Ordinary Meeting, 2003 January 4
held at the St Bride Institute, Fleet Street, London EC4Y

Guy Hurst, President

Ron Johnson, Nick Hewitt and Nick James, Secretaries

The President opened the 3rd Ordinary Meeting of the 113th session, and invited Dr Hewitt to read the minutes of the previous meeting, which were approved by the members present. Mr Johnson stated that no presents had been received. The election of 15 new members was proposed, and the 16 members proposed at the previous meeting were elected. The President invited any new members who he had not already met to introduce themselves after the talks. Mr James announced that one paper had been approved by Council for the Journal:

Lancaster Astronomical and Scientific Association by Peter Wade

Mr Hurst pointed out that the meeting was the first to be held at the St Bride Institute, and requested feedback with regard to its suitability as a venue for Ordinary Meetings. He then advertised an exhibition organised by John Alcock, brother of George Alcock, which would take place at Priestgate in Peterborough until the end of January. The Association would be supporting Astrofest on February 7, and would have a stall. The next meeting would be on February 15 at the Institute of Astronomy in Cambridge, and this would be the first of the Association's observing workshops. It would be free to members and non-members alike, and the President recommended the meeting to all, hoping it would be of use to observers ranging from beginners to the experienced. The arrangements for the meeting were experimental, and support was requested.

The President then proceeded to introduce the afternoon's first speaker, Prof Joseph Silk. He currently held the Savilian Chair of Astronomy at the University of Oxford, but during his distinguished career had previously held numerous other chairs around the world.

The Big Bang

The speaker suggested the subheading "The Creation of the Universe" for his talk, and explained that he would be presenting evidence that the cosmos had begun in a dense hot fireball that had later cooled as time progressed. He would also be arguing that it was likely to continue expanding forever.

Such an idea had first been proposed shortly after Friedmann's discovery in 1923 that Einstein's equations of general relativity had a solution which was an expanding, non-static universe. Curiously, Einstein himself had overlooked this possibility, mainly on philosophical grounds. The same solution was later found independently by Lemaître in 1927. Observational support for the physicality of this solution came famously in 1929, when Edwin Hubble published his redshift data, providing direct observation of expansion.

Hubble's work had revolved around accurately measuring the recession velocities of distant galaxies, and he found that this velocity was proportional to the distance of the objects. A second profound, but often neglected, feature of Hubble's data was that the universe appeared isotropic, or the same in every direction. This was also manifest in the expansion law that Hubble found, since linear recession laws are the only possible modes of expansion which preserve the shapes of groups of commoving galaxies as they grow apart.

With hindsight, the speaker believed only one of Hubble's original data points was accurate, and it seemed surprising that he had successfully arrived at the conclusion he did, based on such unreliable data. Recent advances, however, had allowed the expansion law to be tested to much greater distances than Hubble had achieved. A particularly profound consequence of Hubble's observation was that it suggested a finite beginning to the universe. Extrapolating the observed expansion back in time, we find that at time H_0^{-1}, the entire universe coincided at a single point. Currently, we believe this time to have been 15 billion years ago, and it is the event now known as the Big Bang.

Following Hubble's work, there had been little development in the field until 1949, when George Gamow demonstrated that the observed abundance of helium (≈20%) within stars could not be accounted for purely by fusion events within them. Such mechanisms could only account for an He abundance <5%. Gamow proposed that a more viable theory was that the helium had originated in the hot early universe. This was the first evidence that the universe had had a hot beginning. The present-day ratio of hydrogen and deuteron abundances could be used to infer the density of this early phase.

The next significant development had come in 1964, when Penzias and Wilson stumbled serendipitously upon the Cosmic Microwave Background Radiation (CMBR). This had previously been predicted by the Big Bang model, though Penzias and Wilson did not realise it at the time. It represents a fingerprint of the structure of the universe at an age of 500,000 years, when it was at a temperature of 4000K. Before this time, known as the epoch of last scattering, the universe had been highly opaque. At the time of last scattering, neutral atoms were formed, and for the first time photons could travel without scattering from them. As the universe expanded after recombination, this fossil radiation underwent a stretch in wavelength, bringing the radiation primarily into the microwave region. The spectrum of this radiation, as measured by the COBE satellite, and published in 1992, showed stunning correlation to that of a blackbody. This data implied that the early universe was very close to thermal equilibrium, and indeed very much closer than any other physical system ever measured. In the time since recombination, wavelength stretching had cooled this blackbody spectrum from 4000K to 2.73K today.

Prof Silk moved on to discuss techniques for dating the universe, pointing out that prior to the Big Bang theory this question had been left by science to the realm of mysticism. One of the best estimates of the pre-Big-Bang-theory era was that of Bishop Ussher, who had predicted in the 17th century from the Bible that the world had been created on Sunday 23rd October 4004 BC at 10.30am. Thankfully, the modern techniques were believed to be more reliable, and currently three methods for estimating the age were in good agreement. Radioactive dating from the observed ratios of ^{238}U and ^{205}Pb abundances yielded an age of 4 billion years, while stellar evolution models suggested an age closer to 12 billion years, and the Hubble expansion an age of 15 billion years. A significant difficulty in predicting the age from the observed Hubble expansion was selecting between various accelerating and decelerating models of the expanding universe. Currently a flat, or critical density, picture was favoured.

The speaker confidently asserted that our current understanding of general relativity was likely to give us an accurate model of physics back to 10^{-43} seconds after the Big Bang. Before such a time, we would need a complete theory of quantum gravity to understand the laws which would have governed the universe. There were indications that an extra ingredient might be needed in a complete theory of the evolution of the expansion at much later times, however, and this arose from the observed uniformity of the CMBR. General Relativity suggested that photons within the CMBR arriving at the Earth at angular separations of more than a degree or so would have had no causal contact after the Big Bang prior to recombination. This meant that there was no possibility of information transfer between the photons – any such signal would have to travel faster than light, and it seemed impossible for the photons to have reached any form of equilibrium. The observed uniformity of the CMBR had become enigmatic, and led to the proposal of so-called inflationary expansion theories. Such theories featured a rapid period of accelerated expansion 10^{-35} seconds after the big bang, fuelled by energy from a phase change in the fabric of spacetime. This inflationary period would have the effect of smoothing out ripples in the universe.

Small fluctuations within the CMBR had been highly influential on our understanding of cosmology, following the initial observation of such variation by the COBE satellite in 1992. The fluctuations had a characteristic length scale of $\approx 1^{\circ}$, and an amplitude of 1 part in 10^5. The fluctuations represented the seeds which later led to structures such as galaxies. Prof Silk believed that the characteristic angular scale might be explained by the lack of causal contact between photons at angular scales larger than a degree between inflation and recombination. The particle horizon of photons in the CMBR, that is the most distant objects which would have had time to act on them, was also a length scale of around a degree in a flat universe. It would take different values in non-flat universes, since light travels in curved paths in curved spaces. Hence the observed length scale of the CMBR provided further evidence for flatness.

Prof Silk proceeded to discuss a mapping of four million galaxies projected onto the southern sky. The mapping confirmed earlier speculation that the distribution of galaxies in the sky is uniform. An apparent reduction in the numbers of galaxies at large redshifts was attributed to our inability to observe the fainter galaxies at these distances. The distribution of galaxies was not uniform, but showed a number of voids and dense regions. Importantly, the calculated mass of these galaxies was not enough to account for a flat universe, and suggested that the gravitational binding forces would not be enough to halt the current expansion. This was clear evidence for the existence of dark matter and dark energy adding to the total gravitating mass in the universe.

The speaker discussed a number of computational models which aimed to simulate the formation of structures such as galaxies. These worked on a simple “billiard-ball” principle, and started with a distribution of masses with a minute perturbation from uniformity. As time progressed, the distribution was observed to become highly non-uniform, and large clumps and filaments formed. However, the speaker showed images of the Sombrero and Andromeda galaxies, and pointed out that the real-life structures had a much greater richness than the simulated ones. He believed that computational power was the only barrier which limited the range of features seen in the simulations, and thought that with time they would achieve greater complexity by the use of physics which was already established. Recently, the formation of spiral arms had been simulated by considering the collision of two galaxies, and studying the evolution of streaks of material thrown out from the core in such events.

It had been claimed that by taking a cluster out of a large-scale simulation, zooming by a factor of 100, and then repeating the simulation, the formation of stars of around a hundred solar masses had been observed in simulation. It was now understood that the first generation of stars would have been very massive, since they formed from gas with low heavy element abundances, and such gas would have cooled significantly more slowly than the material from which later stars formed. Such theories were experimentally supported by the observation that the abundances of even-numbered elements were significantly greater than those of odd-numbered elements. This was a key prediction of nuclear formation models.

Prof Silk explained that evidence had recently emerged that the Hubble expansion law broke down at large distances. The use of type Ia supernovae as standard candles had shown a luminosity deficit in the most distant events, suggesting them to be more distant than their redshifts indicated by the Hubble law. This deviation from linear expansion suggested the universe to be accelerating under the force of a non-zero cosmological constant, and supported the view that the universe would not recollapse in a “Big Crunch”. However, the speaker warned that the universe was to become very dull in the distant future as star formation would come to a halt and everything would decay into a cold soup.

The speaker closed on a more speculative note, discussing black holes and worm holes, both of which were named by John Wheeler. Whereas the former had been experimentally observed, the latter remained speculative. Black holes are regions of very highly curved space around massive objects, while worm holes present the possibility of travelling instantaneously to another place in space and time. It was speculated that we might one day be able to make such an object artificially, since quantum mechanics predicts that they should momentarily exist everywhere in a so-called "virtual" state. The artificial creation of such an object would require us to convert such a "virtual" worm hole into a real one. This presented questions as to whether there were more advanced civilisations elsewhere in the universe who already possessed such technology, and whether they might visit us. However, the concept of time travel presented the famous "matricide paradox": what would happen if you were to murder your own mother before you had been conceived? An unsatisfactory answer to this paradox was that if you had no control as to where your worm hole took you, the universe would be sufficiently large that you would find it difficult to find her.

In response to a question with regard to the use of type Ia supernovae as standard candles, Prof Silk explained that around 20% accuracy was required in the measurements to provide evidence for a non-zero cosmological constant. He believed that despite a number of uncertainties, this level of accuracy had been obtained.

After prolonged applause, the President thanked Prof Silk for his thought provoking talk. The meeting then broke for tea, after which Mr Martin Mobberley was invited to deliver his Sky Notes:

The January Sky

Mr Mobberley opened with a summary of the events of the past year: there had been 38 comet discoveries, and over 300 supernovae, including 5 galactic events. Of the comet discoveries, LINEAR had taken a firm hold with 20 discoveries, compared to 8 by NEAT. Five comets had been found by amateurs. The speaker commented on the contrast with 2001, when LINEAR and NEAT had been neck-and-neck with numbers of comet discoveries. The greatest of the supernovae was undoubtedly 2002ap, discovered by Hirose on January 29, which had been classed as hypernova. BAA members Tom Boles and Mark Armstrong had made 11 and 6 discoveries respectively.

The speaker gave some background to the observations in his report with a slideshow of the observatories of the members whose observations he would be showing. These included Ed Grafton, who the speaker believed to be the world's greatest planetary imager. Damian Peach had recently moved from northern Tenerife to a new observing site to the south of the island. This was perched on a balcony above a nightclub! Mr Peach's images of Saturn continued to show a small SPC, with greenish tint around it. There was also a steel grey tint to the A Ring. Both Peach and Grafton had resolved 3-4 pale spots on the surface of Saturn in the past month, each one persisting for a few days. These were around half a second of arc in diameter and hence it would not have been possible to resolve such objects prior to the CCD era. Images by the HST were of one of the same spots that Grafton had noted, and confirmed his observations.

Moving onto Jupiter, ovals A2 and A3 in the South South Temperate Belt (SSTB) had been of recent interest. It appeared that they were moving closer together, squashing the material between them, which included a cyclonic white oval. There was interest as to whether they might eventually merge. Looking back to data from earlier in the year, it was unclear as to whether the white oval currently labelled A2 was the same oval that featured in the earlier observations, or whether that oval had been subsumed into A3 and a new oval formed in its place.

The North Temperate Belt (NTB) was not clearly visible in the wake of the Great Red Spot (GRS). This fading had been anticipated as it follows a ten-year cycle, although on this occasion had not recurred for over 12 years. A comparison of images from October 22 and December 7 showed a marked contrast in the NTB colour. The GRS itself had acquired a dirty appearance, with a dark rim. On December 21, Peach had imaged a dark spot close to the rim, and this appeared in Grafton's December 22 images as a doughnut shape. Damian Peach had continued his search for the Ashen Lights of Venus, but despite very sophisticated image processing his latest images remained negative.

On the comet front, Comet 2002X5 (Kudo-Fujikawa) presented exciting prospects in the early evening sky until mid-January. Discovered on December 14, it was anticipated to reach perihelion on January 27 at around mag 0. It would not be observable after January 19, however, when it would be mag 3. It would reappear in March at mag 8 as a binocular object. 2002Y1 (Juels-Holvorcem) would brighten from mag 15 to mag 13 whilst passing through Bootes in the latter half of January. 2002RX14 was presently around mag 11, but was showing a spectacular tail even at 2 a.u. On December 14, this comet had provided a good photo opportunity as it had passed close by NGC3726. 2002V1 was currently passing through Pegasus, and would reach mag 10 by February. Estimates for its magnitude at perihelion on February 18 ranged from 2 to –15, making it a comet worth watching. 154P/Brewington would brighten to mag 12 by Januiary 21 and mag 11 by February 10. It was currently in Aquila.

Recent supernova discoveries included Ron Arbour's seventh, 2002jy, on December 17 in NGC477; and Tom Boles' 30th, 2002jn, on December 9 in UGC11523. The total solar eclipse of December 4 had been clouded out for African observers, but many BAA members had enjoyed good weather during the 26 seconds of totality in Australia.

The occultation of a mag 7.73 star (TYC 0231-00063-1) by minor planet 441 Bathilde would be visible across southern England on January 11, and would be scientifically interesting. When 345 Tercidini had recently occulted a mag 5.5 star on

September 17, a tremendous number of observers had submitted timings, which allowed 55 chords to be placed across the minor object. This gave superb measurement of the shape of the object. On January 8, YY Piscium (mag 4.4) would graze the darkened part of the six-day old moon. In Exeter, a graze would be observed, while in London a near miss was anticipated.

The speaker commented that some spectacular events were anticipated involving the moons of Jupiter. These events would be enhanced as a result of the ability of the moons to totally eclipse one another. On January 10, Europa and Io would simultaneously cast shadows onto the Jovian surface. At 21:10UT, the shadow of Io would overtake that of Europa, with an annular eclipse of Io to a maximum of 74% for 254 seconds. The whole eclipse would last from 20:54UT to 21:23UT.

This could be seen as a warm up for an even more spectacular event on January 17/18. On this occasion, Europa would first eclipse Io from 19:25UT until 20:16UT (low in the eastern sky). At this time, Callisto would also be casting a shadow onto the Jovian surface, with the shadow leaving the surface at 21:52UT. Io's shadow would pass onto the surface at 22:31UT, with Callisto still in transit. Io itself would enter transit at 22:54UT. This would be closely followed by the shadow of Europa, appearing on the face of Jupiter at 23:05UT. Finally, Europa itself would enter transit at 23:52UT, while simultaneously Io's shadow would pass under Callisto. At this time, there would be five objects on the surface of Jupiter – surely a once in a lifetime occurrence. Additionally, a mag 9.2 star (GSC 14011341) would pass behind Jupiter for 2.5 hours, also at 23:52UT. Io's shadow would leave the surface at 00:48UT. Then, from 00:51UT until 01:05UT, Io would pass under Callisto and be occulted by it. Away from the Jovian surface, Europa would later pass under Callisto from 04:50UT until 05:12UT.

To close, the speaker recommended observation of a close pass of 4 Vesta (mag 7.1) within 20 arc-seconds to the south of δ-Vir (mag 3.4). Following the applause for Mr Mobberley's lively and informative report, the President welcomed the afternoon's final speaker, Mr Peter Hingley, librarian of the Royal Astronomical Society.

Astronomers and Oddities

Mr Hingley expressed his privilege at having been invited to address the Association for the first time. He explained that the RAS library placed great emphasis on keeping items of great obscurity and rarity, rather than items such as Newton's Principia, which are found in a great many other academic libraries. Its archive included the original photographic plate of an astrophotograph of the 1882 comet. This plate marked the start of astrophotography as we know it today. The library had been used on a great number of occasions in tracing early observations. For example, one observer had predicted an event similar to the collision of comet Shoemaker-Levy 9 with Jupiter in 1994, based on historical archives in the library. More recently, the archives had been used by the Beagle 2 team to assist them with Martian landing site selection.

The RAS had been conceived by a group of 14 astronomers in the Freemason's Tavern, Lincoln's Inn Fields, London on 1820 January 12. This had been against a background of great opposition from the influential Sir Joseph Banks, then life President of the Royal Society. He was concerned, perhaps rightly, that the formation of the RAS would leave the RS with no unique ground of its own. This concern had also led him to oppose the foundation of the Royal Institution in 1799. The Duke of Somerset had previously pledged to be the first President of the new Astronomical Society, but withdrew his offer when he heard of Banks' opposition. This problem was eventually overcome when William Herschel agreed to be the first President, despite his initial refusal on the grounds of his age. Herschel served as the first President, though he never chaired a meeting. In 1831, the Society was granted a Royal Charter by William IV on March 7, and then became known as the Royal Astronomical Society.

Mr Hingley explained that from 1834, the government had made free accommodation available to the RAS in Somerset House, on the Strand. In 1874, the Society had moved to its present location in New Burlington House, having previously refused an offer from the government of accommodation in Kensington, on the grounds that this was a distant suburb of the city at that time.

The Society continued to hold a large archive of Herschel's work. This had been stored at Churchill College, Cambridge, but had recently been moved to Burlington House to make space for the Thatcher collection at the College. Included in this collection was Herschel's famous star count map of the universe, sometimes known as the "amoeba model", which showed a reasonable approximation to the shape of the Milky Way. In fact, many of the assumptions made in constructing this model were incorrect.

The speaker described the current activities of the RAS as including the publication of a number of journals, most notably the Monthly Notices, which was one of the "big five" journals in astrophysics. Astronomy and Astrophysics was a more recent venture, with a more glossy approach. Generally, this new publication was considered to have been a success. The Observatory was not produced by the RAS, but had always been published in close collaboration with the Society. It was intended to publish more speculative subject matter.

The Gold Medal of the Society was intended to reward those who had made significant advances in the field, and was first awarded to Charles Babbage. It is often forgotten that the pioneer of the computer was a close acquaintance of John Herschel, who dreamt that a steam-operated machine might replace his tiresome calculation tables. It was Babbage who provided the realisation of this dream.

Mr Hingley explained that much of the library's stock dated from the 19th century. At this stage the RAS had been a young Society, and made a purchasing drive to stock its library. Generally, it had a superb collection of articles relating to people and instruments, but less actually relating to the sky. The collection of Presidential portraits was surely a superb historical record. The library included around 4000 rare pre-1850 items, including a number of star atlases from the 1800s. A personal favourite of the speaker was a first edition copy of Copernicus' 1543 *Rotating Celestrial Spheres*.

The treasures of the library included the archives of the Spitalfield Society – a group of gentlemen who met to discuss mathematical problems. When this Society closed, it was subsumed into the RAS and the archives retained. Tragically, many annotated copies of books from Spitalfield were discarded in favour of clean copies, which is an example of how attitudes have changed in the last century. Furthermore, the minutes of the Society had also been lost without trace. The librarian personally believed they had been lent to University College London and lost during the blitz.

The speaker had often heard the criticism made that the RAS was a highly reactionary organisation, but pointed out that it had been selling large astrophotographic prints from as early as 1870. This move was surely a very revolutionary step at that time, and most certainly not reactionary. Finally, the speaker discussed some of the more bizarre enquiries he had received as librarian, which included one forwarded by BAA Assistant Secretary Eddie Watson-Jones: "What is known about the unknown?" A number of astrologers had also approached him over the years with various concerns.

In response to a question, Mr Hingley said that the RAS library would be very willing to answer inquiries from any BAA member, whether an RAS member or not. However, readers would be expected to join the RAS if they intended to make prolonged use of the library. He issued a stern warning to any astrologers contemplating approaching him, however!

The President thanked Mr Hingley for his excellent and unusual talk, before adjourning the meeting until Saturday February 15 at the Institute of Astronomy, Cambridge.

Dominic Ford