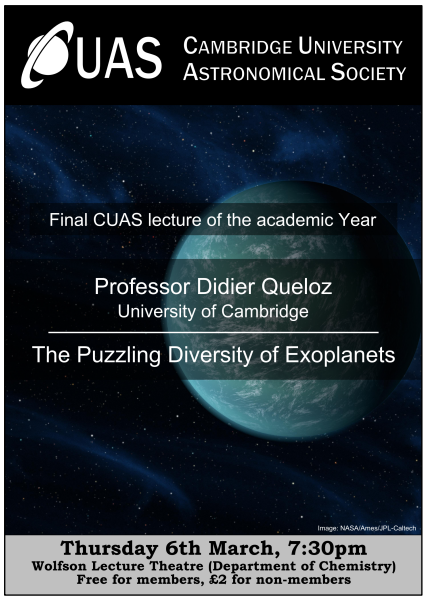
Want to read more? Please find the books listed on the Wikipedia page:
http://en.wikipedia.org/wiki/Scuttling_of_the_German_fleet_in_Scapa_Flow

'Moon and Earthshine', February 1st 2014, by Brian Josephson

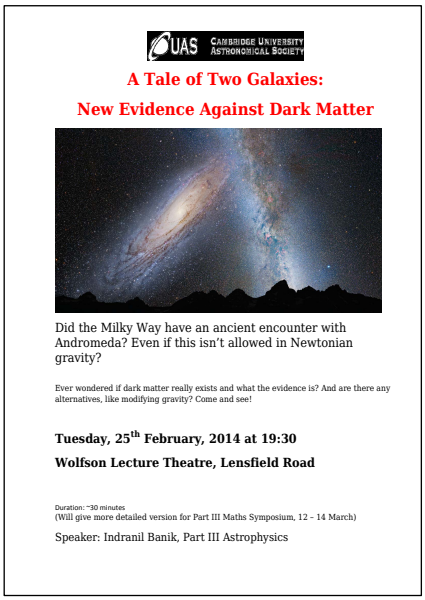
Speaker meetings 2013-2014

Speaker meetings were held in the Wolfson Lecture Theater of the Chemistry Department, Lensfield Road. The default time was from 19:30-20:30. These are posters for this year's speakers:

Prof. Didier Queloz



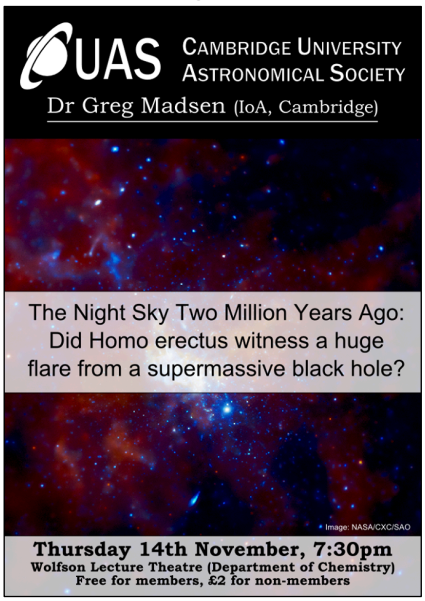
Indranil Banik



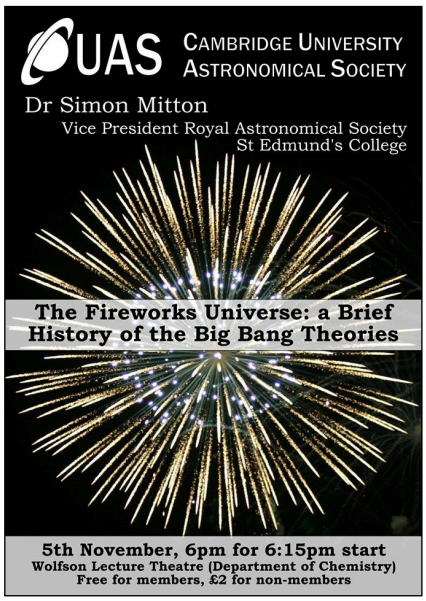
Dr. Hiranya Peiris

Jonathan Shanklin

Dr. Greg Madsen



Dr. Simon Mitton



For two speakers of this academic year, there was no poster:

- Prof. Gerry Gilmore, 'Gaia: ESA's Next Big Astrophysics Mission', October 29, 2013.
- Dr. Mustafa Amin, 'Exploring Our Invisible Universe: Dark Matter and Dark Energy', October 23, 2013.