Ordinary Meeting, 2008 November 22

held at the Royal Astronomical Society, Burlington House, Piccadilly, London SE1

Roger Pickard, President

Ron Johnson, Hazel Collett and Nick James, Secretaries

The President opened the second meeting of the 119th Session and invited Mrs Hazel Collett, Meetings Secretary, to read the minutes of the previous meeting. These were approved by the audience and duly signed. It was announced that 15 new members were proposed for election, and those 18 new members who had been proposed at the previous meeting were approved by the audience and declared duly elected. Mr Nick James, Papers Secretary, reported that four papers had been approved for publication in the *Journal*:

[check these]
The Leonid Meteor Shower in 2002, by Neil Bone
A Method for Determining the V-magnitudes of Asteroids, by Roger Dymock & Richard Miles
SDSS J…. , by Jeremy Shears et al.
…., by Richard McKim

The President announced that the next Ordinary Meeting would be the Christmas Meeting, to be held on Saturday December 13 at the present venue. Before then, the Webb Deep Sky Society would be holding their Annual Meeting on Saturday December 6 in Cambridge. The President then introduced the afternoon's first speaker, Dr Sarah Bridle, Lecturer and Royal Society Research Fellow in the cosmology research group at University College, London.

Cosmic Lensing: Shedding Light on the Dark Universe

Dr Bridle opened her talk with an overview of our current understanding of the composition of the material which made up the Universe. She explained that over the past few years, cosmologists analysing data from a range of experiments, most notably the *Wilkinson Microwave Anisotropy Probe* (WMAP), had converged upon a *concordance model* in which the familiar protons, neutrons and electrons which made up all of the materials familiar to us on Earth composed a mere 5% of the total mass of the Universe. The remaining 95% of the mass was in the form of *dark matter* (20%) and *dark energy* (75%).

The speaker explained that evidence for the presence of dark matter had been accumulating over several decades: its existence had first been proposed by Fritz Zwicky in 1933, who had observed that galaxy clusters appeared to be bound together by a gravitational force which was stronger than could be accounted for by the masses of their visible constituent galaxies alone. Then, in the 1960s and 70s, observations had shown that the outer regions of many spiral galaxies appeared to rotate much faster than would be expected from calculations of the total inward gravitational pull that these regions would feel from all of the visible stars in each galaxy. Such observations, now very well corroborated, suggested that both galaxies and galaxy clusters contained a very substantial amount of non-luminous material in addition to their visible stars, whose mass was responsible for the bulk of the gravitational force which bound them together.

However, the speaker moved on to say that the evidence for the existence of dark energy had emerged much more recently, and was, on balance, considerably weaker. This evidence rested principally upon a particular class of supernovae, termed type Ia supernovae, whose luminosities could be rather precisely estimated from their light curves. Objects such as these, termed *standard candles* because they could be thought of as light sources whose luminosities were very well regulated, were a valuable tool for estimating the distances of astronomical objects because their observed brightnesses could be thought of as depending purely upon their distance, rather than any variability in their intrinsic luminosity. Faint standard candles were a long way away, and bright standard candles were nearby. Observationally, such a rule seemed to apply very well to type Ia supernovae in nearby galaxies: in many cases it was possible to compare distance estimates for the host galaxies derived from supernova luminosities with those derived from the galaxies' cosmological redshifts, and the two methods were invariably found to be in excellent agreement. However, the same was not true for very distant galaxies, in which type Ia supernovae typically appeared fainter than would be expected based upon the distances estimated for these galaxies by other means. The speaker explained that within Einstein's theory of General Relativity, the theory which was understood to describe the effects of gravity on the very largest scales in the Universe, it was possible to reproduce the anomalous faintness of these supernovae by the addition of a material called dark energy to the model.

The speaker conceded that this evidence might not be thought particularly compelling. Its principal weakness was that it relied upon a comparatively modest number of observations of distant supernovae, and assumed these to have the same intrinsic luminosities as nearby supernovae. Various other explanations for these observations, which did not require the existence of dark energy, could be proposed: perhaps the data was spurious, or perhaps the luminosities of type Ia supernovae had increased over the history of the Universe, in which case it would naturally be expected that more distant supernovae, with longer light-travel times, would appear fainter than closer events. The speaker explained that, when studied in detail, neither of these arguments were particularly tenable, but conceded that there was need for an experiment which would test for the presence of dark energy by an entirely independent means. Observations of gravitational lenses, she explained, could provide the evidence which was required.

Turning to outline what gravitational lenses were, Dr Bridle explained that when light travelled past massive objects such as galaxies, its path was deflected by the object's gravitational field. This effect was broadly analogous to the gravitational deflection of a hypothetical spacecraft travelling past the same galaxy. Strictly speaking, because light travelled so fast, the precise amount by which its path was bent could only be calculated by turning to Einstein's theory of General Relativity, but whilst this was important when making precise calculations, it was not conceptually important. Applying these ideas to rays of light travelling towards us from a distant galaxy, which might happen to skim close to another galaxy or cluster of galaxies on its way to us, the speaker explained that the apparent position of the distant galaxy would be shifted on the sky by the deflection of its light rays by the intervening object.

The easiest case to consider was that where the distant galaxy happened to lie precisely behind the nearer *lensing* galaxy. In this case, the deflected rays would appear to us as a halo around the nearer galaxy, termed an *Einstein ring*. More usually, things were more complicated – either the alignment was not exact or the lens galaxy had a complicated clumpy mass distribution – and lensed images could take on a range of morphologies, ranging from partial arcs of rings to pepperings of multiple distorted images of the same distant galaxy around the nearer object.

The speaker showed several images of gravitational lenses which had been taken using the *Hubble Space Telescope* (HST), and explained that these images provided direct evidence for the presence of dark matter in the lens galaxies. The mass of each lens galaxy could be estimated directly from measurements of the angle through which its gravity had deflected the light from a distant galaxy. Typically, the masses found from such calculations were around 100 times estimates of the total mass of stars in each galaxy, or around 10 times estimates of the total mass of gas associated with each galaxy. It seemed that 90% of the mass of most galaxies was in some non-luminous form, composing neither stars nor gas.

The speaker went on to add that these images also contained information about the dark energy content of the Universe. Theoretical simulations of how dark matter behaved showed that it tended to clump together into tight structures in the absence of dark energy, but that when the simulations were re-run with dark energy added, the dark matter was much more smoothly spread out. In principle, these two distinct dark matter distributions would produce different lensing patterns which could be observationally distinguished. However, the speaker added that it would be necessary to observe a very large number of lenses to come to a conclusive result, since there were many other effects such as recent mergers between galaxies which would also act to give dark matter distributions in galaxies a range of disturbed and unusual shapes.

The speaker explained that there were some difficulties in compiling the large catalogues of gravitational lenses which would be required for such an investigation. In practice, it was comparatively rare for gravitational lenses to be so well aligned, or for a lensing galaxy to be so massive, that very severely distorted images were produced. The cases discussed thus far had been rare and extreme examples. Thus, in order to make a catalogue of more than the finite and rather modest number of heavily lensed galaxies on the sky, it was necessary to develop ways of detecting objects whose appearances were only weakly distorted by gravitational lensing. This was not easy: the kinds of warping and stretching which were characteristic of the morphologies of lensed galaxies were rather modest in comparison to the huge range of irregular and distorted morphologies which galaxies naturally showed, especially those which had recently interacted with and been disrupted by their neighbours.

The speaker explained that it was possible to detect such distortions, however, by looking for patches of sky where large numbers of galaxies appeared to be orientated in similar directions. Assuming that galaxies were randomly orientated in space, it would be very unlikely that several nearby galaxies would all be stretched out in the same direction. However, this was precisely the observation that would be made if a single gravitational lens were distorting all of their images. The speaker explained that gravitational lenses detected by this means were termed *weak gravitational lenses*.

The speaker added that the first gravitational lens to have been detected by this means had been Abell 1689, whose lensing effects had been uncovered by J. Anthony Tyson and collaborators in 1990.[1] In 2003-5, the HST had undertaken a deep survey, *COSMOS*, of a two-square-degree patch of sky, recording the morphologies of over two million galaxies down to mag. 23 in the I-band. A painstaking analysis of position-dependent trends in the orientations of these objects had allowed a three-dimensional map of the dark matter distribution in this region of the sky to be constructed from its weak lensing effect.

However, the speaker added that this field remained young. Her research group at University College, London, were currently assembling a camera which would be placed upon a 4-m purpose-built telescope presently under construction at the Cerro Tololo Inter-American Observatory in Chile. Once completed, in 2009-10, the instrument would conduct a five-year survey of 5,000 square degrees, or 12%, of the sky down to around mag. 24 using a range of visible-light and infrared filters. Analysing the data returned by this instrument would be a massive computational challenge, but the end result would be a much more comprehensive mapping of the distribution of dark matter in the Universe than was presently available.

Following the applause, the meeting broke for tea. After the break, the President introduced the meeting's second speaker, Dr David Rothery of the Department of Earth and Environmental Sciences at the Open University, who would be talking about observations of Mercury made by the *MESSENGER* spacecraft. The President added that as well as being a professional astronomer, Dr Rothery had also once been an amateur astronomer, and was a former member of the Association's Variable Star Section.

The Mercury *MESSENGER* Mission

Dr Rothery set the scene for his talk with some general remarks about Mercury, commenting that it was the smallest of the terrestrial planets in the solar system, measuring 38% of the Earth's diameter across, and that it orbited the Sun at 35% of the Earth–Sun distance. Mercury was notoriously difficult to observe in any detail from the Earth, the speaker added, since it was never very far away from the Sun: observers faced a choice between trying to observe it in twilight and then trying to remove stray light from the resulting images, or to observe it in darkness, by which time it would be very close to the horizon where atmospheric seeing conditions were invariably very poor. Even the best professional images of Mercury taken from ground-based telescopes showed few albedo features.

The situation was no better for observers wanting to point space-based telescopes at it. The *Hubble Space Telescope* (HST), for example, could not be pointed close enough to the Sun to ever see Mercury; too much scattered sunlight would enter its optical tube in the process, upsetting the fine thermal control of its optics. Hence, our knowledge of Mercury, more than for any other planet, rested almost exclusively upon data from spacecraft which had been sent to make close-up observations. Until 2008 January 14, when *MESSENGER* had made its first close fly-by past Mercury, this had meant specifically data from *Mariner 10*, the only previous space probe ever to have visited Mercury.

Mariner 10, the speaker explained, had been launched on 1973 November 3, and, after its initial close approach to Mercury on 1974 March 29, had been inserted into an elliptical orbit lying between the orbits of Mercury and Venus, with an orbital period of exactly twice that of Mercury and a perihelion distance exactly matching Mercury's orbital radius. This clever choice of orbit had meant that *Mariner 10* would make further close approaches to Mercury every time its elliptical orbit returned to perihelion, though unfortunately it would see exactly the same areas of the planet's surface on every occasion since Mercury's rotation rate was tidally locked to its orbital period: it rotated about its axis exactly three times in every two orbits around the Sun. In practice, the speaker explained that *Mariner 10* had made three close approaches to Mercury over a period of 12 months before it had exhausted its fuel supply.

As well as mapping 40-45% of Mercury's surface, *Mariner 10* had also established some of the planet's basic physical characteristics. It had produced the first meaningful estimates of the planet's mass, finding its density to be surprisingly high – only fractionally less than the Earth's – and this despite its being a smaller body with less internal gravitational compression than the Earth. This hinted that Mercury probably had a large iron core which, relative to the overall size of the planet, was much larger than the Earth's. The discovery by *Mariner 10* of a magnetic field around Mercury, though its strength was only 0.1% that of the Earth's magnetic field, was in contrast to the absence of any magnetic fields around Venus, Mars or the Moon, and likewise suggested that Mercury and the Earth were set apart from the other terrestrial planets in that they had iron cores at their centres capable of producing such fields. Current best estimates of the size of Mercury's core placed it at 42% of the planet's volume, as compared to 17% for the Earth's core.

The speaker explained that modern models of the formation of the planets tended to assume that in the final stages of their assembly, very violent collisions were taking place between similarly planet-sized bodies. For example, it was thought that the Earth-Moon system had been formed by the collision of a Mars-sized planet called *Theia* with the proto-Earth. In this collision, a large lump of the Earth's mantle had been thrown off, later to form into the Moon. The speaker explained that a similar model could also account for Mercury's large core: if an originally large planet in Mercury's orbit had undergone a violent collision which had thrown off a substantial fraction of its mantle, the result might have been a planet with a large core and only a thin layer of mantle left surrounding it.

Turning to discuss what *Mariner 10* had seen on Mercury's surface, the speaker explained that its images had revealed extensive cratering, including several of the largest craters seen anywhere in the Solar System, among them the Skinakas and Caloris Basins. A number of fault lines, running for hundreds of miles along the planet's surface, were also striking. Close inspection revealed these not to be quite sheer cliffs, but escarpments with steep gradients of around 30-40%. The International Astronomical Union (IAU), whose conventions required that Latin terminology be used when naming geological features on other planets, had termed these escarpments *rupes*. As an indication of their scale, one of the largest such faults, *Discovery Rupes*, had a total height of around 2 km. The speaker explained that the age of these 'wrinkles' could be estimated by looking at places where they intersected craters: if the rupes was visible cutting across the floor of the crater then it was newer than the crater, but if there was no sign of the rupes on the floor of the crater, the crater had clearly been superimposed on top of a pre-existing rupes. Best estimates placed all of Mercury's rupis at between 3 and 3.5 billion years old, suggesting that they formed relatively early in Mercury's history. The leading theory for their formation suggested that the material of the planet's core had undergone a phase change at this time, reduced its volume by around 1-3% and causing the surface to 'shrivel' around it.

The speaker added that one outstanding mystery in the data returned from *Mariner 10* was that the surface had been found to be rather deficient in iron oxide. On a planet which was thought to have such a large iron-rich core, it seemed surprising that the surface was not also iron rich.

Turning to give more detail about current models of the formation of Mercury's surface, the speaker explained that during its early and very violent history, when it was colliding with other planet-sized bodies, the whole planet would have been so hot as to be molten. Gradually, after the violent bombardment had ceased, the rock would have begun to cool and solidify, but this would not have happened uniformly across the planet. Within the complex mixture of different minerals present, different materials would solidify at different times determined by their various melting points. Gradually, lumps of solidified rock might begin to float on the surface of an ocean of magma, forming what was termed *primary crust*. Eventually, the magma itself would freeze around these 'rockbergs' to form *secondary crust*. On the Moon, the distinction between primary and secondary crust was quite apparent: the mountainous lunar highlands were understood to have formed as primary crust, whilst the maria were understood to have formed as secondary crust. One of the objectives of the *MESSENGER* mission, Dr Rothery explained, was to try to distinguish the different kinds of crust on Mercury.

The speaker explained that *MESSENGER* had been launched on 2004 August 3, and after flying once past the Earth and twice past Venus – each of these close approaches being used both for gravity assist manoeuvres and to test the spacecraft's instrumentation – it had made its first close approach to Mercury on 2008 January 14. *MESSENGER* had not gone into orbit around Mercury on this first pass since it had been travelling too fast to do so; instead, it had been put into an elliptical orbit which would bring it back to Mercury on 2008 October 6, 2009 September 29 and 2011 March 18. On the final of these occasions, it would be travelling slowly enough for an orbital insertion burn of its engines to be feasible, placing it in orbit around Mercury.

On its first approach to Mercury in 2008 January, the speaker explained that *MESSENGER* had seen a crescent disk as it had drawn close to the planet, though the regions of terrain visible in this crescent had perhaps been of secondary interest since they had lain within the hemisphere which had already been mapped extensively by *Mariner 10*. *MESSENGER* had then flown around the night side of the planet, before attaining a view of the gibbous disk on the opposite side of the planet as it receded. The terrain visible in this gibbous disk had primarily been regions which had not been mapped before. The speaker added that *MESSENGER* had been able to reveal a great deal of information on both the approaching and receding legs of its journey because its cameras had much superior colour differentiation as compared to those flown on *Mariner 10*. This meant that even its images of previously mapped areas revealed a wealth of new information about the chemical composition of the rock. Dr Rothery drew particular attention to a pale-coloured patch on the floor of the Caloris Basin, which, he explained, appeared to be young and smooth. He explained that this was the best candidate yet found for a volcanic vent on Mercury's surface.

The speaker went on to explain that although this first flyby had filled in a large part of the unmapped portion of Mercury's surface, some narrow tracts of terrain had still remained unmapped. He added that *MESSENGER*'s second close approach, made earlier in the month, had at last filled these in, and remarked that the event had marked the passing of a special milestone in our understanding of the Solar System: Mercury was the last of the terrestial planets to have had any unmapped areas of terrain, termed *terra incognita* by the IAU, and now, at last, our mapping of the Solar System's rocky planets was essentially complete, though many of the details remained to be filled in in coming years.

Looking to the future, the speaker explained that a future mission to Mercury was already being planned. The European Space Agency (ESA) and Japanese Aerospace Exploration Agency (JAXA) hoped to launch a collaborative mission in 2014 called *BepiColombo* after the engineer, Guiseppe Colombo, whose pioneering work in the 1970s had led to the idea that spacecraft could reach distant planets by flying close past nearer planets to obtain a 'gravitational slingshot'. His name was especially appropriate to give to a mission flying to Mercury since *Mariner 10*'s close approach to Venus in 1974 had been the first time that any spacecraft had made use of such a manoeuvre.

The speaker explained that the *BepiColombo* mission would place two spacecraft in orbit around Mercury. The Japanese were building the first – *Mercury Magnetospheric Orbiter* (MMO) – which would fly in an elliptical orbit around the planet studying its magnetic field. The latter – *Mercury Planertary Orbiter* (MPO) – would fly in a close circular orbit around the planet, imaging its surface at a wide range of wavelengths. Especial interest would be taken in X-ray images of the surface taken by MPO, which it was hoped might detect the fluorescence of iron atoms excited by solar wind particles. These, it was hoped, would help to reveal why Mercury's surface was so deficient in iron oxide, perhaps revealing that the iron was all locked up in a metallic form.

Following the applause, the President invited Dr Nick Hewitt to present the month's Sky Notes.

The November Sky

Dr Hewitt opened with a summary of the current circumstances of the Sun, Moon and planets. The Sun continued to show very little sunspot activity, as had been discussed in several previous Sky Notes talks. A few small sunspots were occasionally visible, but there was still no sign of the start of a new sunspot cycle. The Moon was currently waning and would be new on November 27, full on December 12, and new again on December 27. As a stalwart member of the Deep Sky Section, the speaker joked that members would have no excuse for not observing the deep sky with their new telescopes at Christmas.

Among the planets, Saturn was currently the best placed, and Venus would be creeping into the evening sky over the coming months. Of the remaining planets, Mercury was not currently visible – it was about to pass superior conjunction on November 25 – but would return into the evening sky in the latter half of December, reaching maximum solar elongation on 2009 January 4. Mars was also near to the Sun presently and would pass solar conjunction on December 5; it would not be visible again until late summer in 2009. Jupiter's present apparition was now well past its best, having passed opposition on July 9; it too would not be easily visible until summer 2009. Uranus and Neptune remained visible in the early evening sky in Aquarius and Capricornus respectively, but would soon disappear into evening dusk.

Returning to talk about Venus' coming apparition, the speaker explained that though it remained low on the western horizon in the evening sky at present, it would become a major sight within the next few weeks. Its gibbous disk measured 15.6" across at the time of the meeting, and its magnitude was around –4.1. By mid-December its disk would grow to 18" across and brighten to mag. –4.2, and by the end of the year it would reach 20.8" across and mag. –4.3. As its orbit brought it closer to the Earth over the next few months, its phase would wane to a crescent, passing half-phase at around New Year, though as its disk correspondingly grew in angular size, it would continue to brighten for some weeks to come, reaching maximum brightness in mid-February and remaining visible until mid-March.

In the more immediate future, Venus was heading towards two conjunctions at the end of the month. On the evening of November 30, Jupiter and Venus would pass within around 2° of each other, low on the western horizon at dusk, not far from the handle of the teapot in Sagittarius. On the following afternoon, Venus would be occulted by the Moon, and although the occultation would begin in broad daylight, at 15h47 UT, and end in dusk, at 17h17 UT, the speaker thought it would be readily visible through a pair of binoculars. Venus would be seen to disappear behind the dark limb of the three-day-old Moon, and reappear from the illuminated limb. Given the relatively large size of Venus' disk, its appearance and disappearance would not be instantaneous, but would take several seconds.

Turning to Saturn, the speaker explained that it was presenting an unusual image at present on account of its rings being aligned very close to edge-on to our line of sight. As a result, its visual brightness was around a magnitude fainter than usual, and some of the appeal of its telescopic majesty was missing, but the speaker lamented that there seemed to be so few amateur images in circulation of the planet when in this configuration. He added that with the rings now obscuring a minimal area of the planet's 15.5" disk, this was an ideal time to study surface detail, and that the edge-on orientation of Saturn's system of moons also afforded a rare opportunity to observe transits and occultations, as the moons passed in front of or behind the planet, and mutual shadow events, when the moons cast shadows upon one another.

Turning to discuss comets, Dr Hewitt explained that there were no especially bright objects in the sky at present. Perhaps the best prospect was C/2006 W3 (Christensen), which had been discovered by the Catalina Sky Survey on 2008 November 18 and which was presently well placed in the circumpolar constellation of Cepheus at mag. 10. C/2006 OF2 (Broughton) was currently a little fainter at mag. 11, lying in northern Lynx, close to the border with Camelopadalus. Rather less well placed was C/2008 A1 (McNaught), reportedly at around mag. 8, but low down in Ophiuchus and fading fast.

The speaker then invited Dr Richard Miles, in the audience, to outline briefly an observing programme which he was currently undertaking with the Faulkes Telescope, targeting Comet 17P/Holmes following its dramatic and unexpected outburst to visual magnitudes in 2007-8. Dr Miles explained that Comet Holmes had now faded to mag. 20, and that it now took a 45-minute exposure with the 80-inch Faulkes Telescope to resolve the comet and its tail. However, he was continuing to image it in the hope that as its coma began to disperse, it would become possible to resolve its nucleus and perform photometry to determine its rotation period. Dr Miles explained that he suspected that the nucleus might rotate unusually slowly, because all of the other comets which were known to have undergone outbursts were slow rotators, but that he needed observations to back up this theory. He added that he would be discussing his work in more detail at a future meeting on 2009 March 31.

Dr Hewitt briefly mentioned that the next major meteor shower would be the Geminids, due to peak on December 13, but added that since the Moon would be full on the preceding day, this normally rich shower would be rather spoilt this year.

Two well-known variable red giant stars would be approaching maximum in the next few weeks. Mira, also known as Omicron Ceti, would reach a maximum brightness of mag. 3 on around December 30, with a few days' uncertainty either side, and would be visible to the naked eye from now on. The speaker added that this star, 420 light years distant and varying with a period of 330 days, had been one of the first variable stars to have been discovered; its existence had certainly been known to David Fabricius as early as 1596. Dr Hewitt added that in modern times, this star was also remarkable for having been the third star, after the Sun and Betelgeuse, to have had its radius measured – a task which had been made easier by its large disk, measuring 3 AU across. Before Mira's forthcoming maximum, another notable but slightly fainter red giant star, R Aquarii, would be coming up to maximum on around December 17, expected to reach around mag. 6.5.

Dr Hewitt then turned briefly to discuss the triple star system o^2 Eridani, also known as 40 Eridani. At a distance of only 16 light years, this was the eighth closest of the naked eye stars, and it was an easy target to find, situated around 14° to the west of Rigel. Despite its proximity, it nonetheless appeared a comparatively moderate mag. 4.5 star to the naked eye on account of its low mass, around 80% that of the Sun, which also gave it a reddish spectral type of KI. Of greater interest, however, were its two companion stars, both situated around 83" from the primary and easily telescopically resolvable at a separation of 8". The first of these, 40 Eri B, was the only white dwarf star to be easily visible through the eyepiece of a moderate-aperture telescope at mag. 9.5. The second, 40 Eri C, was an exceptionally low mass red dwarf star, having only 20% of the mass of the Sun. Whilst these two stars were almost certainly specimens of the most common stellar types in the Universe, their intrinsic faintness made them very difficult objects to see at any great distance, and it was only on account of the closeness of the 40 Eri system that it was possible to see these rare examples.

Turning to his home ground of the deep sky, the speaker mentioned that four fine variable nebulae were visible at this time of year. The best known of these, Hubble's Variable Nebula, NGC 2261, was to be found in Monocerus. Hind's Variable Nebula, NGC 1555, was associated with the mag. 9.5 variable star T Tauri. Less well known, and more recently discovered, were Gyulbudaghian's Nebula, associated with the variable star PV Cephei, and McNeill's Nebula in Orion. The speaker recommended that observers try to take time-sequenced images of these nebulae with consistent instrumentation, as it could often be difficult to distinguish the intrinsic variability of the nebulae from effects resulting from the different sensitivities and wavelength responses of different cameras when comparing disparate images.

To close, the speaker showed a range of recent images taken by members of the Deep Sky Section. Of the autumn galaxies, M33 was a comparatively easy target, but M74, in Pisces, a much greater challenge, having perhaps the lowest surface brightness of any of the Messier objects. The speaker remarked especially upon an image of NGC 925 by Jeremy Shears, taken with a CCD through a 102-mm Takahashi refractor; modern cameras could obtain remarkably fine images through telescopes with surprisingly modest apertures.

Other challenging autumn objects included the planetary nebulae Abell 12, Abell 21 and NGC 7635. However, the speaker closed with a more familiar deep sky gem: the open cluster M41 in Canis Major, showing a fine image taken by Maurice Gavin from Worcester Park.

Following the applause, the President adjourned the meeting until December 13.

Dominic Ford

References

[1] Tyson, J.A., *et al.*, *ApJL*, **349**, L1-L4 (2000)