Annual Meeting of the Deep Sky Section, 2007 March 3
held at the Humfrey Rooms, Castilian Terrace, Northampton

Dr Stewart Moore, Director, opened the meeting with a summary of the past year's activities. Since the 2006 meeting, he had received in excess of 330 observations – an increase on previous years. The number of contributing observers had also risen, and he was especially pleased to see a growth in the number of visual observers: it was good to see that the art of admiring the aesthetics of objects at an eyepiece was still appreciated.

Three newsletters had been produced, available in hard copy for £4/yr, or in pdf format on the web. Dr Moore called for submissions, offering a free issue to anyone whose material was published. He remarked that the number of textual descriptions accompanying observations sent to him seemed to be in decline; he wondered whether this was a result of the rise of CCD imaging and urged members to keep up this art. In addition, he had sought to reach out to non-members by writing topical articles in the *Observers' Forum* sections of every issue of the BAA *Journal*, and by getting images by members of the section published there. Most prominently among those which had appeared in the past year, Gordon Rogers' image of the Christmas Tree cluster had been used on the cover of the December *Journal*.

Turning to observations, Dr Moore reported that Tom Boles had passed a milestone on 2006 April 3: the discovery of his 100th supernova; he had gone on to catch his 101st on the same night. His tally had since moved on to 105. Showing a selection of section members' images of Mr Boles' discoveries, Dr Moore commended Martin Mobberley for his habit of putting textual footers on his images, detailing the conditions and time of the observation; it was helpful to have this information so readily to hand. He urged others to follow suit where possible.

Turning to the section's observing programmes, Dr Moore remarked how the lack of popularity of the planetary nebulae programme had always surprised him – these were a varied selection of visually pleasing targets, and whilst some were quite challenging, others were visually accessible through even quite modest apertures. In the past year, their popularity had increased a little, however, and M27 remained the best observed of them. Dr Moore noted in passing that a new object, Howell-Crisp 1, had recently been discovered; Owen Brazell would say more about this later.

Among local group galaxies, NGC 147 in Casseopeia was suddenly proving very popular. The speaker challenged members to image Leo I – well placed at this time of year, but made very difficult by its proximity to Regulus, only 12' away. Visually it was very tricky – the speaker had found it barely visible through a 20" aperture – but he thought it should be quite possible with a CCD. One observation had been received in the past year, from Grant Privett. Leo II posed an even greater challenge, though the speaker showed a 15-hour exposure by Peter Erdmann in the US to prove that it was possible.

At the previous year's meeting, he had called for observations of Hubble's Variable Nebula, and these were still coming in. He was especially keen to receive regular observations made with a common eyepiece and in similar conditions; one problem when comparing observations from different observers was trying to distinguish equipment-related variability from that intrinsic to the sky.

He was also keen to receive more observations of supernova remnants; in his time as Director, he had never received any observations of Simeis 147, despite its being a beautiful large object in Taurus, subtending more than three degrees on the sky. Abell 85 in Casseopeia was another nice target.

Among the Messier globular clusters, Dr Moore had put out an especial plea for observations of M3, 5, 10, 14 and 22 at the 2006 meeting. These were bright and aesthetically pleasing clusters, and seemed to be often visited by visual observers, but less so by CCD imagers. The speaker hoped in due course to compile an illustrated Messier guide with good modern images of all objects, and so was keen to fill these gaps; he noted how imaging technology had moved along in recent times. In passing, he commended Nick Hewitt's imaging for his placement of objects in their surrounding starfields; as a visual observer, he liked to see deep sky objects put into context.

To close, he remarked upon the good turnout at the meeting. He invited members to get in touch if they had views upon Northampton's convenience and suitability as a venue for future meetings; in response, members expressed general approval. Andrea Tasselli was then invited to present the first talk.

High-Definition Imaging of Planetary Nebulae

Mr Tasselli opened by describing his instrumentation: an 8" Intes Micro M809 Cassegrain of working focal length 1,400-2,000 mm, fitted with a Starlight Xpress SXVF-H9 CCD array, which yielded a resolution of 0.65-1" per pixel. For filters, he used a True Tech *SupaSlim* filter wheel with RGB, Hα and OIII filters.

The term 'high-definition imaging' could be defined in many ways; presently, the speaker would consider work to qualify as such when the full width half maximum (FWHM) of the point spread function (PSF) of the unprocessed frames was 2” or less and the spatial sampling of the CCD pixel array was fine enough to satisfy the Nyquist criterion – a necessary requirement for subsequent deconvolution.

Outlining why he was attracted to imaging planetary nebulae (PNs), he explained that they comprised some of the brightest deep sky objects – many were brighter than Uranus and Neptune – and this made them quite easy targets. They were usually compact, fitting readily into single CCD frames. Their edges were usually sharp, unlike those of galaxies, whose extremities usually faded more gradually into the sky background; this meant that thorough flat-fielding was not so vital when imaging them. They showed a plethora of emission lines, and so responded well to the use of a wide range of narrow-band filters – of great help when observing from sites with significant light pollution. Put together, these considerations meant that expensive equipment was generally not required.

The array of objects on offer were themselves a very pleasing crop, showing clear contrast and colour variations, and amongst them great a diversity of shape and form. Surprisingly, they seemed to be rather under-appreciated objects: many had never been imaged by either amateurs or professionals before, let alone at high resolution.

Outlining what was required, the speaker identified good seeing as the single greatest prerequisite. Matters which were under the observer’s control, those of equipment choice, were surely secondary. A telescope with good mechanical stability was a great help, but only to minimise the time spent tweaking instrumentation rather than taking images. Its optics needed to be good, but once again, nothing special. Good focusing was needed, but no special hardware was needed to achieve it. A dew shield was, however, strongly recommended – dewed up optics were easy to miss, and it could be infuriating to later find many tens of minutes of exposures so ruined.

The thermal stability of one’s observatory needed consideration. In the winter, when daily temperature variations were usually only 3-4°, this was less important, but in the summer, when they could reach 20°, it was much more so. The speaker’s garden observatory had no roof – a set-up with a great strength here: there were no walls around it to retain heat and produce thermal currents. Even so, he still found the telescope’s own heat retention to be sufficient to render an internal fan necessary in summer. One drawback of this set-up, however, was that it needed to be polar aligned anew every night; it could take 1-2 hours to achieve 0.2”/minute tracking accuracy. He remarked, though, that even fixed plinth mounts could require similar treatment for their first few years, as their foundations shifted in the rain.

In good seeing, he aimed to focus to within 0.1” accuracy, which generally took around 30 minutes. In the winter, he usually found that after one focussing session at the start of each night, a single quick check in the early hours sufficed. In the summer, however, 3-4 full re-focussing sessions were often required as the temperature fell through the night.

Mr Tasselli always worked by taking large numbers of short exposures, no longer than 30 seconds each. He found seeing conditions to often vary greatly from one 30-second period to the next; by taking many 100s–1000s of such exposures and discarding all but the best, he could build up a long exposure whilst “freezing” the best seeing. This also minimised the effect of tracking errors upon the final image; the speaker found that auto-guiding was unnecessary with this approach.

He worked only in the best seeing conditions, which usually accompanied anti-cyclonic weather in the summer months; high-pressure systems tended to yield a steady atmosphere. January and February could also bring similar conditions, though they had not in the winter just passed. The speaker avoided observing objects at low altitudes, where atmospheric distortions were greatest; as a rule of thumb, he restricted himself to altitudes >65°.

Having obtained raw data, he used four post-processing software packages: the standard Starlight Xpress image capture programme, the powerful free *Iris*[1] image processing suite for the bulk of his image enhancement, *Adobe Photoshop* to perform final retouching, and finally *Neat Image*[2] to reduce noise by filtering out the graininess of his CCD array.

After visually selecting his best exposures, he applied standard processing techniques to them: dark subtraction and flat-fielding. He then averaged them with sigma rejection – a technique good for filtering out especially noisy images, those with cosmic ray hits, etc. This yielded low-noise images, but the results were still typically quite blurry, due both to tracking errors and seeing conditions. To rectify this, he used three contrast enhancement tools: unsharp masking, Richardson-Lucy Deconvolution, and – somewhat stronger – Van Cittert Deconvolution. To achieve dark backgrounds, and to bring out contrast among the upper luminance contours, the speaker also applied some histogram modification, using the Digital Development Process (DDP) pioneered by Kunihiko Okano and *Photoshop*’s non-linear curve modification facility.

He applied these in a fairly consistent pipeline. First he made a luminance image, to which he applied DDP to get the right distribution of grey levels across the image. He then filtered out any pixels with negative luminances – a prerequisite for deconvolution – before applying 4-5 iterations of Richardson-Lucy Deconvolution, saving the result as a “low-resolution” frame. He then applied a further 3-5 iterations of stronger Van Cittert Deconvolution, used a weak low-pass filter to remove some of the resulting noise, and saved a second “high-resolution” frame. In

Photoshop, he blended the high-luminance levels of the latter image with the lower-luminance levels of the first. In the result, the fainter regions of the frame – typically the sweeping extremities of objects, dominated by lower spatial frequencies – were only mildly sharpened, to minimise noise, whilst brighter regions were sharpened quite strongly to bring out fine structure.

The speaker closed by showing a number of examples of his work – the Cat's Eye Nebula (NGC 6543), the Blinking Eye Nebula (NGC 6826), the Cheeseburger Nebula (NGC 7026), the Blue Snowball (NGC 7662) and the Ring Nebula (M57) – in each case comparing the amount of detail resolved in his images with results from the *Hubble Space Telescope* (HST); he remarked that the comparison was not a bad one with early HST images.

Following the applause, Dr Moore introduced the morning's second speaker, Mr Paul Clark.

A Pinch of SALT

Mr Clark explained that the "SALT" in his title was the *South African Large Telescope*; he would be describing a 10-day observing expedition to South Africa upon which he and Mike Cooke had embarked in 2006 August, hoping to find skies better than those of his native Manchester – perhaps England's cloudiest corner. His destination had been Sutherland, a remote settlement in the midst of the high-altitude South African desert, 80 miles from the nearest town. Posting queries online had put him in contact with the *Astronomical Society of South Africa* (ASSA) – a ProAm society who had proved an invaluable contact. He had learnt that Sutherland had roughly 50% completely clear nights, 75% spectroscopically clear, and 25% cloudy, which would prove roughly in line with what he was to experience.

He had flown to Cape Town and arrived in pouring rain, but as he travelled inland, the weather had greatly improved – this was apparently quite usual; such weather systems clung tightly to the coast. Along the final 80 miles of road from the nearest civilisation to Sutherland, he had not passed a single other car. His destination had turned out to host a few B&Bs, a trade which it apparently tried to make from its vicinity to the *South African Astronomical Observatory* (SAAO); the town nicknamed itself the "Gateway to the Universe".

On his first night, he had taken advantage of the lack of traffic to observe from the road, 3 km outside Sutherland; he had been able to set up his 4" telescope on the tarmac undisturbed. As darkness had fallen, the Milky Way had stretched across the sky from north to south, with its brightest part – Scorpius and Sagittarius, containing the Galactic Centre – roughly overhead; this remarkable sight had been the focus of this entire night. A pair of 15×50 Canon image-stabilised binoculars had proven a remarkable tool for observing it; the speaker could not recommend them more highly.

Subsequently, he had gained access to the instruments in the public observatory on the SAAO site – a 16" Schmitt and another 14" – about 200 m from the SALT itself; he had had five nights of observing with them. Presently, he would arrange his observations from them into a mythical night's observing, though his images were in practice taken over five. He remarked that the instruments had proven to be quite poorly maintained; he had been able to substantially improve their collimation, and he wondered whether this show of expertise was responsible for the staff's subsequent willingness to give him free access to them. Their lack of dew shields had been an initial source of anxiety, not entirely understood by the locals; he had later realised that on a site with 20-30% relative humidity, such worries were quite alien.

At sunset, he had been able to see the green flash quite easily, followed by the rising of a beautiful pearly-red Belt of Venus in the east. The sight had been quite special in such clear air. As darkness had fallen, the most obvious sight had been that of the Milky Way – the η-Carina nebula perched on the southern horizon, the Coalsack Nebula just above it in Crux, the Sagittarius clouds overhead, the Scutum star cloud and the Wild Duck Cluster (M11) further north still, and the Dumbbell Nebula (M27) on the northern horizon. This whole complex of objects – all naked-eye-visible – had been littered with dark clouds and dust lanes – a very rich sight. The speaker remarked how astoundingly bright a truly dark sky was – whilst he couldn't have read by the light of Sagittarius, it had been quite bright enough to cast shadows; they had been visible moving up the wall of the observatory as the night progressed.

The zodiacal light/band had been readily visible, about 20-30° across, as well as the gegenschein; using the Bortle scale[3], the speaker rated Sutherland considerably better than an 'excellent dark site'.

Within the Milky Way, there had been relatively little colour as compared to the warmer hues of the zodiacal light, but it had appeared remarkably broad; elements of its visual extent had seemed to stretch right out as far as the Large Magellanic Cloud (LMC). Sweeping the 4°-field of his 4" into its path, the flooding of stars into view had been a memorable sight. Around it had been 8-10 naked-eye globular clusters – both Messiers and some of which he had never before heard of. M5, 15, 2, 30 and 22 had all been visible to the unaided eye. Telescopically, even many lesser-known galaxies and clusters had often been quite breathtaking.

The ω-Centaurus cluster (NGC 5139) had been a remarkable telescopic sight, seeming to overflow the eyepiece with a sprinkling of diamonds – pin-points of light everywhere. By comparison, the Jewel Box open cluster (NGC

4755) had been almost a disappointment – perhaps the speaker was just more of a galaxy observer. As the night had drawn on, the Milky Way had begun to sink into the west, making other objects more inviting. In the southern pinwheel galaxy (M83), bright knots, dark dust lanes, and the beautiful spiral shape, had all been accessible with minimal effort. The Hamburger Galaxy (NGC 5128; better known as the radio source Centarus A) had been another inviting target. Barnard's Galaxy (NGC 6822) had passed virtually overhead later in the night, and lying back, looking through the 16", the speaker had found its granular nature, emission nebulae and the structuring around, to be all clearly visible; it had been incomparable to the meagre sight seen from the UK.

As the night had drawn on further, some degree of darkness had been achieved as the Milky Way had begun to set further, and the southern galactic pole in Sculptor had opened up, bringing with it a rich cluster of galaxies. In the Fornax Group, NGC 1365 had seemed to rival M51 in magnificence, having a very rich zig-zagging spiral structure. Visiting a few more familiar areas, the speaker had found the Lagoon Nebula (M8) and Trifid Galaxy (M20) to be well-placed – quite a contrast to their skirting along the southern horizon in the UK. All that he could say was how disappointing their appearance had seemed upon his return.

He closed by mentioning the Magellanic Clouds, which had been best observed later in the night. In the SMC, the 47-Tucanae globular cluster was a rival in greatness to ω-Centaurus, and quite a contrast to it, having a tight central condensation. The LMC offered a rich array of clouds and star clusters; the Tarantula Nebula (30 Doradus) had proven especially memorable.

In addition to his observing, the speaker had also toured the research instruments on the SAAO site, including 1.4- and 1.9-m infrared instruments, the southern *SuperWASP* exoplanet search instrument, and, of course, the SALT itself. He remarked upon how the 91 hexagonal mirrors of the SALT's 10-m primary had appeared quite grey with dirt; he presumed that the cost of cleaning them was simply not economic. Amateurs with grubby optics might take some comfort from seeing that the mirrors of a premium professional telescope were no better.

Following the applause, a member asked whether this opportunity to use the SAAO instruments was open to all amateurs. The speaker replied that when he had flown, he had not expected that he would have access to the 14" and 16" instruments – they were not generally available, but he had struck very lucky in making contact with the ASSA and convincing them of his competence. Dr Moore asked of the security situation in South Africa. The speaker replied that remote areas such as Sutherland tended not to have a problem; it was built-up areas which tended to have no-go districts.

After a break for lunch, the Director invited Dr Richard Miles, BAA President, to speak.

Two-Colour Imaging of the Deep Sky

Dr Miles explained that his primary interest was in the photometry of comets, asteroids and variable stars. The equipment that he had bought for this deep photometric work also, however, happened to be quite well-suited to deep sky imaging; indeed, whenever he performed photometry on supernovae, deep galaxy images were an immediate by-product. His set-up comprised of a 28-cm Celestron C/11 with two co-mounted 60-mm Takahashi FS60C refractors, one fitted with a V-band (500-700 nm; green) filter and the other an I-band (700-900 nm; infrared) filter, both from Norman Walker. Each Takahashi had a Starlight Xpress SXVF-H9 CCD array attached. In this talk he would be probing the deep-sky potential of these two 60-mm refractors.

The speaker remarked that the separation in wavelength between the V- and I-bands was rather greater than that between the RGB-bands. Consequently, some objects showed I-band magnitudes which were remarkably different from those seen in the V-band. Prototypical variable-star Mira, for example, usually measured around mag 1.5 (I-band) versus mag 6.5 (V); at its recent maximum, it had reached mag –1.4 (I), making it one of the brightest stars in the infrared sky. More extreme still, RYI Andromeda measured mag 8.8 (I) versus mag 15.7 (V); it was 850-times brighter in the infrared than in visible light. The response of his instrumentation was such that for average stars, the V-band filter reduced the amount of light collected from its white-light response by around one magnitude, while the I-band filter reduced it by two.

Dr Miles showed one of his earliest deep-sky images – a 33-minute stacked exposure of the Whirlpool Galaxy (M51), taken as a by-product of his making photometric measurements of supernova 2005cs. Comparing the result with an image by Martin Mobberley from 1992, taken through a 12" aperture on film, showed that long exposures with modern CCDs could now compete, even when taken through small apertures. Comparing the I- and V-band images, there was a slight loss of detail in the I-band; specifically, the star-forming regions in the spiral arms did not stand out so clearly. This loss of detail might be expected; colour images showed these regions to be relatively blue, and so B- or U-band images might have proven a more revealing comparison with the V-band data. A slightly deeper exposure of the Leo Triplet (M65, M66, NGC 3628) revealed a similar comparison between I- and V-band morphologies, as did a 3.5-hour exposure of the Coma Cluster. The speaker reiterated how well these Starlight Xpress images had responded to stacking; he compared the image of Coma with one from his 12" Celestron; the level of discernable detail was comparable. Even a comparison with imaging from the *Palomar Sky Survey* (POSS I; 1950-7), which had used a 48" Schmidt with 400-times the collecting area of the speaker's Takahashi, was not unfavourable.

The speaker then began to move south, explaining that objects at southerly declinations, which never rose very high in the UK sky, were more accessible in the infrared because atmospheric refraction – the plague of low-altitude imaging – was less severe at these wavelengths. He showed images of open clusters M46 and M47 in Puppis, around 1° apart at $\delta=-14.5°$; at this declination, the level of detail seen in the I- and V-band images were comparable, though the former better differentiated red and blue stars. He pointed out that planetary nebula NGC 2438 – a small smudge tucked within the V-band image of M46 – was completely absent from the I-band image. Evidently the latter filter did not encompass any of the nebula's bright emission lines – Hα (656.3 nm), for example, fell significantly blueward of it.

Moving further south, Dr Miles turned to open clusters NGC 2571, 2580 and 2587, all in Puppis, at around $\delta=-30°$, each of which he had imaged with sixty 30-second frames. He remarked that his infrared imaging was here beginning to show superiority, though the fleeting appearances of these objects severely limited the time available for imaging them. He also showed an image of the Galactic centre, at $\delta=-29°$; he had been somewhat curious to see how it would appear. Whilst nothing had been visible in the V-band, I-band imaging had revealed a source with strange extended morphology, whose position matched that of radio source Sgr A.

A condensed globular cluster in Sagittarius, M69, at $\delta=-32°20'$, provided the next step in the southward journey, and a passable I-band image. By contrast, V-band imaging was now virtually impossible. The speaker explained that objects close to the horizon appeared at slightly higher altitudes than suggested by their celestial coordinates, as a result of refraction by the Earth's atmosphere. Moving down in altitude, this phenomenon became rapidly more pronounced in the final few degrees just above the horizon – the regime which his imaging was now entering. At its most extreme, objects which appeared on the nautical horizon had celestial coordinates which actually lay ~0.5° below it. The altitude dependence of this effect was a serious problem when stacking long exposures; it produced a time-varying distortion of the sky along the altitudinal axis, causing stars to appear to set more slowly as they approached the horizon. The effect was also wavelength-dependent: blue light was affected more than red. This led to a *chromatic dispersion* of these sources; their blue emission was seen at higher altitudes than their red, an illustration of which was the *green flash* seen at sunset. This rendered it necessary to observe using fairly narrow-band filters to avoid altitudinal smearing, but also meant that the stacking of I-band images was much more feasible than that of their V-band counterparts.

Concluding his southward journey, the speaker showed images of NGC 6723, at $\delta=-36°37'$, and NGC 1808, at $\delta=-37°31'$. His observatory's physical southern horizon was at $\delta=-38°09'$, but he had yet to identify any deep sky imaging targets in the final 30'.

Returning to where he had begun, he concluded by showing an image which he had acquired as a by-product of photometry of variable star SS Cygni, which he had been studying intensively over the past couple of years. Nearby lay a mag 15.3 (V) galaxy, UGC 11799. By stacking 12-hours-worth of his CCD frames, he had been able to obtain an image of this galaxy which revealed a comparable degree of detail to its POSS image. He added that he had applied no sharpening or other post-processing to his image; these, no doubt, could improve it further.

Dr Miles concluded by arguing that the power of small aperture instruments for imaging was not to be neglected in the age of CCDs and frame stacking. Following the applause, the Director invited Grant Privett to speak.

Going Deep

Mr Privett conceded that the term 'deep' was somewhat ambiguous; its meaning depended upon both site and equipment. A Londoner might consider the Crab Nebula (M1) so, meanwhile it had taken on a wholly different meaning in Paul Clark's earlier talk. He hoped presently to give advice which would be relevant irrespective of the definition chosen, and to both visual and CCD observers.

Some, he suspected, might ask the motivation for chasing faint objects, when such fantastic detail was to be found in the likes of M42, M57 and M27. He supposed that he saw them, first and foremost, as a challenge; imaging them required persistence, the refinement of some skills, and the learning of other entirely new ones. If the resulting images were not reward enough, the learning experience might later feed back to allow superior imaging of brighter objects.

The equipment requirements for deep imaging, were, above all, a set-up which was in every way easy to use and maintain. A portable telescope, not too heavy, was ideal. Unwieldy instruments were to be avoided; the work involved in transporting them and setting them up would be a psychological barrier to their use. A driven mount was vital for CCD imaging and very useful for visual observers; a digital setting circle would also save a lot of time in finding objects. Whilst some observers enjoyed DIY work, the speaker viewed telescope maintenance as a separate pastime from that of observing, and was inclined to view any time spent tinkering as time spent not observing.

More mundane items were equally important: a comfortable chair, a chart table at a convenient height, and warm clothing. Anything which made observing uncomfortable would bring on tiredness, and ultimately bring observing sessions to premature closes.

The speaker noted that even his comparatively portable set-up, with which he was well practiced, took him nearly an hour to set up. The advantages of fixed observatories were clear – the speaker admitted that he himself was tempted to set one up – but the drawback was that they didn't allow one to travel to find the best skies, and this was essential in most residential areas.

A dark site was essential, and to aid in finding one, the *Dark Skies Map* published by Philips was to be highly recommended. Likewise, a moonless night was also near-essential, though First Quarter skies were, at a pinch, usable late in the night, provided that the objects targeted were >90° and not exactly 180° from the Moon, to avoid any scattering into the telescope tube. The speaker used only the darkest area of the sky, which he typically found to be slightly displaced from the zenith, depending upon the directionality of local light pollution. He also only imaged during the hours of astronomical darkness, which meant not at all in June or July.

Mr Privett then turned to give advice specific to CCD imagers. He recommended trying several different eyepieces before imaging, to see which best framed any given target. Having a well-calibrated CCD was vital to minimise image noise. This meant that hot and cold pixel maps needed to be carefully constructed to filter out faulty pixels. Dark subtraction was vital even with the best detectors; he found it necessary to take several dark frames through the night as the detector temperature changed. Flat-fielding could also not be neglected. Finally, vignetting around the edges of frames was an effect to be mindful of; generally, the edges of CCD frames were best discarded. Whilst bright objects could be quite forgiving of these calibrations, they made a huge difference to deeper exposures, and no amount of stacking could average out poor calibration.

As an illustration of the power of stacking, the speaker showed an animation of the improvement in image quality as more and more frames were combined. He generally recommended stacking large numbers of quite short exposures, as an increasing fraction of longer exposures had to be discarded due to cosmic ray hits, etc., though he noted that CCD read-out noise grew with the number of frames stacked, and, as it had non-Gaussian properties, was virtually impossible to remove. An equipment-dependent medium had to be found.

Good focussing needed to be maintained, and the speaker recommended re-checking this at least once an hour. Finally, before post-processing frames, he recommended applying linear gradient removal; the scattering of ambient light around one's observatory into telescope optics invariably produced some linear background gradient.

The speaker then turned to present some of the fruits of his work. Showing first some comparatively well-known objects, he began with M29, remarking how pleasing it was to have an image with not just the bright members of this open cluster, but also much fainter stars. Next, he showed a fine image of local group galaxy Leo I at mag 11.2.

Among some publicity stunts, he had imaged dwarf planet UB313 at mag 19, which, on the grounds of having been an object in the news of late, had impressed his work colleagues. The detection had actually been quite straightforward. In 1996-7 he had set himself a greater challenge of trying to image quasar PC1247+0340 at mag 20.4 in Canes Venatici; at a redshift of z=4.687, this had been the most distant known object at the time, and he had hoped to publish the work as a local paper story. Unfortunately his attempt had been unsuccessful, though with greater experience, he had subsequently managed a positive detection in 2005, stacking 450 frames, each 30-second exposures. The red colour of this object made it difficult: the observation had only been made possible by the good response of modern CCDs into the near-infrared; at 1-μm wavelength, his detector still yielded 10% of its sensitivity at visible wavelengths.

To conclude, Mr Privett remarked that he seemed to have found a niche for himself which he felt was much more rewarding than trying to compete with the fine images which already existed of brighter objects by means of post-processing. Following the applause, a member asked whether a conflict existed between the recommendation of easy-to-use equipment and that of a very portable instrument; as the speaker himself had mentioned, having a fixed observatory saved a lot of time. Mr Privett agreed that there was a conflict, but the majority of observers who lived in light-polluted areas could gain much better images by travelling to a dark site.

After a break for afternoon tea, the meeting resumed with a talk by a professional: Prof. Janet Drew, of Imperial College, London. Prof. Drew was the Principal Investigator (PI) of a project to survey the northern half of the galactic plane in Hα emission – the Isaac Newton Telescope (INT) Photometric Hα Survey of the Northern Galactic Plane (IPHAS) – which would be the subject of her talk.

The Northern Sky Hα Survey

Prof. Drew explained that IPHAS[4] was using the Wide Field Camera (WFC) of the INT to survey a 10° strip of sky following the northern galactic plane – an area totalling 1,800 deg^2. Images were taken using three filters: Hα, r' and i'. The latter two, pioneered by the Sloan Digital Sky Survey (SDSS), were similar to R- and I-band filters, but were preferred on account of their having more rectangular transmission profiles.

The survey collaboration consisted of 30-40 people, based in the UK, Spain and the Netherlands. Image reduction was been undertaken by the Cambridge Astronomical Survey Unit (CASU) of the Institute of Astronomy in Cambridge.

Prof. Drew explained that the Hα line (656.3 nm) was indicative of a range of interesting astrophysical environments. It was a transition line of atomic hydrogen, but was only excited where that hydrogen had become ionised; emission in it resulted only when free electrons and ionised hydrogen nuclei recombined. Astrophysically, exposure to ultraviolet photons was the principal mechanism for the ionisation of gas, and so Hα was a tracer of environments such as those around young massive stars, post-AGB stars, and accreting systems such as cataclysmic variable stars, which produced appreciable numbers of ultraviolet photons. In extragalactic astronomy, Hα was known as *the* tracer of star formation. Its position in the R-band was of practical use: this was the least dust-obscured part of the visible spectrum, allowing greater penetration of dusty environments, including the Milky Way's disc.

Until recently, a deep survey of Galactic emission had been lacking; the deepest catalogue of point sources had dated from the 1970s and stopped at mag 13. The *Anglo-Australian Observatory* (AAO) had rectified this in the southern hemisphere, conducting a survey using the *UK Schmidt Telescope* (UKST) which had gone 1000-times deeper, picking up all point sources to mag 20.5 (R). This had reached completion in 2003.

From the surveys of the 1970s, it was clear that the population of Hα sources seen in the northern galactic plane was markedly different from that seen in the south; it was much sparser – presumably due to the geometry of the galaxy. Given the difference, it seemed worthwhile to complement the AAO survey with a northern counterpart, which IPHAS now sought to provide. It would detect all northern Hα-emitters between mag 13–20 (r').

To cover the 1,800 deg^2 survey area required 7,635 pointings of the INT; each field was exposed for 120 s in Hα, 30 s in r' and 10 s in i'. Each field was observed twice, both to provide confirmation images, and to catch objects which fell between the four CCD chips of the WFC. The speaker remarked that an advantage of working so late in the INT's lifetime was that the camera's response had now been very well characterised. As the filters used by IPHAS all lay at the red end of the spectrum, the survey was comparatively tolerant of Moon interference, and tended to be scheduled during Moon bright time, when there was a reduced demand for telescope time.

To date, 72% of the survey had been completed, with an average seeing of 1.7". It was hoped that the observations would be completed in late 2007. CASU was presently working to calibrate the data to ensure photometric uniformity throughout; to date, some weather-induced variability in the photometry remained.

The speaker explained that whilst line emission was most commonly associated with nebulae, much of the science from IPHAS was actually stemming from unresolved point sources. The r'–Hα and r'–i' colours of main sequence stars provided superb diagnostics both of their spectral types and of the dust extinction along our lines of sight to them. This facilitated mappings of both stellar masses and dust extinction across the Galactic plane. Stars with strong line emission – Ae and Be stars, indicative of young systems, still enshrouded in their natal gas clouds, and accreting cataclysmic variable stars – stood out on account of their bright Hα emission. Conversely, white dwarfs stood out as Hα-faint objects on account of significant absorption by circumstellar hydrogen.

As an example of the power of IPHAS, the speaker showed work done on the Cygnus OB2 association. Though its O- and B-type stars were the most prominent, one would also expect a much larger population of fainter A-type stars to accompany them. IPHAS colour selection had allowed 1,500 such stars to be identified for the first time. Moreover it had allowed their distances to be accurately estimated: because their spectral types were so well constrained, so too were their luminosities, allowing their brightnesses to be converted into distance estimates. The resulting three-dimensional map of this cluster clearly showed two distinct stellar populations; this was apparently not a single cluster at all, but rather two, one in front of the other.

IPHAS was also expected to detect many hundreds of new planetary nebulae (PNs), which appeared as extended Hα-bright objects. The first to be reported, IPHAS PN-1, had proven an especially interesting object, situated in the Milky Way's extremities, 1.5 times further out than the Sun, at 13 kpc from the Galactic Centre. In the outer Galaxy, chemical abundances were expected to be radically different from those seen in the solar neighbourhood, and so there were likely to be many follow-up studies of this object. Aside from its chemistry, its morphology was also strikingly unusual. An Hα-bright point source in the centre – rarely seen in PNs – suggested that the parent star was in an accreting binary system. Moreover, the nebula itself showed two distinct rotation axes, a phenomenon which had only before been seen in a handful of PNs; the formation of such nebulae was yet to be understood.

Prof. Drew closed by adding that plans were already being made for a deeper survey of the southern Galactic plane after IPHAS. The Very Large Telescope (VLT) Survey Telescope (VST) Photometric Hα Survey (VPHAS) was scheduled to commence in 2008, and would image in Hα, u', g', r' and i'.

Following the applause, the Director introduced two short talks to conclude the meeting. The first was by Mr Gary Poyner of the Variable Star Section.

OJ287 – An Update

Mr Poyner explained that OJ287 was a quasar which showed variability on all timescales from minutes to years; it was widely thought, though by no means confirmed, to be a binary pair of black holes, with accretion disc viewed face-on, looking directly down its jet. In this model, its flaring behaviour was attributed to shock fronts in the jet.

It had until recently been thought to have a period of 11.5 years, though its most recent outburst, predicted for mid-2006, had occurred earlier than expected, in October/November 2005. It was now suspected that the object only showed periodic behaviour for around 50 years at a time before this became unstable, as had apparently just happened.

Being in Cancer, it was unobservable from June through September; the speaker showed a lightcurve of its behaviour since solar conjunction in 2006, up to the present. It had never been entirely quiescent in this time; initially it had appeared to flare every 31 days, though this period had recently reduced to 14 days.

The Variable Star Section had in recent times undergone a revolution; though visual observers remained, many now used CCDs to perform photometry of objects like OJ287. Noting that many of the deep sky observers in the audience also had CCD equipment, the speaker put out a call for them to consider contributing observations of this most enigmatic object. He closed by referring potential observers to the VSS's observing campaign webpage[5] for more details.

The Director then invited Mr Owen Brazell to present the afternoon's final talk.

Planetary Nebula Howell-Crisp I

Mr Brazell described how there had been considerable activity in recent times among amateurs searching for previously uncatalogued planetary nebulae (PNs). One such amateur was Richard Crisp in Texas; he was perhaps most distinguished as a pioneer of amateur narrow-band imaging in, for example, the Hα and OIII lines. In 2006 November, he and Michael Howell had noted a curious smudge close to supernova remnant IC443 in Gemini, which he believed might be a PN. This had subsequently been confirmed by a professionally-obtained spectrum.

The speaker expressed some surprise that this PN had not been noticed before; it was quite apparent in the Digitised Sky Survey (DSS), and since the announcement of its discovery, many other amateurs had succeeded in imaging it. However, he noted that it seemed to be far from unique; Crisp alone had several other PN candidates awaiting confirmation.

The Director then closed the meeting, expressing his gratitude to all who had assisted in organising it, and especially to all of the speakers.

Dominic Ford

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