Meetings

Ordinary Meeting, 2011 January 26

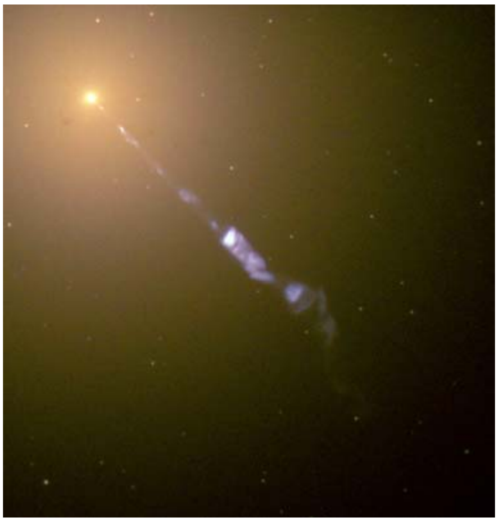
held at the Royal Astronomical Society, Burlington House, Piccadilly, London W1

David Boyd, *President*
Hazel Collett, Ron Johnson & Nick James, *Secretaries*

The President opened the fourth meeting of the 121st session, and invited the audience to approve the minutes of the last meeting. Ten candidates for membership were approved and declared elected. Mr Nick James, Papers Secretary, read the list of papers accepted for publication in the *Journal* by Council that day:

Noctilucent Cloud over the UK and Western Europe, 2009–2010, by Ken Kennedy
The unusual case of 'asteroid' 2010 KQ: a newly-discovered artificial object orbiting the Sun, by Richard Miles
The 2010 perihelic opposition of Jupiter from Barbados, by Damian Peach

The President then announced that a *Back to Basics* meeting would be held on March 5 in Macclesfield, a Deep Sky Section meeting on March 12 in Ashford Hill, Berkshire, the next Ordinary Meeting on March 30 in London, and the Winchester Weekend on April 15–17. He then introduced the first speaker, Dr Ryan Hickox of Durham University.



A massive jet of electrons & subatomic particles streams out from a supermassive black hole at the centre of elliptical galaxy M87. ***(NASA/Hubble Space Telescope Heritage team.)***

Supermassive black holes and the growth of galaxies

Dr Hickox said that the principal questions his work was concerned with were how do black holes grow, and how do they influence the galaxies in which they reside? He first explained what black holes are – objects whose density is such that the escape velocity at their surface exceeds the velocity of light, *c*. For example, were the Sun compressed to a 3 mile radius, its escape velocity would exceed *c*, and it would be a black hole. In terms of general relativity, the curvature of space at the surface of a black hole becomes infinite.

Some black holes have been detected because they reside in binary star systems, drawing mass from the companion star into an accretion disc, a process that produces X-ray emissions. Such black holes typically have masses around 10 times that of the Sun. But there is a radio source known as Sagittarius A* (pronounced 'Sagittarius A star') at the centre of our galaxy, and infrared telescopes equipped with adaptive optics show stars orbiting an invisible object of 4 million solar masses at this point. This is a supermassive black hole. Such objects are found in the centres of most massive galaxies.

Dr Hickox reviewed the structures of galaxies, which may be divided into ellipticals and spirals. Young blue stars are found in the arms of spirals, old red ones in the cores. Ellipticals are more massive statistically and composed of old stars. We can see young galaxies at great distances, but there is a dearth of elliptical galaxies at these distances, suggesting they are a later stage in galactic evolution. The structure of the universe on the largest scale is dominated by the gravitational effects of dark matter. Dr Hickox showed a computer simulation of the gravitational accretion of matter that corresponds well to the matter distribution that we see in the universe. But this simulation fails to model the colour distribution of galaxies correctly: it gives massive galaxies in which efficient collapse of gas towards the centres produces vigorous star formation and blue colour, whereas in the real universe we know that the most massive galaxies are red ellipticals. Dr Hickox proposed that the reason for this is that the simulation neglects the influence of black holes.

Supermassive black holes in galaxies can be detected from X-ray emissions caused by matter spiralling into the black hole. Quasars are thought to be the most powerful black hole emissions – these could be cases where merging galaxies are causing rapid black hole growth. In elliptical galaxies, much of the potentially star-forming gas may have been blown out of the galaxy by this merger process. This process could shut off star formation in these massive galaxies and give the result that we see, that the most massive galaxies are red, not blue.

In questions to Dr Hickox, an audience member queried why elliptical galaxies do not collapse into their black holes. He said this was because the stars in them are still in orbits around the galaxy core, but these orbits are random, as opposed to the ordered motion in spiral galaxies. Furthermore, in these galaxies the total mass is many thousands of times the black hole mass, so they are not dominated gravitationally by the black hole. Another questioner asked if it is known how supermassive black holes form and grow. Dr Hickox stated that it is not really known how they are seeded and how they relate to galaxy evolution, whether they precede the formation of stars in the galaxy or form afterwards, but there is a correlation between black hole mass and the mass of the host galactic bulge. Another questioner asked if black holes could be dark matter, to which the answer was 'probably not'.

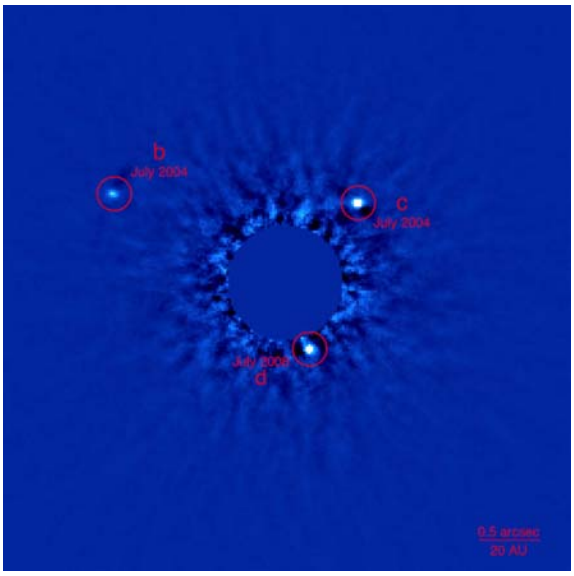
The President thanked Dr Hickox and introduced Dr Suzanne Aigrain of Oxford University.

Portraits of other worlds

Dr Aigrain began by reflecting on the Earth–Moon system. No other planet in the solar system possesses such a large satellite in relation to its own mass. The Moon and the Earth were probably both created by a collision with another body. Dr Aigrain then went on to discuss the mass distribution in the solar system: 98% in the Sun, 1% in Jupiter, and 1% in all the other bodies. But the angular momentum in the solar system is mostly in the planets. This indicates that the process of solar system evolution from the early spinning accretion disc around the Sun must have involved a transfer of angular momentum away from the Sun. The solar system includes not only the major planets but the Edgeworth–Kuiper belt and Oort Cloud. Dr Aigrain showed diagrams to demonstrate the scale of the overall solar system compared to the planetary orbits.

Planetary nurseries can be seen using very powerful telescopes as dark dusty discs around some stars forming from nebular materials, but to see planets of other stars directly is very difficult. To separate the light of Jupiter from that of the Sun at 30 light years distance is on the limit of current technology. Dr Aigrain showed an image of HR 8799, the first accepted direct image of an extrasolar planet, in which the planet was revealed through the star being occulted.

Due to limitations of the methods of detection, known exoplanets are mostly massive bodies close to their stars. The methods of detection can be divided into dynamical and transit methods. The dynamical methods break down into astrometry, and radial velocity measurement, with most discoveries coming by the latter method. If we can combine transit data with radial velocity we can find the radius and mass of a planet. The known extrasolar planets are predominately very low density giants. But for an isolated ball of hydrogen we expect a predictable relationship between mass and radius. The discrepancy we see is due to these planets being close to their stars and getting heated and 'puffed up'. Planets that are more dense than expected



One of the first direct images of an extrasolar planetary system, HR8799 observed in near-infrared light with adaptive optics by the Gemini North telescope. The central star is occulted to reveal the planets. ***Gemini Observatory/NRC/AURA/Christian Marois et al.***

must have an admixture of heavier elements. Gliese 436b is a 'hot ice' planet. Twenty times the mass of Earth, the water in it is very compressed, and it might have oceans on top of an ice layer.

The *CoRoT* probe, which consists of an orbiting 27cm telescope, is looking for transits that could be terrestrial planets. NASA has a larger equivalent in *Kepler*. *CoRoT* filters lightcurve signals for the high frequency range to exclude stellar variability. One discovery, CoRoT-7b, is 1.7 times Earth mass, and likely a similar composition to Earth. Kepler-10b is a slightly smaller planet, but both are very close to their host star, so both are probably lava worlds. As yet there have been no firm detections of terrestrial planets at terrestrial distances.

In the case of a transit of a 'hot Jupiter', when the planet goes behind the star, there is a secondary eclipse of emitted or reflected light. When the planet transits in front it is possible to obtain a transmission spectrum from its atmosphere. When the planet is far from the star, the phase lightcurve can give information on temperature distribution and atmospheric dynamics. 'Hot Jupiters' have one side always facing the star, and the resulting large temperature difference and strong winds give rise to planet-scale eddies that are detectable in the phase lightcurve. Hence we can deduce thermal maps of such planets, and we find that the hottest part is not directly opposite the star. Wind speed has also been measured. HD189733b has had a transmission spectrum taken in IR and optical wavelengths by the Hubble and Spitzer space telescopes. We know from these that it has a haze of 1 micron particles.

A transmission spectrum is gained from comparing the total spectrum when the planet is in transit from that when it is not. This is not easy to do, and there is a lot of debate about whether the molecular signatures are correctly interpreted.

Dr Aigrain concluded by giving some websites where further information on the subject can be found:

http://www.centauri-dreams.org, the forum of the Tau-Zero organisation, will keep you informed about exoplanet research.

http://var2.astro.cz is an exoplanet transit database kept by the Czech Astronomical Society.

http://oklo.org is a site that allows amateurs to get involved with dynamical analysis of exoplanet systems.

http://www.planethunters.org is similar to Galaxy Zoo. You are shown a lightcurve and have to identify transits.

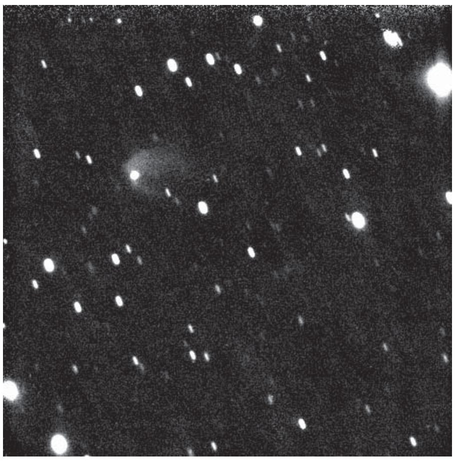
A questioner asked, 'What is the size of stars that are being examined? Surely small stars would allow easier detection of transits?' Dr Aigrain answered that this is true, but we have no detections of planets around white dwarf stars.

The President thanked Dr Aigrain and introduced Nick James to give the regular *Sky Notes*.

Sky notes for February

Mr James noted there had been a lot of cloud across the UK in January. He reviewed the lunar eclipse of 2010 December 21, showing images by from Geoffrey Johnstone, Damian Peach, Maurice Collins (New Zealand), and Rik Hill (USA), and the partial solar eclipse of 2011 Jan 04, with images by Denis Buczynski, Martin Mobberley, John Vetterlein and Andrew Robertson. Thierry Legault had managed to take an image from Oman showing the partial eclipse plus the International Space Station in transit. (ISS transit information is available from **http://www.calsky.com**). The Sun itself has been quiet. A couple of spot groups are currently rotating off.

As for the planets, Jupiter's disk is shrinking and getting into twilight at dusk. The South Equatorial Belt has started to return, having been absent for all of this apparition. Mr James showed Jupiter images and a rotation video by Damian Peach. Saturn is rising at 23:30 and a prominent feature is the North Tropical Zone storm: images of this by Anthony Wesley and Jim Phillips, and drawings by Richard McKim and David Gray, were shown. There has also been a new northern hemisphere spot imaged by Paul Maxson on January 08.



Asteroid (596) Schiela developed cometary characteristics. Image by Nick James, 2010 December 15.

The ISS will pass over on January 29 07:23 UT at mag. –3.6; **http://www.heavens-above.com** is a source for predictions of these passes. Asteroid (106) Dione occults a mag 12 star on February 15; the track crosses the south of England, but the magnitude drop will only be 0.5. The BAA Asteroids and Remote Planets Section has been carrying out 'Project NeilBone' to observe the opposition effect of asteroids. Asteroids (62) Erato, (283) Emma and (334) Chicago have been chosen for photometry, which needs to be accurate to 0.01 magnitudes.

There are few interesting comets available at the moment. The best is C/2009 K5 (McNaught), which is showing a tail. Richard Miles has continued observing 17P/Holmes using the Faulkes Telescope North, and has showed it still has a coma. Asteroid (596) Scheila has turned into a comet, probably because of an impact. Mr James showed his own image of this object. Comet C/2010 X1 (Elenin) was discovered at mag 19. It has a close perihelion of 0.48 AU and approaches Earth within 0.22 AU. It could attain mag –1 due to forward scattering when 2° from the Sun, and could be mag 3–4 when it emerges from morning twilight in October.

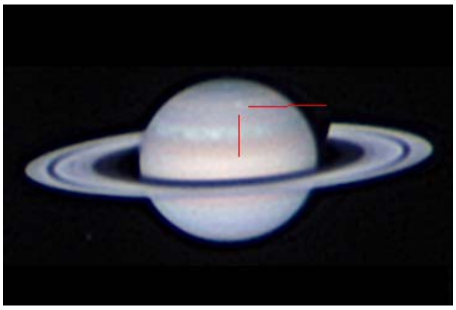


Image by Paul Maxson showing the new storm in the northern hemisphere of Saturn, 2011 January 8.

Moving on to variable stars, a lightcurve of the Epsilon Aurigae eclipse has been contributed by many observers. 3rd contact will be in March and 4th contact in May. It is well-positioned for observation at the moment. R Coronae Borealis and HR Lyrae are both visible in the morning sky. R CrB has been at minimum for more than two years, and is worth keeping an eye on with binoculars. HR Lyr is an old nova; during summer 2010 it began an unusually deep fade, which lasted 4.5 months. A lightcurve by Jeremy Shears was shown.

The President thanked Mr James and adjourned the meeting to 2011 March 30.

David Arditti