Ordinary Meeting, 2009 January 28
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 fourth meeting of the 119th Session and invited Mr Tom Boles to read the minutes of the previous meeting on the behalf of the Meetings Secretary. These were approved by the audience and duly signed. It was announced that 25 new members were proposed for election, and those 8 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 two papers had been approved for publication in the *Journal*:

[check these]
CCD UVB-Photometry of Three Southern Galactic Open Clusters…. , by David Boyd et al.
The Comets of 1999, by Jonathan Shanklin

The President announced that the next Ordinary Meeting would be held on Wednesday March 31 at the present venue. Before then, the Association would be holding a *Back to Basics* workshop in Canterbury on January 31. The President then introduced the evening's first speaker, Dr Nick Achilleos of the Atmospheric Physics research group at Imperial College, London.

Rotation, Magnetism and Mass Loss at Saturn

Dr Achilleos opened his talk with an overview of Saturn's magnetosphere, which he explained was the region of space around the planet where its magnetic field was strong enough to disrupt the flow of the solar wind; he added that in practice, this region extended out to around 20 times the planet's radius. He described the morphology of this region, explaining that it had a sharp boundary on Saturn's sunward side, termed a *bow shock*, where the outward streaming flow of the solar wind impacted upon it. He explained that the exact position of this shock front changed over time: at times of intense solar activity, Saturn's magnetosphere tended to become a little compressed and so the shock front moved inwards, but at times when the solar wind was weaker, its magnetosphere tended to expand outwards. By contrast, he explained that its boundary on the side of the planet facing away from the Sun was rather more weakly defined, because here there was much less pressure being exerted on it from the solar wind. Consequently, the magnetosphere stretched out into a long and variable comet-like tail called a *magnetotail*, which gradually tapered away as it moved away from the planet. As the magnetotail grew narrower and narrower, the solar wind particles surrounding it gradually reformed into a steady flow having passed around the planet.

The speaker added that although it was not generally possible for solar wind particles to penetrate into Saturn's magnetosphere – the combination of the electrical charge of the particles and the magnetic field of the planet made this impossible – there were two points on the magnetosphere's boundary immediately above the planet's north and south poles where the planet's magnetic field was relatively weak, and where charged solar wind particles could penetrate it; these were termed *cusps*. The speaker explained that it was the flow of particles through these 'holes' which gave rise to aurorae on Saturn as on the Earth, but that the detailed behaviour of the magnetospheres of the two planets differed considerably. In particular, the high density of ionised particles in Saturn's magnetosphere suggested that it must have its own internal source of such particles, meanwhile almost all of the charged particles in the Earth's magnetosphere seemed to have leaked in from the solar wind.

The speaker explained that recent data from the *Cassini* spacecraft had identified eruptions of water from vents on Saturn's icy moon Enceladus as the source of both the ice particles in Saturn's E ring, and also of the ionised particles which seemed to populate the plane of the ring and moon system. Current models suggested that at present Enceladus was ejecting a steady flow of around 10 to 100 kg of such material per second, but that the total mass of plasma in the ring plane was remaining roughly constant as a result of a corresponding leakage of material down Saturn's magnetotail, whence it was lost into the solar wind.

The speaker then turned to describe Jupiter, which he explained provided a good benchmark against which to compare the other gas giant planets. He explained that the Jovian magnetosphere also had its own source of plasma in the form of the planet's innermost moon, Io. This moon was well known for its extremely active volcanism, and, as in the case of Enceladus, it seemed to be venting some material into space. Perhaps unsurprisingly on account of its vigorous volcanism, Io was in fact very much more active as a source of plasma than Enceladus, venting around 1000 kg of sulphurous compounds to space per second. The speaker added that one of the most compelling demonstrations of this leakage of material were ultraviolet images of Jovian aurora taken by the *Hubble Space Telescope* (HST), which showed that, in addition to the solar-triggered auroral ovals around the poles, there was also a bright auroral spot on Jupiter's surface at a significantly lower latitude, which followed Io's orbit around the

planet. It was apparent from this that electrical currents were flowing between Jupiter and Io through some conductive medium – undoubtedly a sea of plasma.

The speaker closed his talk with a discussion of his current research into the interaction of the magnetospheres of Jupiter and Saturn with the plasma that they contained. He explained that whilst the *Cassini* probe was returning a wealth of valuable information, the complex feedback mechanisms and internal regulation which seemed to be at work required some very detailed mathematical modelling.

Following the applause, the President introduced the evening's second speaker, Dr John Rogers, Director of the Association's Jupiter Section.

Jupiter in 2007 and 2008

Dr Rogers explained that what he had to say would neatly follow on from the previous talk: he would be providing an overview of the visual appearance of Jupiter over the past couple of years, as observed by amateurs. He began with an overview of the circumstances of Jupiter's 2008 apparition, as seen by the casual observer. He commented that since Jupiter had lain in Sagittarius throughout the whole year, at a declination a little south of –20°, this apparition had not been at all well placed for observation from the UK. At opposition, Jupiter had reached a peak altitude of only 16° in the UK sky. However, naked-eye observers with a good southern horizon had nonetheless been able to enjoy two conjunctions of Jupiter with Venus which had neatly bracketed the apparition: the first had occurred close to its beginning and the second had occurred close to its end. On the occasion of the first, around 2008 February 1, the pair had passed within 35' of each other, forming a brilliant conjunction. On the occasion of the second, around 2008 December 1, the pair had made a more distant conjunction at a separation of around 2°, but the addition of a three-day-old waxing crescent Moon to the pair's west had led to the event's being dubbed the 'smiley face' conjunction. The speaker noted that later on the evening of December 1, the Moon had gone on to occult Venus.

Dr Rogers then turned to describe the fine detail which amateur planetary imagers had been able to resolve with the use of modern webcams, some good seeing, and the stacking of large numbers of short exposure images. Among these imagers, the speaker reserved especial mention for local expert Damian Peach: whilst it had to be conceded that his images from Jupiter's 2008 apparition were far from his best, and certainly could not compete with those taken by the southern-hemisphere's amateurs, they were nonetheless highly impressive given that he had been working exclusively from the UK, against the problems of the planet's southerly declination at this apparition. Dr Rogers explained that the remainder of his talk would be about what could be learnt from such amateur images, with a bias towards images taken by those southerly-based amateurs who had had the best observing conditions.

The speaker identified three key milestones which amateur imagers of Jupiter had passed for the first time in 2008, and which he believed summarised their achievements rather well. The first of these was that substantially more fine detail had been recorded in the alternating latitudinal wind patterns across the planet's disk than had been recorded at previous apparitions. He explained that for many years it had been possible to observe and measure the speeds of Jupiter's well-known currents and jet streams. It had long been known that each of these had its own individual speed which could be measured by observing the movements of conspicuous spots in them. The resulting speeds were typically found to be around 1° of longitude per month relative to System I. The speaker went on to explain that there were much faster currents called *jet streams* on the edges of the belts at the equator which moved at characteristic speeds of several degrees of longitude per day. These too had been observable by amateurs in some detail for many years, but spacecraft observations had revealed, by looking at the movements of subtle textures in the clouds, that there was a smooth transition in rotation speed with latitude between these jet streams and the neighbouring belts, which amateur observations had not had sufficient angular or time resolution to record prior to 2008.

Dr Rogers explained that it was interesting that the first amateur observations of this zonal wind profile, made by a wide range of imagers and then collated and analysed by the *JUPOS* project over the course of 2008, agreed well with older data taken *in situ* by *Voyager* and *Cassini*. He explained that this might not have been expected, given that the planet had undergone a *global upheaval* in 2007, and that substantial changes had been observed in the visual appearances of many of the belts at that time. Specifically, he remarked that during the global upheaval, the generation of many new vortices had been observed in several of the belts. The South Equatorial Band (SEB) had been observed to become very faint before undergoing a vigorous outburst of spots which appeared to have revived it. The Equitorial Zone (EZ) had darkened substantially from its previous pale colour, but had since cleared again. And the North Temperate Belt (NTB), which had been absent for several years prior to 2007, had undergone a vigorous outbreak of spots and revived. In view of these planet-wide changes, the speaker explained that the agreement of the jet speeds measured by amateurs in 2008 with previous data – with the single exception of the NTB whose speed did appear to have changed – was surprising, and appeared to reveal something significant about the nature of the global upheaval. It appeared to have been a purely meteorological phenomenon which had not affected the underlying pattern of the planet's jets and winds.

The speaker then turned to discuss in more detail the revival of the NTB which he had earlier alluded to; he

explained that this was normally the fastest jet stream on the planet. He explained that, in its normal state, a series of conspicuous vortices ran along it, from whose motion the speed of the jet could easily be estimated. These had been monitored extensively between the mid-1990s and 2002, revealing that the jet had maintained a roughly constant speed of 120-130 m/s relative to System III over that time period. In 2002, however, the vortices had disappeared, leaving only a few flecks with which the jet speed could be measured. Observations since that time had suggested that the jet stream had been steadily increasing in speed. The speaker explained that in 1990, following a similar disappearance of the vortices from the NTB, there had been an outbreak of very fast-moving spots in the jet, moving at speeds greatly in excess of those normally observed. There had in the past few years been some anticipation that a similar outbreak might be seen again.

He could now confirm that such an outbreak had indeed been seen during the global upheaval of 2007: great white plumes had been seen at an altitude much above the planet's normal visible surface, becoming the brightest features on its disk at any wavelength accessible to amateur observers, and moving at speeds of up to 13°/day relative to System II. Dr Rogers identified the observation of these plumes as the second milestone which amateur imagers had passed in Jupiter's 2008 apparition, and reported that recent professional attempts to model them suggested that they were clouds of water vapour which had emerged from a water layer deep beneath the planet's cloud level. These models went on to argue that the high speed of these plumes could only be explained by the presence of a permanent fast jet at this depth[1], and that in the coming months and years these plumes would disperse and the vortices which normally populated the NTB would reform. To date, amateur observations seemed to be in agreement with this analysis; they had recently revealed the formation of a deep orange belt, the formation of some subtle lozenges within it, and a slowing of the jet speed. If the belt did indeed revert to its pre-2002 behaviour as was now expected, this would represent the first continuous amateur observations of the increase and subsequent decrease in the jet's speed accompanying a complete cycle in its behaviour.

Finally, the speaker turned to discuss the merger of two red anticyclonic ovals in the southern hemisphere – the Great Red Spot (GRS) and a smaller red spot which had appeared at a similar latitude in 2008 and which had been dubbed the Baby Red Spot (BRS). The speaker added that the appearance of the BRS had been a highly exceptional event: the appearance of new red spots on Jupiter was very rare and that only a handful had ever been observed. Whilst it was well established that such spots were anticyclonic circulations, the exact reason for their red colour remained unclear. Empirically, though, it appeared that red spots were those which were unusually vigorous and deep-rooted as compared to other circulations. The speaker added that the precise origin of the BRS was somewhat unclear, since it had formed during Jupiter's solar conjunction of 2007-8 and its birth had been largely unobserved.

Returning to the story of the end of the BRS's life, the speaker explained that on 2008 June 30 the spot had approached the following edge of the GRS, and had subsequently been squeezed through a vanishingly narrow current between the southern edge of the GRS and the northern edge of Oval BA, which had happened to lie due south of the GRS at this time. At the time, there had been much speculation as to whether the BRS would be torn apart during this passage, or whether its deep rooting would be sufficient to ensure its survival. The speaker explained that in the event, it had reappeared a few days later on the leading edge of the GRS, appearing coherent but highly deformed. A white track, however, had also become apparent, connecting at one end to the emergent BRS, and which could be followed around a full 360° path around the rim of the GRS. The speaker favoured the interpretation that this track represented material which had been torn from the BRS by the GRS. Within a few days, the main part of the BRS's circulation had apparently been drawn back into the GRS and entirely swallowed, and so it appeared that it had been entirely torn apart over the course of two encounters with the GRS. The speaker noted that amateurs had never before seen the merger of two red spots on Jupiter, and so these observations were the third milestone which he identified in amateur observations of Jupiter's 2008 apparition.

The speaker closed his talk by showing video compilations of the amateur observations discussed earlier in his talk. Following the applause, the President invited Mr David Arditti to present Sky Notes.

The January Sky

Mr Arditti opened with a review of the circumstances of the solar system bodies. He reported that the Sun remained quiet and continued to show very little sunspot activity, but that some prominences could still be observed on the solar limb in Hα. Of the planets, he reported that Venus and Saturn would be well placed for observation in the coming month, but that Mercury, Mars and Jupiter were not currently observable. He added that whilst it might still be possible to catch Uranus in evening twilight, its present apparition was near its end.

Turning first to Venus, Mr Arditti explained that it presently appeared as a brilliant object in the evening sky and continued to brighten; it would attain a maximum brightness of mag. –4.6 on February 19. He added that as it was presently getting nearer to the Earth, its disk was growing in size – this explained why it was getting brighter – but that the phase of the illumination of its disk was also waning to a crescent. He remarked that whilst the illuminated portion of Venus' disk showed notoriously little detail to the visual observer on account of the thick layers of cloud that enshrouded the planet's surface, some planetary imagers had recently been experimenting in imaging the night side of its disk. By using CCD cameras with near-infrared filters operating at around 1000 nm, some had reported being able to see some clear morphological features on this unilluminated portion of its disk. These were often

found to correlate well with surface maps compiled from observations made by the *Venus Express* spacecraft, suggesting that these observers had, for the first time, successfully made amateur observations of the planet's surface. It seemed likely that this infrared band happened to coincide with a wavelength window where the Venusian clouds were at least partially transparent, and that the surface of the planet was hot enough to glow thermally at these wavelengths, though it had to be conceded that the correspondence of the morphological features in the amateur images with those present in *Venus Express* observations was not perfect. It consequently seemed likely that at least some of features apparent in the amateur images were actually of atmospheric origin.

The speaker also commented upon the 200-year-old speculation that the planet's night side could be observed to faintly glow – a phenomenon termed the *Ashen Light*. This effect was exceptionally difficult to observe due to the glare of the nearby illuminated portion of the disk, to the extent that its existence remained controversial to this day, but it had nonetheless been reported very widely by visual observers. To date, no photographic observations had ever been made of it, and the speaker posed this as a challenge to the audience.

The speaker then turned to the Moon, which he explained had passed New Moon two days previously on January 26, would reach Full Moon on February 9, and would reach New Moon again on February 25. On February 4 it would occult the Pleiades between 2h15 and 4h30 UT, though the circumstances were not favourable for observation from the UK since the Moon would be at an altitude of only 7° at the start of the occultation, and would set before its conclusion. The brightest star to be occulted by the Moon in the coming month would be ε-Gem (mag. 3), which would disappear behind the Moon at 19h25 UT on February 6 and reappear at 20h30 UT; at this time, the Moon would be 89%-sunlit and at an altitude of 50° in the UK sky. Finally, the speaker briefly mentioned that in the early morning sky of January 30, the Moon would pass within 1.5° of Venus, forming a photogenic pair.

Mr Arditti reported that Saturn's rings continued to present themselves in an edge-on orientation, as had been discussed in previous Sky Notes talks. He added that they had opened out a little in the past few months, from 1° inclination in December to 2° presently, and that it was now just about possible to resolve the Cassini division. They would, however, narrow again later in its apparition and eventually close completely in August, though this ring-plane crossing would itself not be observable owing to Saturn's proximity to the Sun at the time; it would be only a few weeks away from reaching conjunction on September 17.

Several minor planets were well placed for observation from the UK at present, including 2 Pallas, at mag. 8.2 in Eridanus, and 27 Euterpe, at mag. 9.0 in Cancer, close to the Praesepe Cluster (M44). Early in the evening, 4 Vesta could be found at mag. 8.0 in Cetus, and later in the night, 1 Ceres, could be found at mag 7.4 in Leo.

The principal comet of interest over the next few weeks would be Comet C/2007 N3 (Lulin), which was currently a mag. 6-7 object in Libra. Though it did not rise until the pre-dawn hours at present, it was rapidly moving westward and brightening; it was forecast to pass close by Spica on February 16, and then pass M44 on March 5-6. If it continued to brighten as expected, it was predicted to reach around mag. 4 in late February, becoming an easy binocular target in the UK sky.

The speaker identified ζ-Aur as a variable star to watch over coming months; this was an eclipsing binary whose next eclipse was forecast to begin early in March. The ingress and egress of this eclipse would each take 1.5 days, during which time the star's magnitude would change modestly but detectably from 4.0 to 3.7 in the V-band. Totality was expected to last for 37 days. The speaker also went on to urge members to observe the Variable Star Section's Variable Star of the Year, IP Pegasi, about which more details could be found in the Association's *Handbook* for 2009.

Turning lastly to the deep sky, Mr Arditti extended warm congratulations to Mr Ron Arbour upon the discovery of his 20th supernova, 2009M, on January 20 in NGC 1028 in Cetus. He then gave a brief review of the open clusters which were accessible in the winter sky. At present, the three famous clusters in Auriga, M36, M37 and M38 were all at high latitudes and relatively easy targets in the UK evening sky. However, he added that M46, M47, M48 and M50 were more challenging and not often observed from the UK on account of their southerly declinations; he closed his talk by showing some sketches of these clusters by Dale Holt.

Following the applause, the President adjourned the meeting until Wednesday March 31.

Dominic Ford

References

[1] Sánchez-Lavega *et al.*, *Nature*, **451**, 437 (2008)