Ordinary Meeting, 2005 January 26
held at The Geological Society, Burlington House, Piccadilly, London W1

Tom Boles, President

Ron Johnson, Nick Hewitt and Nick James, Secretaries

The President opened the fourth Meeting of the 115th session, inviting Dr Nick Hewitt to read the minutes of the previous meeting. After these had been approved, Mr Boles expressed his gratitude to Mr Guy Hurst, who had chaired the latter part of the proceedings in his absence. It was announced that ??? new members were proposed for election, meanwhile the audience approved the twenty-five who had been proposed at the previous meeting. Mr James announced that two papers had been approved for Journal publication:

The Zeeman Effect observed with a spectrohelioscope, by Fredrick Veio
A discussion of the duration of central transits as seen from the Earth, by Darren Beard

The next Ordinary Meeting would be held, along with a Special General Meeting, on March 30, at the present venue. In the meantime, however, there was also to be an experimental *Back to Basics* workshop in Chichester on January 29, the sixth in the Association's successful series of *Observers Workshops* at the Open University in Milton Keynes on February 26, and a Sectional Meeting of the Deep Sky Section in Northampton on March 5. Finally, in accordance with traditional practice at this point in a President's tenure, Mr Boles announced his personal nomination for his successor, due to take office at the start of the following session. He was pleased to recommend Dr Richard Miles for the post, and offered him his warmest congratulations should he be elected.

Mr Boles then proceeded to welcome the evening's first speaker, Dr David Boyd, Vice-President of Newbury Astronomical Society, and an active member of the Variable Star Section.

Clocking a Spinning White Dwarf

In his talk, Dr Boyd outlined his observations of the variable star DO Draconis (Dra) during its outburst of 2004 January. He opened by explaining that this system was a member of a class of cataclysmic variables known as *intermediate polars*. Such systems consisted of a pair of stars, orbiting about their common centre of gravity, where the more massive star had exhausted its fuel and become a white dwarf, while its less massive companion continued to burn hydrogen. Upon reaching the red giant phase of its life, the smaller secondary star would expand, pushing its outer layers towards its companion, such that some of its outer envelope entered the strong gravitational field surrounding the white dwarf – a process called *Roche-lobe overflow*. This gas, having no escape from the white dwarf, would spiral in towards it, forming an *accretion disc*.

From his observations of the variations in the brightness of DO Dra, the speaker explained that he had found it possible to measure what he believed to be the spin-rate of the white dwarf in the system. He added that this had been possible as a consequence of the behaviour of the inner-edge of the accretion disc. It was well established that white dwarfs were surrounded by intense magnetic fields, essentially the result of compressing the magnetic field of an entire star into the tiny volume of such an object – comparable to that of the Earth. This was relevant, as the material falling onto the accretion disc would rapidly become ionised, a result of the tremendous temperatures generated by viscous friction within the disc, fuelled by the acceleration of material to velocities of several thousand km/s upon falling in towards the white dwarf. However, such ionised material was known to follow the direction of magnetic fields, and so the strong field in the vicinity of the white dwarf would be expected to alter the dynamics of the inner parts of the accretion disc, drawing material out of its plane, along the field lines emanating from the star's magnetic poles, and ultimately onto the surface of these poles.

However, the speaker explained that there was no reason why the white dwarf's magnetic poles should be aligned with its rotation axis, and so as it spun, the magnetic poles would rotate, and the geometry of the inflow onto them change with respect to our line of sight. The result would be some periodic modulation of the observed brightness of the system, typically with two brightenings per rotation, on account of seeing both poles alternately crossing its disk.

As a historical note, Dr Boyd added that DO Dra had not been identified as an intermediate polar until it had been realised to be a significant source of X-ray radiation, suggestive that accretion onto a compact object was involved in its variability. Prior to this, however, in 1934, an eclipsing binary, catalogued YY Dra, had been identified very close nearby, though it was apparently no longer observable. Recent literature argued that it seemed likely that this was a case of misclassification, and both were in fact the same object.

Previous observations taken over the course of the 1990s by *ROSAT* in X-rays, and by the *Faint Object Spectrograph* (FOS) aboard the *Hubble Space Telescope* (HST) in the ultraviolet, had identified two periodic variations in the brightness of DO Dra, with periods of 530s and 265s, interpreted as being due to the spin period of the white dwarf and its first harmonic respectively. The detection of brightness modulation at the first harmonic of the spin period fitted well with the suggestion that there should be two brightenings per rotation, corresponding to accretion onto each of the two magnetic poles. Previous observations in the V-band (visible light), yielded a marginal detection of the 530s modulation, but no detection of its first harmonic.

Moving on to discuss his own observations, the speaker explained that these had been made during the outburst of 2004 January. Normally DO Dra varied in the range mag 15-15.5, but on 2004 January 23, Mike Simonsen had reported that it appeared brighter in his images, around mag 14.5. The subsequent brightening was rapid, and the speaker's photometry the following night found it closer to mag 11.5. During the course of the night of January 24/25, he had set his CCD to take automatic 30s integrations over a period of 7.5 hours. In each of the resulting frames he had later been able to use a reference star in the same field to estimate the brightness of DO Dra. He had repeated the same procedure with a second reference star to estimate the error in his photometry. More details of the data analysis can be found in his paper, Boyd (2005)[1].

When the frequency spectrum of the brightness variations over the night was calculated, significant modulation with a period of 527.8±1.8s was identified, though the first harmonic, at half this period, was not observed. This value was compatible with the best professionally measured value of the spin period of the white dwarf from the HST, of 529.42±0.1s. In conclusion, the speaker believed he had measured the spin-rate of a white dwarf using only a 10-inch aperture amateur telescope – he found this rare opportunity to plot his personal observations alongside HST data rather satisfying. In addition, he had uncovered something of a mystery: why he had only detected only one brightening in the V-band on each rotation, as previous observations in that band had also hinted, and yet two brightenings per rotation were observed in X-rays and the ultraviolet. More observations would be required to answer this question, and the speaker felt concurrent monitoring in both the V-band and at shorter wavelengths would be valuable to ensure that the explanation did not simply lie in a change in the behaviour of the object between the observations at different wavelengths.

Following the applause, the President congratulated Dr Boyd on undertaking observations of genuine scientific value, and expressed his hope that his success might encourage other amateurs to pursue similar projects. A member asked the speaker why he had chosen to observe in the V-band, using a green filter, rather than observing in white light with an unfiltered CCD. The speaker explained that this made it easier to compare his results with those of others, as the wavelength response of unfiltered CCDs varied considerably. A member asked if Dr Boyd would be willing to speculate as to what physical mechanism caused the difference between his V-band observations and those at shorter wavelengths. The speaker replied that he was reluctant to do so, as he was not aware of any well-established explanation having appeared in the professional literature.

Finally, Mrs Hazel McGee asked whether the previous X-ray/UV observations had been taken at times of quiescence or outburst, whether the speaker had made any V-band observations during quiescence, and whether any discrepancy here might account for the different behaviour of the object. The speaker replied that the previous observations had mostly been taken during quiescence, but his own attempts to make V-band observations at such times had been plagued by large error-bars, a result of the object's faintness.[2]

The President then welcomed the next two speakers, who together would be discussing a new design of telescope optics. Mr Peter Wise, the telescope-maker behind the idea, would explain the design of the instrument, whilst Mr Martin Morgan-Taylor would be presenting some of his results obtained using a telescope with such optics.

New Movements in Imaging Technologies: Telescopic Imaging with Digital SLR

Mr Wise explained that his optical design, which he called *Newsie*, employed a spherical primary mirror, with two subsequent lenses used to correct for the spherical aberration before rays were brought to focus. The first of these, a negative (diverging) doublet, was placed in front of the focal plane of the primary, and brought the converging rays from it into a near-parallel configuration. As with the Newtonian design, rays were then deflected through 90° by a small flat mirror, leaving the side of the instrument. Here, a positive (converging) doublet brought them to focus.

The speaker saw a number of advantages to this design. The distance between the primary mirror and the secondary optics was shorter than that of most comparable instruments. The result was a compact telescope, which was more readily transportable than an instrument of comparable aperture using more conventional optics. The optics were also comparatively fast – the speaker showed the audience an easily-carriable 200mm f/6 prototype, explaining that he had also made a 400mm f/3 instrument. The usable fields of these were 1.5° and 0.9° respectively, making them ideally suited to wide-field work. He added that he had hopes to make a 24-inch version within the coming year, if the cost was not too great.

In addition, Mr Wise explained that the distance between the last lens of the system and the focal plane was comparatively large, making it straightforward to take images simply by placing a standard camera in front of the eyepiece, without the need for a transfer lens, as was so often the case with other designs. Finally, to reassure the sceptics, he added that the instrument exhibited "no chromatic aberration", despite the use of lenses.

Mr Morgan-Taylor then explained that he would be presenting a series of images, comparing the results from a conventional CCD with those from a consumer digital SLR camera. In the process, he hoped to demonstrate what imaging was possible with some of the newer cameras on the market and, in addition, what it had been possible to achieve using a telescope of Mr Wise's new design. All of the images in his talk had been taken from a location three miles outside Leicester. He had used a so-called "deep sky" filter, about which he regretted he had been unable to find any technical specification, either from the retailer or from his own research. However, in practice it appeared to add a blue tint to colour images, excluding much of the red end of the spectrum, and with it much of the sodium light pollution. Whilst not ideal for colour imaging, the filter seemed a useful tool if the results were grey-scaled.

The advantages of CCDs as imaging sensors were, the speaker was sure, very familiar to many in his audience. They gave a penetrating view of the sky, often less affected by light-pollution than traditional film. In addition, they were typically more sensitive, and free of the reciprocity failure suffered by so many film emulsions when used with long exposure times. Digital SLR cameras themselves brought further advantages: an LCD display on the back, allowing the focussing to be checked quickly prior to taking long exposures, and relatively large chips, the speaker's being 20×16mm. However, the downside was that the CCD arrays in such cameras were usually based on CMOS semiconductors, which astronomers had tended to shy away from in the past on account of their being cheap and invariably rather noisy. Whilst they performed well for daylight shots, long astronomical exposures had historically been rendered impossible by the build-up of noise.

Starting with the Orion Nebula, Mr Morgan-Taylor first showed results obtained directly from the eyepiece, with no flat-fielding or stacking. His first reaction had been that they were exceptionally pleasing images, which perhaps one might normally have expected to have come from a telephoto lens rather than a telescope. In view of this, it seemed that technology had finally arrived which allowed wide-field imaging to be straightforwardly undertaken with an auto-guided instrument. Moving on to the Pleiades, a similar raw image from the eyepiece provided a good view of the cluster, while minimal processing in Adobe® Photoshop® was required to bring the surrounding nebulosity into view.

An animation of Comet Machholz, composed of two-minute exposures taken every three-and-a-half minutes on January 8 revealed another advantage of the use of digital SLR cameras: their ability to be driven by a digital cable release. In this case, the speaker had been able to program such a cable release to take a series of exposures of his chosen length, before retiring into the warm.

In conclusion, the speaker felt that there had been great advances in the quality of CMOS CCD detectors in recent years, to the point where they were now useful tools for astrophotography. In response to a question concerning the temperature-dependence of the noise in the CCD, the speaker replied that he had found images taken at sub-zero temperatures to be greatly superior to those taken when the camera had been warmer. Following applause for Messrs Wise and Morgan-Taylor's presentation, the President welcomed Mr Nick James to speak on a similar theme.

Wide-Field Astrophotography

Mr James recalled that in the past he had been something of a sceptic regarding digital cameras: they had seemed relatively insensitive, and to have rather small fields. He was one of many who had chosen instead to dedicate his attention to following the development of new types of film, each supposedly giving superior performance to its predecessors for long exposures. However, he proceeded to show an image which had caused him to think again: a wide-angle image of the Milky Way, which Nigel Evans had taken during their expedition to Sharm-el-Sheikh in Egypt in 2004 June to view the transit of Venus. The quality of this image, taken with an 8mm aperture lens and digital SLR camera, had convinced him that technology had moved on, and on the grounds of it he had since bought his own camera. The speaker remarked that he had often heard the question asked whether "film was dead", and in contrast with his previous opinions, he was now convinced that digital technology had reached a stage where it was challenging even the final remaining strengths of film.

The speaker's own camera was a *Canon 10D*, already an obsolete model, though he noted it had a consumer counterpart, the *Canon 300D*, which was essentially the same, except that it was packaged in a more compact and somewhat less sturdy case. Essential for astrophotography was a very high-quality lens, as it was relatively difficult for them to focus stars into point sources without any appreciable spreading of the light. Mr James recommended the eBay® website as a good source, remarking that he had himself found a very good lens there, priced at £160. The trend seemed to be towards increasing popular demand for zoom lenses, and so the fixed-focus variety could often be found quite cheaply.

The CMOS sensor array in the 10D was found to have quite a low noise-level, and without any cooling, exposures of up to five minutes were possible before it began to become an issue. The chip itself contained 7.4μm-square pixels in a 3,072 by 2,048 array, measuring 15.1mm by 22.7mm in total.

Mr James remarked that whereas CCD-users needed to carry a laptop with them to drive their cameras, digital camera users had no such need, as the body of the camera itself read and stored the data from the sensor, whilst at the same time being somewhat less bulky to carry around. The capacity of consumer flash memory cards was growing incredibly fast, so that a card with plentiful storage for a night's observing was now available at minimal cost. The control of the speaker's camera was very similar to that of a standard SLR – for example it had a 'bulb' setting for long exposures. By default the camera returned images in JPEG format, though it also supported the return of raw data directly from the sensor. The speaker reminded members that the latter option was essential for astrophotography, as it allowed tasks such as flat-fielding and the removal of hot pixels to be undertaken on the images. By comparison, these were impossible after the image had been compressed into JPEG format, as information from each of the individual detector elements were blurred together.

The speaker had found the LCD display on the back of his camera to be remarkably useful as a focussing-aid since it could display the image at a very high magnification. Whereas older SLR cameras had invariably provided a split-prism in the viewfinder to aid with reaching sharp focus, their modern counterparts tended to lack such niceties on the assumption that automatic focussing was a ubiquity. In addition, it appeared that the focussing wheels of all Canon lenses could now be turned beyond infinity, which meant that it was no longer possible to simply turn them to the end-stop when doing astrophotography.

Mr James commented that the 10D, along with many similar cameras, had an ISO setting, allowing the user to make the sensor simulate the behaviour of film of a given speed. He remarked that for astrophotography one might intuitively choose to use a high-sensitivity setting. However, he explained that this was actually not a good choice. When images were read in raw format, each pixel directly returned a 12-bit number (4096 quantisation levels), giving the number of quantised units of brightness detected. The ISO setting increased the gain between the CMOS sensor and the sampler, but beyond a certain setting there was no benefit, since the image noise was already covering several quantisation levels. In fact higher ISO merely had the effect of reducing the dynamic range available and restricting the maximum exposure time in light polluted environments. Thus, best results were obtained by configuring the camera to a relatively low ISO setting (200), and taking a longer exposure.

The 10D supported the use of a programmable digital cable release, which made it straightforward to schedule the exposure of a series of images at given intervals. The speaker noted, however, that photographers who were happy with old-fashioned push button releases would have to pay £30 for the digital equivalent. This seemed an extortionate price, though Mr Maurice Gavin had reportedly soldered together such a device himself, with minimal cost or effort involved.

Moving onto software, the speaker recommended the use of a package called *Iris*, which was freely available online.[3] For new-comers to the field of image processing, there was an extensive online tutorial at the same website. The software itself supported the input of images in the raw data formats used by both Canon and Nikon cameras. As an example, Mr James demonstrated what he had been able to achieve with a single 180s exposure of Comet Machholz. The raw image from the camera suffered a significant transverse gradient as a result of shadowing caused by the reflex mirror mechanism, as well as a few blotches caused by dust on the sensor. To counter these blemishes, he had taken an image of the flattest field he could find, by directing the camera at a blank region of the sky in twilight. The comet image was then divided by this, and any residual background variation was identifed by letting Iris fit a polynomial to the result. The calibrated image was then divided by this smoothed flat, and both the dust and ion tails were then clearly visible, despite their brightnesses being a mere ~1% of that of the sky background. That the 10D was able to obtain such detail from a sub-optimal suburban location seemed an impressive feat.

To conclude, the speaker mentioned one downside of the 10D. Although CMOS image sensors were typically quite sensitive well into the infrared part of the spectrum, the 10D incorporated a filter in front of the sensor, which blocked much of this light. The reason for having such a filter was that the focal length of the optics differed with wavelength, and so if infrared light were detected, it would not be in focus when visible light was, causing a blurring of the image. However, the filter's cutoff was around 20nm shortwards of the Hα line at 656nm, making it a poor tool for imaging hydrogen emission. To give an example, the Horsehead Nebula in Orion would be virtually invisible. However, the speaker concluded that on balance the Canon 10D was an outstanding imaging tool for £700. Given how unimaginable its imaging capabilities would have been only a very few years previously, he wondered what technology might become available to amateur imagers in years to come.

Following applause, a member asked Mr James how easy the sensor was to clean. He replied that Canon's official advice was that it should be returned to them for cleaning, but that as this seemed somewhat impractical, he had personally chosen to use a blower brush to blow air over it, without any physical contact. This procedure had seemed adequate so far. Whilst researching what others had done, he had found various accounts on the internet, describing the passing of various cleaning fluids over the sensor, though he did not envisage he would be risking this himself. He also remarked that he had read similar accounts of people dismantling the camera to remove the infrared filter – though this idea also failed to entice him.

The President then proceeded to introduce the evening's final speaker, Dr Nick Lomb, former Vice-President of the Association's New South Wales Branch, and current Curator of Astronomy at the Sydney Observatory.

The Sydney Observatory

Dr Lomb opened by asking how many members of the audience had visited the Sydney Observatory, and found that a considerable number had. He explained that historically, it had been founded in 1858, built next to Sydney harbour with the principal aim being that a time-ball should be placed on its roof, from where it would be visible to all shipping across the harbour. To this day, the panoramic view across the harbour from the top of the time-ball tower remained an exceptional sight. This foundation date was – the speaker added – very old by Australian standards, and placed it as the country's oldest observatory.

An impression of the Observatory from the late 1860s showed that, at this time, it had had a single observatory dome, with an attached residence for the Government Astronomer. In these early days, the principle telescope had been a transit instrument, though various other instruments were soon added to the collection, most notably the Schroeder 11.4-inch refractor, procured in 1872 by the then Government Astronomer, Mr Henry Russell. This telescope, now the oldest working instrument in the country, remained at the Observatory, and was still in regular use for public observing nights.

The speaker added that Russell had dedicated a great deal of attention to the transits of Venus of 1874 and 1882, and published his observations in a book in 1892. To commemorate this, the speaker showed the scene from the recent transit of 2004 June 8, which he added had attracted a great deal of interest, even though only the early stages had been visible from Australia. He remarked that it was curious that the black-drop effect was clearly observed from Sydney, although many UK observers had not seen it. Given that the Sun was low in the sky at the time of ingress in Sydney, this seemed to support the suggestion that it was predominately a seeing-related effect due to the Earth's atmosphere, rather than one due to the atmosphere of Venus or the Sun.

Moving on to the Observatory's present day activities, Dr Lomb described these as including the organisation of exhibitions and displays concerning its history, running workshops for local school groups and adult education programmes. In addition, there were frequent telescope viewing sessions, which combined the use of the historic Schroeder instrument with a recently acquired 16" Meade. However, the speaker regretted to report that the Association's New South Wales Branch had had a dwindling membership in recent years and, as a result, had decided that its name was excessively antiquated. Under its new name, the *Sydney City Sky Watchers*, it continued to hold monthly meetings at the Observatory. Dr Lomb also remarked that there was also a group based at the Observatory who were working to combat light pollution, and which was actively campaigning against any planning proposals which it was thought might significantly change the lighting conditions of the city.

To close, the speaker extended an invitation to all members to visit the Observatory, adding that they would be particularly welcome to join the Sydney City Sky Watchers' meetings on the evenings of the first Monday of each month. Concerning the light pollution issues raised in the talk, a member asked how Australian legislation in this regard compared with that in the UK. The speaker replied that Sydney was split into several municipal regions, and the situation varied between them. However, in the city centre, planning restrictions on lighting were comparatively favourable, though not all proposals complied with them.

The President then adjourned the Meeting until March 30, at the present venue.

References

[1] Boyd, D, Detection and measurement in the V-band of the white dwarf spin period in the January 2004 outburst of DO (YY) Draconis, *JBAA*, **114**, ??? (2005)

[2] It occurs to the Meetings Recorder that if the outburst behaviour observed in the V-band were explained by a sudden infall of material onto the magnetic poles of the white dwarf, then, if this material were to be falling preferentially (or exclusively) onto one of the poles, the observed periodicity seen at such wavelengths during outburst would also be explained. This hypothesis could be tested either by multi-waveband concurrent observations, or, more accessibly to amateurs, by a detailed V-band study during quiescence, accumulating sufficient data to statistically prove or refute the presence of modulation at the first harmonic of the spin rate outside outburst.

[3] http://www.astrosurf.org/buil/us/iris/iris.htm