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A REVIEW OF ASTRONOMY

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MEETING OF THE ROYAL ASTRONOMICAL SOCIETY

Friday 2007 May 11th at $16^h\,00^m$
in the Geological Society Lecture Theatre, Burlington House

M. Rowan-Robinson, *President*
in the Chair

The President. I have to announce the death of an Associate of the Society, Dr. Bohdan Paczyński of the Institute of Astronomy, Polish Academy of Sciences, Warsaw. Dr. Paczyński died on 2007 April 19. He was awarded the Eddington Medal in 1987 and the Gold Medal of the Society in 1999. He was made an Associate of the Society on 1977 February 11. I also have to announce the death of Virpi Niemela on 2006 December 18, just ten days after being elected an Associate of the Society. I'd like to ask you all to stand. Thank you very much.

It's my pleasure to present the award of the 2007 Price Medal to Professor Andrew Jackson. Andrew Jackson is awarded the Price Medal for his outstanding contribution to geomagnetism, particularly by compiling historical geomagnetic-field observations from the last 400 years and for his compelling work on interpreting the geomagnetic secular variation. His work is characterized by intellectual rigour, whether that be searching all possible archives for the data, analysing those data, paying careful attention to the causes of uncertainty and how they should be treated, interpreting results, or undertaking theoretical developments. His thorough search of the archives and follow-up work has unearthed more than 8000 new observations from the 17th Century alone; his new model runs for four centuries from 1590. The greater part of his new data set originates from mariners engaged in merchant and naval shipping, and the observations are taken from the original ships' logs. His modelling strategy builds in navigational uncertainties, particularly in longitude prior to Harrison's invention of a clock suitable for use at sea. His resulting historical field model is widely used throughout the geomagnetic and palaeomagnetic community. He has also devoted significant amounts of time to community service, notably membership of the team that led to ESA adopting the *SWARM* mission to measure the Earth's magnetic field through a constellation of low-orbit satellites, due for launch in 2009, and media and public-understanding-of-science work where he uses people's interests in navigation and the early explorers to show how magnetic data can further our understanding of the generation of the Earth's magnetic field. [Applause.]

Now we move to the programme, and the first talk will be by Dr. Chris Lintott from Oxford University, talking about 'Astrochemistry beyond the Milky Way.'

Dr. C. J. Lintott. [No summary was received at the time of going to press. The speaker emphasized the importance of chemistry as an astrophysical tool for understanding complex systems such as galaxies, and how a knowledge of chemical molecular abundances in the Milky Way and other galaxies can provide a great deal of information on the processes associated with cloud collapse and star formation.

The example of the Milky Way star-forming region S255 was used to show how the application of chemical models can shed light on cloud collapse. In this object, the observed distribution of CS and N_2H^+ emission is markedly different: the CS emission shows two peaks centred on two star-forming clumps seen in the submillimetre continuum, while the N_2H^+ emission matches only one. The speaker explained how it was possible to model the variation in relative abundances of the two species by changing the rate of collapse of the cloud: such accelerated collapse could be triggered by a shock, for example, in the dynamically active environment of high-mass star formation. The model shows that if the cloud collapses twice as fast as the free-fall rate, the higher density reached at earlier times promotes reactions which produce CS while N_2H^+ is destroyed, changing the contrast in the CS/N_2H^+ ratio by an order of magnitude. These models can be tested further by predicting the abundances of other molecules in these environments.

Moving on to star formation in other galaxies, the speaker described how observations of local starburst galaxies show a very similar chemical mix of molecules — HCN, ammonia, methanol, water, *etc.* — to that found in Milky Way star-forming regions. Models of photon-dominated regions can account for most of the chemistry seen in starburst galaxies such as M82; but a 'hot core' chemistry is also required to explain the molecular abundances seen in many galaxies. During cloud collapse, many gas-phase molecules 'freeze out' onto the surfaces of interstellar dust grains, and complex species may be built up by further chemical processing on the grain surface. The grains become heated once the young star begins to radiate, and the molecular mix is returned to the gas phase. The rich chemical variety observed in these hot cores therefore reflects the history of the cloud, and their chemical state is quite distinctive of regions around recently-formed stars. The presence of methanol is a key signature of hot-core chemistry: methanol is destroyed rapidly in the interstellar radiation field, so a large abundance of methanol likely indicates its grain-assisted formation and shielding within dense clouds around young stars.

Finally, the speaker remarked on how the infrared luminosity of star-forming regions appears to be very well correlated with the luminosity of hot-core molecular lines such as HCN — and that this relation appears to hold up over ten orders of magnitude in luminosity, from Milky Way star-forming regions up to galaxies at redshifts of about 3. However, in higher-redshift sources, the HCN luminosity is found to be somewhat lower than expected from this relation. The speaker argued that this drop in HCN luminosity may be due to nitrogen abundances in those systems being deficient relative to solar; also, one must probably take account of other factors, such as the effect of a black hole at the centre of the galaxy.]

The President. I have a question: you have this very tight correlation between star-formation rate and luminosity in HCN. What is the interpretation of that? I recall a very similar plot involving CO instead of HCN and there the interpretation is the time scale of the starburst.

Dr. Lintott. Yes, it's a similar sort of logic, which is that the infrared luminosity traces the star-formation rate because hot stars heat the dust, which then radiates in the infrared. The reason why HCN reflects the amount of dense gas is that the transitions we are observing are excited by collisions and you need a critical density of about 10^5 molecules per cubic centimetre to excite the HCN, so only that dense gas will radiate in this line.

The President. So a line of constant slope really indicates star formation on a particular time-scale, because you've got star-formation rate vertically and mass horizontally?

Dr. Lintott. Yes, that's right.

The President. So is that a possible interpretation of the points off the line? It's a shorter time scale, certainly.

Dr. Lintott. It's possible. It depends on how long you think that the dense gas is around for, because this is really quite high density. You might only be picking up the time scale on which an individual clump forms a star, so you need to understand the dynamics and the turbulence in these regions before you can draw firm conclusions.

Dr. Lindsay Fletcher. Right at the beginning you showed a slide which was the effect of chemistry on collapse times — the accelerated collapse; could you briefly explain what is going on there to a non-chemist like me? Is it a phase transition or something?

Dr. Lintott. No, it's nothing that complicated. It's simply that these models all end up at the same final density, but if you speed up the collapse you reach that final density much quicker. At high density, reactions occur faster and that promotes the creation of some molecules and destroys others.

The President. Well, let's thank Chris again. [Applause.] Our next talk is by our 2007 Fowler Prize winner, Graham Smith of the University of Birmingham, and he is here to speak about 'Galaxy clusters as cosmological probes — the rôle of gravitational lensing.'

Dr. G. P. Smith. I'll begin by introducing galaxy clusters and gravitational lensing for the non-expert, and then say a few words about dark energy, by way of motivation. The main body of my talk will then address mass-observable cluster scaling relations, in the first place without the use of gravitational lensing to measure cluster mass, and then with the benefit of lensing. I'll then consider the implications of my results for cosmological experiments and discuss a new survey, LoCuSS, which aims to expand previous work tenfold.

Galaxy clusters are simply the most massive collapsed objects in the local Universe, the most extreme examples containing $\sim$ 1000 galaxies, hot ionized gas at $\sim$ 10 keV, and $\sim 10^{15}\, M_\odot$ of dark matter. Indeed, the dark matter dominates the gravitational potential of clusters. If we are to measure accurately the mass of galaxy clusters, we therefore need a tool to map reliably the distribution of dark matter.

Gravitational lensing, the deflection of light by mass, is the cleanest available tool for mapping dark matter in galaxy clusters. The signal, whether in the form of beautiful arcs and multiply-imaged galaxies, as seen in Abell 2218, for example, or the statistical signal on larger scales, is insensitive to the nature and physical state of the matter causing the deflection. Dark matter dominates the cluster mass distribution, and therefore lensing is a uniquely powerful probe of dark matter.

The existence of what is termed 'dark energy' was inferred from observations of Type-Ia supernovae in the late 1990s. These standard candles were measured to be fainter and thus further away from us than expected. Something (so-called dark energy) is pushing galaxies away from us, and each other. Using galaxy clusters to measure the dark energy is a class of experiment that probes the growth of structure in the Universe. The idea is to count clusters as a function of mass and redshift, and from that constrain the dark energy *via* its influence on how quickly mass has assembled into collapsed dark-matter structures, *i.e.*, galaxy clusters.

The key challenge is that cluster mass is not a directly observable quantity, and therefore scaling relations have been developed between mass and directly observable quantities such as the temperature and pressure of the X-ray gas in clusters. Reliable measurement of cluster mass and thus calibration of mass-observable scaling relations are therefore fundamental to robust cosmological constraints from clusters. As we'll see in a moment, this is where gravitational lensing has a key rôle to play.

First, a little history. Ten years ago Evrard, Metzler & Navarro, and Frenk *et al.* used hydrodynamical numerical simulations of dark matter and gas in galaxy clusters to study the cluster mass–temperature relation. A key prediction was that at a fixed temperature the scatter in mass is just 15%, *i.e.*, small enough to encourage the idea that X-ray temperature is a suitable surrogate for mass in cosmological experiments. In the ensuing decade, almost 100 papers have followed up this basic prediction, using X-ray observations of clusters to measure both cluster mass and temperature. In summary, the observations and theory agree on the scatter, although they agree less well on the normalization of the relation. These X-ray studies use the same X-ray photons and spectral analysis of those photons to measure both the temperature and (under the assumption of hydrostatic equilibrium) the mass of clusters. Mass and temperature are therefore intrinsically correlated in the X-ray studies, and an important question is the extent to which this might cause the scatter in the mass–temperature relation to be underestimated.

In the last two years the first results on the mass–temperature relation using an independent mass-measurement method — gravitational lensing — have been published. The first of these, from Smith *et al.* (2005), is based on a sample of ten massive clusters within a narrow redshift range at $z = 0{\cdot}21 \pm 0{\cdot}04$. The gravitational-lensing data come from the *Hubble Space Telescope* (*HST*), and the X-ray data were obtained from archival observations from the *Chandra* X-ray observatory. As one can see in the example of Abell 2219, many gravitational arcs were found in the *HST* observations. Follow-up spectroscopy, in this case with the *Subaru* 8-m telescope, provides redshifts of the arcs. The positions and redshifts of the arcs are then used to constrain parameterized models of the dark-matter distribution in the clusters and thus to measure the cluster masses.

This gravitational-lensing analysis revealed that just three of the ten clusters appear to have simple, apparently relaxed dark-matter distributions, as illustrated graphically by the smooth, almost circular, iso-mass contours and X-ray flux contours of, *e.g.*, Abell 383. In contrast, the other seven all showed evidence of being disturbed; most notably a multi-modal dark-matter distribution was required to fit the lensing constraints — *i.e.*, the disturbed clusters appear to be undergoing a cluster–cluster merger.

The mass–temperature plot for these clusters more closely resembles a scatter plot than a well-behaved scaling relation. The intrinsic scatter in mass at a fixed temperature is estimated to be $\sim 30\%$, *i.e.*, double the prediction and the results obtained from X-ray-only studies. However, more worrying is that the disturbed (merging) and undisturbed clusters are segregated in the mass–temperature plane. The disturbed (merging) clusters are 40% hotter than the undisturbed clusters at a fixed mass. With a sample of just ten clusters, the statistical significance of this result is inevitably modest, at just $2 \cdot 5\sigma$. Nevertheless, it has since been corroborated by independent analysis of similar samples.

So why should cluster cosmologists worry about these results? As a case study let's consider σ_8, the normalization of the matter power spectrum. Cluster cosmologists measure σ_8 by constructing the cluster temperature function (the number of clusters per unit volume per unit temperature interval, $dN/dV/dT$), and then use a mass–temperature scaling relation to convert the temperature function to a mass function ($dN/dV/dM$). The mass function then constrains a cosmological model, from which the best-fit value of σ_8 is calculated. In an *ApJ Letter* that I published in 2003, I showed that if the selection function of clusters used in the temperature function does not match the selection function of clusters upon which the mass–temperature scaling relation is based, then σ_8 is systematically over-estimated by 20%. In other words, if the mix of merging/non-merging clusters in the temperature function and mass–temperature scaling relation samples do not match statistically, then you introduce systematic errors into the σ_8 calculations. Similar issues will exist in cluster-based dark-energy experiments.

Given these results, and the few-per-cent precision targeted by dark-energy experiments, is there any hope for cluster cosmology? The answer to this is a definite 'yes'. Remember that the results that I've presented today are based on just ten clusters, and are of modest statistical significance. Gravitational-lensing-based cluster scaling relations are just beginning to have an impact on our understanding of clusters and their use as cosmological probes. Just five of the $\sim$ 100 papers on the mass–temperature relation in the last decade have used gravitational lensing.

New surveys of much larger samples of clusters are now starting, with the aim of investigating the issues raised today in much greater detail. The goal in the coming years is to learn how to control astrophysical systematics in cluster cosmology experiments. For example, I lead the Local Cluster Substructure Survey (LoCuSS), a survey of 100 clusters at $z \cong 0 \cdot 2$. We are gathering and analysing new data on this large sample of clusters with the *HST*, *Chandra*, and prominent ground-based observatories including the *W. M. Keck* and *Subaru* telescopes. LoCuSS also includes closer collaboration with theorists than previously, for example to generate mock datasets with which to model the uncertainties in our analysis. We have also begun collaborating with Sunyaev–Zel'dovich-effect (SZE) observers at the University of Chicago, aiming to explore the combination of gravitational lensing and SZE data for cluster cosmology. There are many reasons why this lensing–SZE route promises to be very fruitful ... but that is a subject for another talk.

So, with an eye on the clock and refreshments, I'll close by leaving you with some beautiful pictures of gravitational arcs in LoCuSS clusters recently observed by *HST*, and thank my many collaborators, without whom this work would not have been possible. [Applause.]

The President. Questions?

Dr. R. Trotta. Looking at the future prospects for cluster surveys such as the Dark Energy Survey (DES), these surveys will look at thousands of clusters. You have convinced us that it is difficult enough to study carefully those you have hand-picked. So if you want to do cosmology and dark-energy science with tens of thousands of clusters, what are the prospects that you can industrialize the process and study them on such a large scale?

Dr. Smith. That's a very good question. The key challenge will be to automate lens modelling of large numbers of clusters. Currently we select these clusters based on their X-ray luminosity — so we are not hand-picking them to be lensing clusters — and we get follow-up observations and then we make the models. The lens models are done 'by hand', as it were. The modelling process is becoming more automated now using Bayesian techniques like Markov Chain Monte Carlo algorithms, which are more efficient and robust in the exploration of the parameter space. But the next big challenge is that even with, say, 30–40 clusters, you can't do that on a PhD timescale or a timescale which will inform dark-energy surveys. So we are developing methods to automate the modelling within LoCuSS. The lessons that we will learn in LoCuSS will be directly transferable to surveys such as the DES, *LSST*, *SNAP*, *DUNE*, and all of these future lensing surveys.

Rev. G. Barber. Is there a handle on Ω_M and Ω_{baryon} that you can get from averaging out the results you are getting?

Dr. Smith. Well, I think the study of clusters provided among the first compelling evidence that Ω_M is of the order of 0·3. If you are referring specifically to the gravitional lensing, then strictly speaking, lensing gives you a constraint of the total mass along the whole line of sight. It's dominated by dark matter on most scales within the cluster. I haven't done the calculation but it would be relatively straightforward within a system where you've found the total mass to do that calculation.

The President. If you can get the baryons …

Dr. Smith. Most of the baryons are in the form of gas. You can make a direct measurement of the gas mass using X-ray data, but on very small scales the dominant baryonic component is the stars in the brightest cluster galaxy. I include a mass component in the lens models for the brightest cluster galaxies, but it's horribly degenerate with the dark matter, so you need very good data to break the degeneracy between the baryons and dark matter in the centre. But if one is interested on larger scales one can use the X-ray data and the lensing data to get a reasonable handle.

The President. Thank you very much. [Applause.] Our final talk today is the 2007 Harold Jeffreys Lecture, and it's given by Professor Alan Hood of the University of St. Andrews. The title is 'The Sun: a new dawn'.

Professor A. Hood. [It is expected that a summary of Professor Hood's talk will appear in a future issue of *Astronomy & Geophysics*.]

The President. Well, thank you for that wonderful lecture, and fascinating images of the Sun's magnetic field. I'm sure there are some questions.

Dr. G. Q. G. Stanley. With the greater complexity, you see more and more detail as you go on. Have you gone back to look at things like helioseismology, to try and improve on what you've seen, or has it modified that in any way?

Professor Hood. Helioseismology is telling us a lot more about the interior of the Sun; and what you need with the helioseismology is very good time resolution over a long period of time. If you want to understand the global properties of the Sun, you need to have uninterrupted observations that go on for years really to determine what's happening. The problem with the helioseismology from the Earth is that you will have data interruptions, just because your site happens to experience cloud or something like that; these data gaps are a real problem, whereas the continuous observations really help to pin things down.

Dr. F. Diego. Do the plasmoids play a rôle in heating the corona?

Professor Hood. No, I don't think the plasmoids themselves do. They tend to be slightly cooler material that is actually getting ejected out of the system, so my view would be that they are something akin to the coronal mass ejections that we actually see.

Professor N. O. Weiss. Do you think the small-scale fields that are being seen by *Hinode* are going to provide reconnection on a sufficient basis to heat the corona?

Professor Hood. Yes, I think so. When you actually look at all the motion of these sources you can estimate the Poynting flux into the corona, and it looks like it's sufficient.

Professor Weiss. At last.

Professor Hood. At last. So I think it is the magnetic carpet and it is the reconnection of these current sheets that have built up that is heating the corona. I stake my claim: my reputation ruined in a minute! [Laughter.]

Dr. N. Kollerstrom. It seems to me these wonderful moving images you've shown us are so important for presenting the case. Are we getting to a situation where you would prefer to write an account of things on the web where you can show this, rather than in print where you can't?

Professor Hood. Yes, I think you're right actually. I think the electronic journals should certainly take on board the movies. They do take on board the colour images that you can have in the on-line version of the journals, and certainly I encourage my PhD students to submit their thesis with a CD-ROM containing their movies.

The President. The way of the future, then ...

Professor P. G. Murdin. The way of the present, actually. *Monthly Notices* will accept things like movies. They won't be printed, but ... [laughter].

The President. Thank you very much for that wonderful lecture. [Applause.] I'm happy to say that there will be a drinks party today in the library outside, and those of you at the annual meeting will know that the contributions requested are £1 a head. There's been a discrepancy between the number of glasses of wine drunk and the number of contributions received [laughter], so please make sure you put your £1 voluntary donation in the box. The meeting will close, and the next monthly meeting will be on Friday, October 12, so have a very pleasant summer.

FUTURE PROFESSIONAL COMMUNICATION IN ASTRONOMY

History was quietly made at the Palace of the Academies in Brussels from 2007 June 10 to 13. For the first time, indeed, representatives of all major astronomy-related publishers and professional journals were gathered together to present their activities and projects for the future. The attendance included also editors, authors, officers of learned societies, archive managers, as well as several astronomy librarians (two of them from South Africa).

The colloquium, entitled 'Future Professional Communication in Astronomy' (FPCA[1]), was motivated by a convergence of facts and trends in the world of

[1] See detailed programme, list of participants, *etc.*, on http://vizier.u-strasbg.fr/~heck/fpca.htm and linked pages.

publishing, as well as by a number of complaints and interrogations heard more and more frequently within the professional astronomy community. The main themes of the meeting covered progress reports on electronic publishing, new business models, the rôle of learned societies in the changing context, the problematics of the more general communication processes between decision makers and society at large, *etc*.

After welcoming words by co-organizer and host Léo Houziaux[2], an introductory talk by the undersigned outlined the context of the meeting and reminded attendees of the historical background, starting, as far as publishing is concerned, with the first international meeting on electronic publishing held in Strasbourg in 1991 October[3] and from which originated many of today's realities and collaborations in the field. The series of volumes *Organizations and Strategies in Astronomy*[4] (*OSA*) had regularly reviewed the situation, as well as the evolution of more general communication processes — including novel issues such as hype and credibility. But gathering all key parties in the same room had now appeared a much needed step.

While emphasizing the necessary complementarity of media, Heck wondered about possible sociological limitations (among others, at the level of evaluation committees) responsible for the fact that we still mainly produce electronic versions of documents printable or otherwise available on paper instead of practising full electronic publishing for our verified knowledge. After introducing new publishing models and sketching possibly interfering new technologies, Heck also echoed criticisms and questions from the community in what he called "the complaint of the publishing astronomer" that he submitted for comments to the audience.

Kevin Marvel (AAS) presented the outlook for the journals of the American Astronomical Society in the near and far future. After many years at the University of Chicago Press, the AAS journals will move to IOP Publishing in 2008 (*AJ*) and 2009 (*ApJ, ApJLett, ApJS*). This transition is aimed at enhancing the functionality and value of the AAS journals for the astronomical community. The goal for the AAS journals in the future is to be more central in the day-to-day research life of astronomers while maintaining low cost to both subscribers and authors, plus high quality both on-line and in print.

Butler Burton (NRAO) discussed statistics related to *ApJ*, also comparing them with data from *AJ*, *MNRAS,* and *A&A*: numbers of papers published per year in those journals, characteristic numbers of pages per paper, characteristic numbers of authors per paper, *etc*. The statistics showed the current situation as well as trends during the period since 1990, with some lesser attention to the period since 1950. The characteristic page length for *ApJ* showed no evidence for a curtailment following the nominal 20-page limit; the lengths for both *ApJ* and *AJ* showed no curtailment that could be attributed to the direct page charges required from authors.

While stressing the society's emphasis on ethics in publishing, Paul Murdin (RAS) described, with examples from the RAS and *MNRAS*, the function of a scientific learned society as being to advance the science in a way that satisfies the interests of its members. The primary interest of these is to act as a group of peers who maintain the standards of the community in an organized way and to provide a framework which at the same time does this, but allows individual scientists to

[2] Permanent Secretary of the Royal Academy of Sciences, Letters and Fine Arts of Belgium.
[3] A. Heck (ed.), *Desktop Publishing in Astronomy & Space Sciences* (World Scientific, Singapore), 1992 (ISBN 981-02-0915-0).
[4] http://vizier.u-strasbg.fr/~heck/osabooks.htm.

act vigorously — regardless of their ability to pay. Murdin saw the balance to be struck in these ambitions as the essence of open access (OA).

David Nicholson (Wiley-Blackwell) reminded the meeting that learned journals remained an essential part of the scholarly communication process and that the choice of a journal is shaped by a variety of factors. Publishers working on behalf of learned societies not only provide sophisticated technical services, but also play a broader rôle in supporting the work of those societies by strategic advice. Interestingly, Nicholson had learned, the week before at a meeting of young astronomers in the UK, that most of them were getting their initial information and ideas from arXiv (ex-astro-ph) and from conferences.

After recalling that, over the past 15 years, internet technology had changed the ways of publishing tremendously, Harry (J. J.) Blom (Springer) warned that this revolution had not been completed and that all parties involved in science publishing are still continuously adjusting their activities to new rules and opportunities. From a commercial publisher's perspective, he extrapolated what could happen in the next few years with journal subscriptions, book publishing, marketing, production, and other steps in the publishing process.

David Clark (Elsevier) and Jean-Marc Quilbé (EDP Sciences) also presented the activities and future projects of their respective companies. Among the strongest market trends, Clark discussed the challenges presented to the current system by the dramatic increase in the submission of articles from countries such as China and India, and how Elsevier was approaching the various different types of open access.

That OA concept was defined by Stéphane Plaszczynski (LAL) as granting anyone, anywhere, and anytime, free access to the results of scientific research, in general through free availability of the electronic versions of scientific publications on the internet. Plaszczynski introduced, on behalf of the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP^3) Working Party, the model developed for open-access publishing in particle physics.

Michael J. Kurtz (ADS) reminded the audience that the Smithsonian/NASA Astrophysics Data System has been a leader in providing access to the information available in astronomy since its inception, in 1992. The ADS had as its basic precept 'Free access to metadata' and quickly added 'Free access to archival literature' — concepts responsible for much of the success of astronomy's digital library. From his statistics, Kurtz claimed that open access does not lead to higher citation rates — the correlation of *ApJ* citation rates with arXiv availability appearing to be more a matter of early access than of cost.

Terence J. Mahoney (IAC) concluded that open access, in its currently accepted form, should be studied with great care and with sufficient time before any consideration is given to its implementation. If forced on unwilling publishing and research communities, open access could well result in much more restricted access to research results. Mahoney noted that 41% of OA journals are revenue positive one way or another, 24% break even, and 35% are revenue negative.

Rudolf Albrecht (ST–ECF) examined the process of doing research and derived requirements for the interchange of scientific information, mapping them into existing and soon-to-be-available technology. By way of extrapolation, he identified possible improvements to the efficiency and the thoroughness of the research process. Albrecht proposed a pilot project involving some small, relatively new subfield (TNOs for instance) for which we would put all full-text letter-length papers into a database for full-text searching and pattern finding by computers.

Considering references in *A&A* and *ApJ* in decade intervals from 1952 to 2006, Helmut A. Abt (KPNO) showed that journal papers, preprints, and reviews are growing in the frequency in which they are cited, while observatory publications, private communications, theses, conference papers, and monographs are decreasing in cited frequency — the last two being surprising in view of the rapidly increasing numbers of conferences and monographs published annually. Abt concluded that sources of information that are readily available on-line are greatly preferred over sources that are not available on the internet.

A full FPCA session was devoted to astronomy communication with the outside world. Claus Madsen (ESO) shared his experience as a political lobbyist not only in the context of the multilingual and multicultural European mosaic, but also at the United Nations aiming at the recognition of 2009 as the International Year of Astronomy. Quoting his abstract: "From a communication view, political lobbying for science means targeted communication about a long-established, well-tested, fact-based and logically robust system of inquiry to a highly dynamic environment in which decision taking is influenced by many non-scientific factors and with norms that differ widely from the tenets of science."

Lars Lindberg Christensen (ESA/Hubble) and Pedro Russo (MPISSR) reminded the meeting that the communication of achieved results is now seen frequently as a natural and obligatory activity to inform the public and attract both funding and science students. They described how the recently established IAU Commission 55, 'Communicating Astronomy with the Public', seeks to alleviate these problems and to establish and support effective ways to communicate astronomy with the public in the long term — in particular *via* a peer-reviewed journal.

Lindberg Christensen subsequently gave a first-hand account of the events in the press room at the IAU General Assembly in Prague that was the setting of one of the most discussed stories in 2006: the controversial IAU resolution to define a planet. The resolution changed Pluto's status to a dwarf planet and resulted in an unprecedented emotional discussion. Lindberg Christensen reviewed the negative and positive outcomes of the so-called Pluto Affair, as well as the lessons learned from this experience.

Finally, an Editors' Forum and a Publishers' Forum, moderated, respectively, by Helmut A. Abt (KPNO) and Terence J. Mahoney (IAC), discussed matters of interest to these (definitely overlapping) fields of activities: open literature, censoring, refereeing and linked recognition, language problems, multiple authorship, composition and typesetting by authors, archiving in an electronic age, future rôle of libraries, financing models, *etc.* These fora are summarized in the proceedings[5].

Plenty of time had been left for discussions during the meeting and, in a digest of these, Mike A'Hearn (Univ. Maryland) reminded the audience of the widespread agreement that the biggest 'cost' of publishing is in the time of the scientists who write the papers and in the time of the scientists who referee the papers — costs never accounted for in the 'cost of publishing'. Some but not all publishers did in fact emphasize that their goal was to minimize the 'voluntary time' required from both authors and referees. Another widespread agreement was reached on the fact that, on a time scale of 5–10 years, we will probably be producing a large fraction of electronic-only journals with print on demand. FPCA attendees also agreed on the need to work together across all the relevant parties to

[5] The FPCA proceedings are published by the Royal Belgian Academy. See the web site (*cf.* footnote 1) for details.

devise a uniform, scientifically useful (*i.e.*, humanly memorable) method for citing e-only references in the age when pages, issues, and even volumes may become an obsolete concept. The Digital Object Identifier (DOI) is suited for electronically linking to e-only articles, but almost useless as a citation for the average reader, so the DOI is here to stay but won't become the preferred citation method except as a link, which might or might not appear in a printed-out version of the reference list from a paper. A big issue also identified in an all-electronic publishing context is still in deciding who is ultimately responsible for the long-term archive.

Follow-up meetings will definitely be necessary to discuss this question and to review the main themes tackled during the FPCA colloquium, as well as the acceptance (and success?) of the envisaged business models. The mutation of libraries, the evaluation of bibliometric criteria, and other related issues, will certainly be on the menu of those future gatherings too. — ANDRÉ HECK.

SPECTROSCOPIC BINARY ORBITS FROM PHOTOELECTRIC RADIAL VELOCITIES

PAPER 197: HD 10262 AND HD 116127

By R. F. Griffin
Cambridge Observatories

HD 10262, a sixth-magnitude system which featured in a note added to Paper 159 of this series but whose orbit was far from being known at that time, has been followed round one six-year orbital cycle. It is difficult to observe with the available instrument, as it consists of two F-type (or possibly Am) stars whose radial-velocity signatures are very weak, and one of the components is in rapid rotation ($v \sin i \sim 57$ km s^{-1}). The orbit is of high eccentricity, 0·7. Judged from the relative 'dip' areas seen in radial-velocity traces, the components may differ by about one magnitude in luminosity, yet the masses appear to be nearly equal. It is suggested that the primary has evolved a little way above the main sequence. HD 116127 has been found to be an uncannily similar system in terms of magnitude, spectral types, rotational velocities, and high orbital eccentricity, but has a shorter period of 1½ years; in its case the eccentricity is as high as 0·88, and there is no difficulty in assigning spectral types of about F5 and G2 V to the components.

Introduction

The two binary systems that form the subject of this paper are remarkably similar to one another in many ways, but they came to the writer's attention quite independently of one another. HD 10262 is a sixth-magnitude F star, bright enough to be shown in *Norton*[1], about 1° south-preceding *o* Psc. It is one of the stars whose brightness is such that it ought to be in the *Bright Star Catalogue,* but isn't, because at the time that the listing[2] for that *Catalogue* was compiled the magnitude was considered[3] to be $6^{m}\cdot 69$ — well below the cut-off of $6^{m}\cdot 50$. The oversight was identified in time for the star to feature in the *Supplement to the Bright Star Catalogue*[4] that was published shortly after the last edition of the *Catalogue* itself. Abt & Willmarth[5] measured the radial velocities of a considerable number of the objects that featured in the *Supplement* but whose velocities were then unknown. Inevitably some of them proved to be variable in velocity, but in no case did Abt & Willmarth make enough observations to determine any orbit, so the writer observed a few of the objects concerned with the Cambridge *Coravel*, and published the orbits of three of them in Paper 159[6]. In that paper he also discussed a few observations of HD 10262, saying that the traces could be understood as showing two, mutually superposed, weak dips, one of which is enormously smeared out by a projected rotational velocity of nearly 60 km s^{-1}. He concluded by asserting that "it is of only marginal observability; the *Coravel* is really not an appropriate instrument for measuring it, and having tried to elucidate the general nature of the object the writer is inclined not to try to follow it further." Being, however, rather like a dog with a bone when it comes to observing troublesome objects, the author could not bring himself to abandon the investigation of HD 10262, having once made a start on it, and he has in fact pursued it to such purpose as to be able now to present some sort of orbit for the system.

Meanwhile, HD 116127 had come to attention by virtue of its having an astrometric orbit completely determined by *Hipparcos*. In the *Hipparcos Catalogue* there are only 45 stars whose orbits were determined entirely from the satellite data without recourse to any additional information. By 2002 five of them also had orbits[7–11] determined from radial velocities by the present writer (in some cases in collaboration with others), but the coincidence was 'casual' in the sense that the reasons why the stars had been placed on the radial-velocity observing programme were nothing to do with the *Hipparcos* orbits — indeed, three of them were under observation long before *Hipparcos* was even launched. In 2002, however, the remainder of the 45 stars were assessed for suitability for addition to the programme, and HD 116127 was one of those accepted. It is a $6^{1}/_{2}{}^{m}$ star, just marginally too faint to qualify for the *Bright Star Catalogue,* to be found in a region of Canes Venatici that appears rather blank to the naked eye; it is about 11° due south of Mizar (ζ UMa), but the object that is shown at about that position in *Norton*[1] is not HD 116127 but the slightly brighter star HR 5045 (HD 116303) that is about 15′ south-following.

HD 10262

The absence of HD 10262 from the *Bright Star Catalogue* arose from the underestimate of its brightness — assumed here to be constant — when it was observed by Pickering & Wendell[3] with the Harvard meridian photometer[12] and found to be $6^{m}\cdot 69$, which is the magnitude that was subsequently copied into the *Henry Draper Catalogue*. The star had much earlier been adopted as one of 772 photometric standards by Gould[13], with a magnitude of $6^{m}\cdot 5$ upon which all four of his observers were agreed. It is listed as being of *photographic* magnitude $6^{m}\cdot35$ in the *Draper Catalogue*[14], in which its first spectroscopic classification is shown as type A. The *HD* type is F2. The only later classification appears to be that by Abt[15], who considered it to be a metallic-lined (Am) object, with Ca/H/M types of A7/F5/F0. *UBV* magnitudes have been given as $V = 6^{m}\cdot33$, $(B-V) = 0^{m}\cdot399$, $(U-B) = -0^{m}\cdot047$ by Preston & Stępień[16]; they measured it many times in the course of using it as a standard star in a photometric investigation of HD 10783 (UZ Psc), a small-amplitude Ap variable a degree or so following. Indeed, much of the modest literature that mentions HD 10262 refers to it only in that capacity and is not interested in it *per se*. It was Olsen[17] who first drew specific attention to the star's absence from the *Bright Star Catalogue*; he measured it at $6^{m}\cdot339$. In Nordström *et al.*'s large tabulation[18] of F stars, it is given as $V = 6^{m}\cdot343$; no radial velocity is shown for it. In fact the only radial velocities published for it apart from those in Paper 159[6] of the present series appear to be those of Abt & Willmarth[5]. Those authors saw it as double-lined, but of a considerably different character from how it was tentatively portrayed in Paper 159. They made three observations close together in time, and then two more about two years later. The differences within each batch were not significant, so there are effectively two observations. The primary star was seen as having rather broad lines ($v \sin i = 33$ km s^{-1}), and changed its velocity by about 10 km s^{-1} between the two epochs. The secondary was seen as narrower ($v \sin i = 20$ km s^{-1}) and moved in antiphase to the primary, from being about 40 km s^{-1} on one side to about 40 km s^{-1} on the other. What was concluded in Paper 159 was that the signature of the 'secondary' is very wide ($v \sin i \sim 60$ km s^{-1}) and extends far out on *both sides* of the profile of the 'primary': Abt & Willmarth had recognized it only on one side — the side on which its centroid was displaced from the primary and so more of it was uncovered. The rotational velocity suggested for the 'primary' itself in Paper 159 was only 7 or 8 km s^{-1}. In that model the perception as to which star is the primary had to be reversed from the Abt & Willmarth and the 'at first sight' assignment: the star with the high rotational velocity contributed a much larger equivalent width to the 'dip' profile than the much more obvious narrow component. A somewhat analogous situation has been demonstrated[19] in the case of Capella.

The observations made since Paper 159 was written have supported in all respects the model tentatively adopted there for HD 10262, and have definitely validated it by demonstrating that it leads naturally to a self-consistent double-lined Keplerian orbit. Fig. 1 shows a particularly well-integrated trace obtained early in the observing campaign, with the computer-fitted 'dip' profiles of the individual components and of their sum superimposed. As confidence increased that a correct understanding of the nature of the system and of the radial-velocity traces had been reached, integrations were typically terminated at count levels of a third or a quarter of that shown in the figure, typically taking 20–30 minutes. In total, 40 observations have been made with the Cambridge *Coravel*; apart from the first two, whose scans were too short and too poorly integrated, and one other exception in which no satisfactory measurement could be made of the very wide dip, all have been reduced as double-lined. In contrast with the usual situation in which the determination of twin velocities becomes difficult or impracticable when the two are very close together, in this case the great difference in dip profiles allows the velocities of both components to be measured just as readily when they are almost the same (as indeed they are in Fig. 1) as at any other phase. The measurements are listed in Table I, with those of Abt & Willmarth[5] added at the head. For the reason indicated above, the Abt & Willmarth velocities of the broad-lined

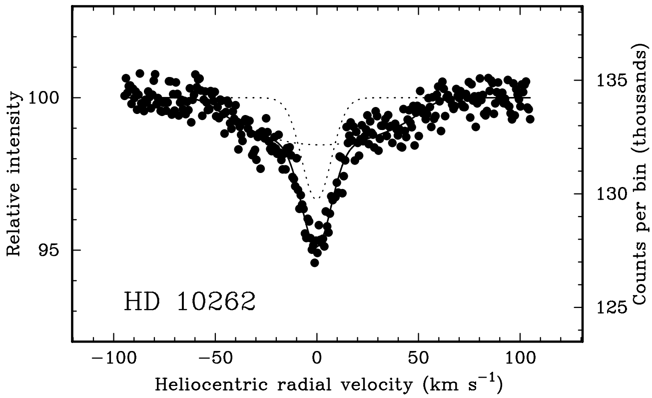

FIG. 1

Radial-velocity trace of HD 10262, obtained with the Cambridge *Coravel* on 2001 January 27. The dotted lines indicate the computed profiles of the individual dips, while the full line is their sum.

star are not correct and therefore have not been listed. The early velocities of the broad-lined star, here designated as the primary, were tabulated in Paper 159[6] only to integer kilometres per second and are repeated here in that form, but since 2004 the measures have been given as usual to one decimal place even though it is of little significance. For no reason except culpable oversight, the velocities obtained on 2000 November 16 were omitted in the earlier paper, but they are included here.

In the solution of the orbit, the velocities of the primary star have needed to be assigned a weighting of only 0·04 to equalize the variances for the two components; the Abt & Willmarth measures of what is here called the secondary have been utilized, with a weighting of 0·2. The first two Cambridge measures of the secondary have been rejected. The resulting solution is plotted in Fig. 2 and has the following elements:

P	$= 2136 \pm 17$ days	T	$=$ MJD $53227{\cdot}7 \pm 2{\cdot}5$
γ	$= +5{\cdot}53 \pm 0{\cdot}12$ km s^{-1}	$a_1 \sin i$	$= 339 \pm 24$ Gm
K_1	$= 16{\cdot}0 \pm 1{\cdot}1$ km s^{-1}	$a_2 \sin i$	$= 342 \pm 11$ Gm
K_2	$= 16{\cdot}1 \pm 0{\cdot}4$ km s^{-1}	$f(m_1)$	$= 0{\cdot}34 \pm 0{\cdot}07\, M_\odot$
q	$= 1{\cdot}01 \pm 0{\cdot}07$ ($= m_1/m_2$)	$f(m_2)$	$= 0{\cdot}35 \pm 0{\cdot}03\, M_\odot$
e	$= 0{\cdot}693 \pm 0{\cdot}011$	$m_1 \sin^3 i$	$= 1{\cdot}39 \pm 0{\cdot}14\, M_\odot$
ω	$= 248{\cdot}6 \pm 2{\cdot}0$ degrees	$m_2 \sin^3 i$	$= 1{\cdot}38 \pm 0{\cdot}22\, M_\odot$

R.m.s. residual (unit weight) $= 0{\cdot}57$ km s^{-1}

The raggedness of the velocities of the primary are all too obvious in Fig. 2, but are to be excused by the breadth and shallowness of the dips from which they were necessarily measured. It is a bit unsatisfactory that there are no measurements at the node that occurs shortly before periastron or for a good part of the ensuing closure. The orbital period is, however, only a little short of an integral number of years (6 years), and the object is not favourably placed in the sky for observation from Cambridge, so major gaps between observing seasons are unavoidable and they progress forwards along the orbit only slightly from one cycle to the next. It would take another three cycles before the phase *lacuna* could be filled, and considerations of mortality make it unwise for the writer to consider delaying this paper for so long.

TABLE I

Radial-velocity observations of HD 10262

The sources of the observations are as follows:
1988–1990 — published by Abt & Willmarth[5], weighted 1/5 in orbital solution;
2000–2007 — Cambridge Coravel

Heliocentric Date	*HMJD*	*Velocity* Prim. km s^{-1}	*Velocity* Sec. km s^{-1}	*Phase*	*(O−C)* Prim. km s^{-1}	*(O−C)* Sec. km s^{-1}
1988 Nov. 23·32	47488·32	—	−2·1	$\bar{2}$·313	—	−1·4
24·22	489·22	—	−2·4	·313	—	−1·7
Dec. 14·25	509·25	—	−0·1	·323	—	+0·3
1990 Sept. 25·45	48159·45	—	+9·0	$\bar{2}$·627	—	+2·1
27·47	161·47	—	+7·3	·628	—	+0·3
2000 Sept. 27·08*	51814·08	—	+3·3	0·338	—	+3·4
Oct. 6·10*	823·10	—	+0·5	·342	—	+0·5
13·07	830·07	+10	+1·5	·346	−0·9	+1·4
Nov. 12·97	860·97	+6	+0·1	·360	−4·6	−0·4
13·94	861·94	+11	+0·5	·361	+0·4	0·0
16·97	864·97	+12	+0·6	·362	+1·5	+0·1
Dec. 6·92	884 92	+12	−0·1	·371	+1·7	−0·8
13·92	891·92	+10	+0·4	·375	−0·2	−0·4
2001 Jan. 27·78	51936·78	+6	+1·2	0·396	−3·7	−0·1
Oct. 12·08	52194·08	+12	+5·1	·516	+5·1	+1·0
Dec. 29·81	272·81	+4	+4·2	·553	−2·0	−0·8
2002 Sept. 2·12	52519·12	+2	+7·5	0·668	−1·0	−0·6
Oct. 28·01	575·01	−3	+8·4	·694	−5·1	−0·5
2003 Jan. 10·81	52649·81	+4	+9·9	0·729	+3·0	−0·2
23·80	662·80	+4	+10·5	·736	+3·3	+0·2
Feb. 19·77	689·77	—	+12·0	·748	—	+1·2
Sept. 18·11	900·11	−4	+16·0	·847	+0·4	+0·5
Oct. 20·02	932·02	−9	+16·3	·862	−3·7	−0·1
Dec. 7·94	980·94	−4	+17·6	·884	+3·0	−0·5
2004 Jan. 27·76	53031·76	−14	+19·9	0·908	−5·0	−0·3
Feb. 23·77	058·77	−8	+21·6	·921	+2·2	+0·2
Aug. 20·14	237·14	−5	+12·5	1·004	−3·9	+0·3
Sept. 1·12	249·12	+8·1	+7·3	·010	+5·1	−0·8
4·14	252·14	+4·7	+7·1	·011	+0·8	0·0
14·11	262·11	+6·5	+4·9	·016	−0·4	+0·8
21·12	269·12	+9·0	+2·1	·019	+0·3	−0·2
Oct. 6·12	284·12	+10·5	−0·3	·026	−1·3	+0·4
22·08	300·08	+18·7	−3·1	·034	+4·7	−0·1
Nov. 12·96	321·96	+20·4	−4·8	·044	+4·5	+0·1
Dec. 19·87	358·87	+15·3	−5·9	·061	−1·9	+0·3
26·85	365·85	+14·5	−6·6	·065	−2·8	−0·3
2005 Jan. 8·85	53378·85	+14·7	−7·2	1·071	−2·7	−0·7
Aug. 16·13	598·13	+10·2	−4·6	·173	−5·1	−0·3
Sept. 8·14	621·14	+14·5	−3·6	·184	−0·5	+0·4
Nov. 5·02	679·02	+15·5	−2·9	·211	+1·2	+0·4
Dec. 17·89	721·89	+14·0	−2·4	·231	+0·3	+0·3

TABLE I (*concluded*)

Heliocentric Date	*HMJD*	*Velocity* Prim. km s⁻¹	*Velocity* Sec. km s⁻¹	*Phase*	*(O−C)* Prim. km s⁻¹	*(O−C)* Sec. km s⁻¹
2006 Sept. 9·10	53987·10	+12·7	+0·2	1·356	+2·0	−0·1
Nov. 2·94	54041·94	+11·5	+1·8	·381	+1·4	+0·9
25·93	064·93	+12·3	+0·8	·392	+2·5	−0·4
2007 Jan. 11·79	54111·79	+10·8	+0·9	1·414	+1·5	−0·8

*Rejected in orbital solution.

The radial-velocity traces offer, collectively, accurate mean values for the projected rotational velocities of the two stars; they are 56·6 and 5·0 km s^{-1}, with standard errors in each case less than 1 km s^{-1}. The traces also provide mean equivalent widths of 1·29 and 0·58 km s^{-1} for the two dips, giving a difference of a factor of 2·2 that suggests a difference in *V* luminosity of just about one magnitude. The *Hipparcos* parallax of 0″·01799 ± 0″·00084 yields a distance modulus of $3^m·73 \pm 0^m·10$ and thereby, for the system as a whole, an absolute magnitude of $+2^m·61 \pm 0^m·10$. The individual magnitudes might therefore be estimated to be about $3^m·0$ and $4^m·0$.

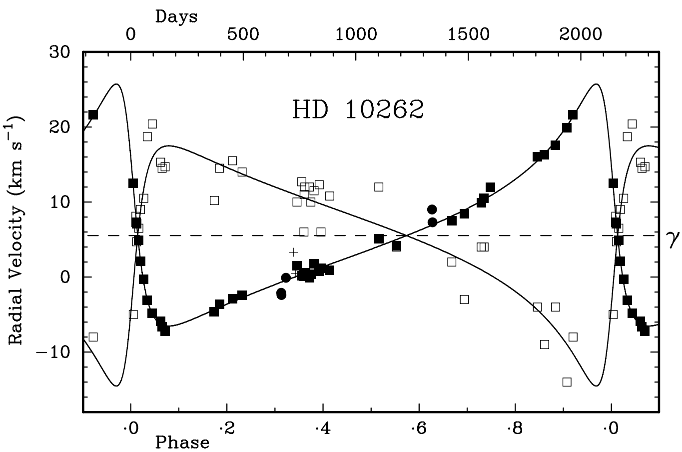

FIG. 2

The observed radial velocities of HD 10262 plotted as a function of phase, with the velocity curves corresponding to the adopted orbital elements drawn through them. Open symbols plot radial velocities of the primary star, filled ones the secondary. The squares denote observations made with the Cambridge *Coravel*. There are five filled circles (two of them almost superposed) which plot the observations published by Abt & Willmarth[6], which were assigned by those authors to the primary; the secondary velocities that they gave cannot usefully be plotted here, as they were based on an incomplete understanding of the HD 10262 system. Two plusses refer to the first two Cambridge measurements, made before the true nature of the system was divined; they have not been used in the solution of the orbit. The raggedness of the primary velocities is due to the extreme width and shallowness of the cross-correlation dip given by that component in radial-velocity traces (see Fig. 1). The points are bunched in phase because the position of the star in the sky causes unavoidable gaps lasting six months between successive observing seasons, and the period is so near to an integral number of years that the gaps fall in nearly the same places in successive cycles.

Main-sequence stars of those absolute magnitudes would[20] have types of about F2·5 and F8, respectively. The writer does not know how to relate that fact to the joint classification[15] of the stars as Am with Ca/H/M = A7/F5/F0, because according to his understanding of Am stars their fundamental distinction is that the metallic-line type is *later* than the hydrogen type. Only the primary is likely to be of early enough type to be a possible Am star in any case. On the other hand it would be a bit ironic, in view of the reputation that Am stars have for being slow rotators, if the component that has the rapid rotation in HD 10262 were to be identified as an Am star. On account of lack of adequate information and understanding of the applicability of Am classifications to HD 10262, we will see where the M_V-based proposal of an F2·5/F8 main-sequence pair leads us.

A photometric model based on interpolated tabular[20] colour indices for such a pair produces integrated colours of $+0^{\mathrm{m}}\cdot 38$ for $(B-V)$ and $+0^{\mathrm{m}}\cdot 04$ for $(U-B)$. The former is satisfactorily close to the observed[16] value of $0^{\mathrm{m}}\cdot 399$; the latter is not a good match for the observed $-0^{\mathrm{m}}\cdot 047$, but that must be the fault — if fault is to be found — of the tabulation and not of the model, because in the table the *minimum* reached by $(U-B)$ in the F types is $+0^{\mathrm{m}}\cdot 03$. The masses of the stars in the main-sequence model would be expected[21] to differ by 15–20 per cent, an amount that does not sit at all comfortably with the difference of only 1 ± 7 per cent found from the orbit. One could argue that little reliance is to be placed on the value of K_1 given by the orbit — but the raggedness of the data is already reflected in the large standard error of the mass ratio, and it would be nice not to have to live with at least a two-sigma conflict with that number. The most plausible means of reducing the discrepancy seems to be to postulate that a good part of the magnitude difference between the components represents incipient evolution on the part of the primary, taking it (say) half a magnitude or so above the main sequence. That is not improbable; indeed, the minimum masses demanded by the orbit are quite enough to encourage the idea that evolution towards the giant branch of the H–R diagram must be imminent if not actually under way. The masses are, however, not sufficiently accurately determined to warrant detailed modelling on that basis. All the same, we could elaborate a little on the 'hand-waving' model by pointing out that it would be nice to believe that there is a significant difference between the masses of the components — say about 1σ up from the central value, making a difference of 8–10 per cent — in order to be able to claim that the primary should have evolved significantly more than the secondary. That would also chime with the fact that the primary has the substantial rotational velocity that is common in mid-F and earlier stars whereas the secondary has a more Sun-like slow rotation.

A possibility that would largely undermine the whole discussion in the paragraph above is that the difference in absorption-line strengths that is responsible for the difference in equivalent widths of the dips in radial-velocity traces might not truthfully reflect the effect of differing luminosities. For example, if we postulated (as a rather extreme proposal) that the line strengths in the component that we have been calling the primary were double what they would be in a normal star owing to the Am phenomenon, then the difference in line strengths would be explained 'at a stroke' and we would be free to suppose that the stars were of approximately equal luminosities and no problem would arise over their apparently quasi-identical masses.

Be that as it may, the masses of the stars cannot in any case be much above the minima required by the orbital elements, so the inclination of the orbit must be high. The true semi-major axis of the orbit is therefore not much above the minimum value given by $(a_1 \sin i + a_2 \sin i)$, which is about 680 Gm or some 4·5 AU. At the 56-pc distance of HD 10262 such a separation would subtend $0''\cdot 08$ if it were directed at right angles to the line of sight; the value of ω, however, shows that we view the orbit nearly end-on rather than side-on (a characteristic that has been noted[22] as common to all spectroscopic orbits of very high eccentricity). The maximum observable separation will therefore be significantly smaller, though by no more than the ratio of the minor to the major axis of the orbital ellipse, $(1 - e^2)^{1/2}$ or 0·72, making it nearly 0″·06 and therefore well within reach of speckle interferometry with a large telescope.

HD 116127

The duplicity of HD 116127 was not discovered spectroscopically or by the direct resolution of its components, but astrometrically — *Hipparcos* recognized that it moved in a small and highly eccentric astrometric orbit with a period of 545 days and a semi-axis of about 0″·009. The satellite found its parallax to be 0″·02060 ± 0″·00084, indicating a distance modulus $3^{m}·43 \pm 0^{m}·09$. In conjunction with the V magnitude determined by Oja[23] as $6^{m}·52$ and by Guetter & Hewitt[24] as $6^{m}·53$, the modulus shows the absolute magnitude to be $3^{m}·1$. Both photometric investigations[23,24] additionally gave the values $(B-V) = 0^{m}·41$, $(U-B) = -0^{m}·03$. The old Harvard meridian-photometer measurements are in much better accord with the modern magnitude in the case of HD 116127 than in that of HD 10262: there were two sets[25,26] of them, giving mean values of $6^{m}·62$ and $6^{m}·53$, respectively, and it is their average, taken as $6^{m}·58$, that is listed in the *Henry Draper Catalogue*, where the type is given as F2, the same as that of HD 10262. HD 116127 had originally been classified, under its *BD* identity[27] of +44° 2265, as type F in the *Draper Catalogue*[14] of 1890. MK classifications of F2 V and F5 III–V have been made from prismatic spectrograms with reciprocal dispersions of about 75 Å mm^{-1} at Hγ by, respectively, Harlan[28] with a 1-prism instrument on the Lick 36-inch refractor and by Sato & Kuji[29] with the *Z-spectrograph*[30] on the Okayama 36-inch reflector. A classification of F3 V was made by Fehrenbach[31] from plates taken with the 80-Å mm^{-1} *Marly* grating spectrograph[32] on the Haute-Provence 1·2-m telescope; Grenier *et al.*[33] gave 'F2 V–IV' from such plates. Both Fehrenbach[31] and Grenier[33], with their collaborators, — consortia that largely overlapped — reported the use of the *Marly* spectrograph to obtain spectra, mainly for radial-velocity purposes, of *Hipparcos* stars, to complement the satellite's astrometric work. Both consortia reported that there were four plates of HD 116127 and gave very similar but not identical results: in one case[31] the mean velocity was given as +7·7 ± 2·5 km s^{-1} and in the other[33] as +7·1 ± 2·4. In the former case (only), the individual dates and results are listed, but it appears from the later paper[33] that changes in calibration and other procedures led to the revision of velocities already published and that the new result was not based on new data but (like the spectral classification) was based on the same plates and was intended to supersede the old one. The revision[33], however, omitted to include the data on the individual exposures.

The only other information that is of interest for present purposes regarding HD 116127 is in the table of F and G stars by Nordström *et al.*[18], which shows that three *Coravel* velocities (not available individually to the reader) yielded a mean velocity of +9·8 ± 3·2 km s^{-1}. Their mutual discrepancies demonstrated that the velocity is variable, and the star is flagged as 'binary with $\Delta m < 5$ mag', but it is not obvious how the authors knew anything about the Δm value; they evidently did not notice the double lines, because they listed the $v \sin i$ value as only 6 km s^{-1}.

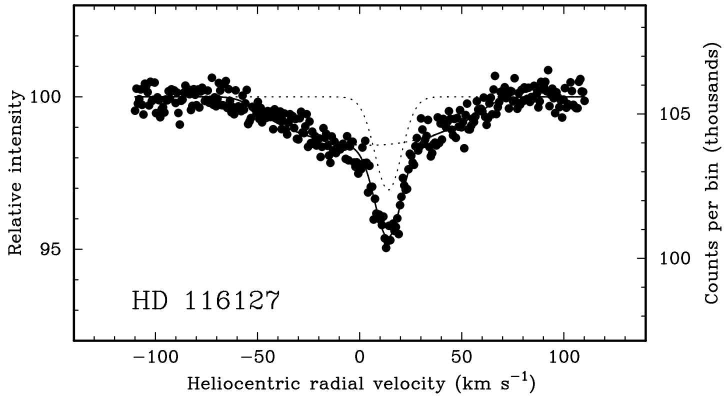

FIG. 3

Radial-velocity trace of HD 116127, obtained with the Cambridge *Coravel* on 2004 May 27. The extraordinary similarity of its unusual character to that of HD 10262 (Fig. 1) is noteworthy.

In just the same way, the primary star was overlooked by the present writer in the initial observation that he made of HD 116127, in the summer of 2002 with the Cambridge *Coravel*, after the star had been selected for observation from among the 45 that had *Hipparcos* orbits; only the comparatively sharp-lined secondary was recognized. The second observation, however, evoked the comment on the observing record, "This star is no good. Its dip fills the whole screen."! The recognition that it gave a trace (see Fig. 3 for an example) quite extraordinarily like that of HD 10262, which had proved to be just about measurable provided a very wide scanning range was used and sufficient integration time was expended on it, encouraged the writer to persist, especially after it was discovered that what must have been a dramatic periastron passage had been missed when only a single calendar month had passed without an observation. The 18-month orbital period became clear long before the ensuing periastron passage, which occurred conveniently near to opposition in the spring of 2004 and was attentively observed. Even then, however, only two measurements were achieved on the very steep sides of the orbital velocity curves owing to the extreme eccentricity of the orbit. Periastron passages take place in late May and late November — their dates change by only a few days in a century — and only alternate (May) ones are conveniently observable. Thus the next opportunity after 2004 to see such an event was in 2007, when five more measurements were obtained during the sudden reversal from one node to the other, which occupies only 13 days out of the orbital period of 548 days.

Altogether, 64 observations have been made of HD 116127 with the Cambridge *Coravel* (see Table II), and all but four of them have yielded radial velocities for the broad (primary) dip as well as the more obvious secondary one, which as Fig. 3 well demonstrates is much more conspicuous although of much smaller equivalent width. In the solution of the orbit the primary velocities have had to be assigned a weight of only one-thirtieth, but within their limitations the observations produce a quite satisfactory solution, which is illustrated in Fig. 4 and whose elements are:

P	$= 548 \cdot 03 \pm 0 \cdot 06$ days	T	$=$ MJD $53153 \cdot 69 \pm 0 \cdot 12$
γ	$= +9 \cdot 35 \pm 0 \cdot 10$ km s^{-1}	$a_1 \sin i$	$= 46 \cdot 0 \pm 2 \cdot 6$ Gm
K_1	$= 12 \cdot 9 \pm 0 \cdot 7$ km s^{-1}	$a_2 \sin i$	$= 60 \cdot 8 \pm 0 \cdot 7$ Gm
K_2	$= 17 \cdot 02 \pm 0 \cdot 14$ km s^{-1}	$f(m_1)$	$= 0 \cdot 0129 \pm 0 \cdot 0022\, M_\odot$
q	$= 1 \cdot 32 \pm 0 \cdot 07$ $(= m_1/m_2)$	$f(m_2)$	$= 0 \cdot 0300 \pm 0 \cdot 0011\, M_\odot$
e	$= 0 \cdot 8803 \pm 0 \cdot 0023$	$m_1 \sin^3 i$	$= 0 \cdot 092 \pm 0 \cdot 005\, M_\odot$
ω	$= 268 \cdot 3 \pm 0 \cdot 7$ degrees	$m_2 \sin^3 i$	$= 0 \cdot 070 \pm 0 \cdot 008\, M_\odot$

R.m.s. residual (unit weight) $= 0 \cdot 64$ km s^{-1}

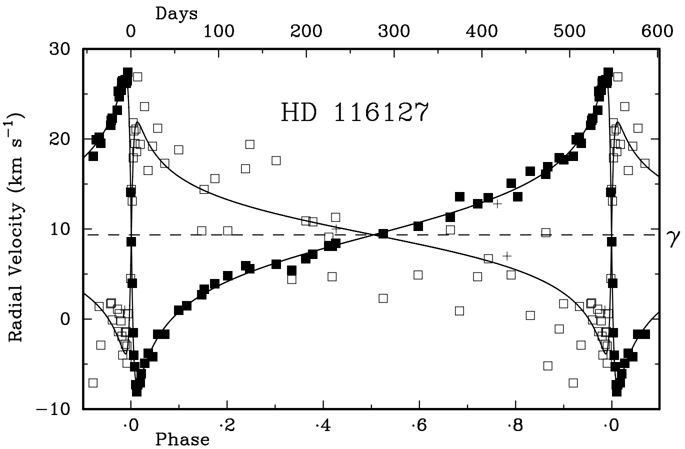

FIG. 4

The observed radial velocities of HD 116127 plotted as a function of phase, with the velocity curves corresponding to the adopted orbital elements drawn through them. The open and filled squares represent Cambridge measurements of the primary and secondary components, respectively. Four plusses plot measurements published by Fehrenbach *et al.*[31]; they were not used in the orbital solution.

The only elements that can be compared with those found by *Hipparcos* are P, e, and ω, for which the *Hipparcos* values (rounded to a sensible number of significant digits) are 545 ± 17 days, $0 \cdot 64 \pm 0 \cdot 19$, and 312 ± 31 degrees, respectively. The period agrees well with the spectroscopic value, and the indication of a high eccentricity is there, but the longitude of periastron is not in good accord, particularly when account is taken of the probability that the respective astrometric and spectroscopic definitions of that quantity warrant an expectation that they will differ by 180°. It is noticeable that the standard errors of *Hipparcos* values of ω (of which there are only 46) tend to be large; only 12 of them are less than 20°.

In comparison with the orbit of HD 10262, we have here obtained more observations and they are better distributed in phase; that is, however, entirely attributable to the much more agreeable position of HD 116127 in the sky (at +44° declination) and the 18-month period, which enables all phases to be observed without difficulty in the course of any two successive cycles, totalling three years of observing.

The mean values for the projected rotational velocities of the components of HD 116127 are $58 \cdot 6$ and $4 \cdot 1$ km s^{-1}, with standard errors less than 1 km s^{-1}. The mean equivalent widths of the two dips in the radial-velocity traces are $1 \cdot 44$ and $0 \cdot 50$ km s^{-1}; their ratio is $2 \cdot 88$, which, according to the 'rule of thumb'[11] that

TABLE II

Radial-velocity observations of HD 116127

The sources of the observations are as follows:
1983/4 — published by Fehrenbach et al.[31]*, not used in orbital solution;*
2002–2007 — Cambridge Coravel

Heliocentric Date	*HMJD*	*Velocity* Prim. km s^{-1}	*Velocity* Sec. km s^{-1}	*Phase*	*(O−C)* Prim. km s^{-1}	*(O−C)* Sec. km s^{-1}
1983 Jan. 17·14	45351·14	+12·8		$\overline{13}$·763	—	—
28·14	362·14	+7·0		·783	—	—
May 19·90	473·90	+1·0		·987	—	—
1984 Jan. 16·16	45715·16	+10·0		$\overline{12}$·427	—	—
2002 Aug. 12·86	52498·86	—	+13·6	0·805	—	−1·0
Sept. 13·81	530·81	+9·6	+16·1	·863	+5·5	−0·2
Oct. 18·74	565·74	—	+19·9	·927	—	+0·4
Dec. 9·21	617·21	—	−6·1	1·021	—	+0·2
2003 Mar. 3·15	52701·15	+15·6	+3·9	1·174	+1·8	+0·4
Apr. 7·06	736·06	+16·7	+5·9	·238	+4·1	+0·9
May 12·03	771·03	+17·6	+6·1	·302	+5·9	−0·2
June 14·98	804·98	+10·9	+6·7	·364	0·0	−0·6
July 14·93	834·93	+4·7	+8·1	·418	−5·6	0·0
Dec. 7·27	980·27	+0·9	+13·6	·684	−6·4	+1·5
2004 Jan. 9·22	53013·22	+6·7	+13·5	1·744	+0·3	+0·3
Feb. 26·15	061·15	+0·4	+16·4	·831	−4·5	+1·1
Mar. 17·15	081·15	−5·2	+16·9	·868	−9·2	+0·4
30·10	094·10	−1·1	+17·9	·891	−4·3	+0·4
Apr. 15·09	110·09	−7·1	+18·1	·920	−9·1	−1·0
22·11	117·11	+1·4	+20·2	·933	+0·1	+0·3
23·96	118·96	−2·9	+19·5	·937	−4·0	−0·7
May 5·00	130·00	+1·7	+21·5	·957	+2·0	−0·7
6·08	131·08	+1·8	+22·1	·959	+2·3	−0·3
7·08	132·08	−0·1	+22·3	·961	+0·6	−0·4
12·93	137·93	+1·1	+23·2	·971	+3·0	−1·0
14·99	139·99	+0·6	+24·7	·975	+3·0	−0·2
17·02	142·02	−0·2	+25·4	·979	+2·7	−0·1
18·92	143·92	−4·0	+26·5	·982	−0·7	+0·4
22·00	147·00	−1·5	+26·6	·988	+2·4	−0·2
22·99	147·99	−1·4	+26·2	·990	+2·4	−0·6
23·92	148·92	−4·9	+26·5	·991	−1·4	+0·1
24·92	149·92	+0·6	+27·4	·993	+3·4	+1·9
27·98	152·98	+4·5	+14·1	·999	−0·8	−0·7
30·96	155·96	+17·9	−1·5	2·004	+0·1	+0·3
June 3·07	159·07	+21·1	−7·3	·010	−0·5	−0·4
5·00	161·00	+26·9	−7·3	·013	+5·0	−0·1
7·95	163·95	+19·4	−7·1	·019	−2·1	−0·4
12·93	168·93	+23·6	−4·9	·028	+3·2	+0·4
16·91	172·91	+16·5	−3·8	·035	−3·1	+0·4
21·97	177·97	+19·2	−4·2	·044	+0·4	−1·1
27·91	183·91	+21·2	−1·7	·055	+3·2	+0·4
July 5·95	191·95	+17·3	−1·7	·070	+0·2	−0·8
30·92	216·92	—	+1·5	·115	—	0·0
Aug. 19·86	236·86	+14·4	+3·3	·152	+0·1	+0·5
Sept. 15·81	263·81	+9·8	+4·8	·201	−3·5	+0·6

TABLE II (*concluded*)

Heliocentric Date	*HMJD*	*Velocity* *Prim.* *km s⁻¹*	*Sec.* *km s⁻¹*	*Phase*	*(O−C)* *Prim.* *km s⁻¹*	*Sec.* *km s⁻¹*
2005 Jan. 9·21	53379·21	+9·1	+8·1	2·412	−1·3	+0·1
Mar. 12·19	441·19	+2·3	+9·5	·525	−6·8	−0·1
Apr. 21·04	481·04	+4·9	+10·3	·597	−3·4	−0·4
May 27·95	517·95	+9·9	+11·3	·665	+2·4	−0·5
June 27·97	548·97	+4·7	+12·8	·721	−2·1	0·0
2006 Feb. 16·18	53782·18	+9·8	+2·7	3·147	−4·6	0·0
Apr. 12·09	837·09	+19·4	+5·6	·247	+6·9	+0·4
May 29·98	884·98	+4·4	+5·4	·334	−6·9	−1·4
June 22·98	908·98	+10·8	+7·2	·378	0·0	−0·3
July 18·95	934·95	+11·3	+8·4	·426	+1·1	+0·2
2007 Feb. 4·22	54135·22	+4·9	+15·1	3·791	−0·8	+0·9
Apr. 5·13	195·13	+1·7	+17·7	·900	−1·2	−0·2
May 15·04	235·04	−1·4	+25·3	·973	+0·7	+0·8
19·01	239·01	−1·9	+26·3	·980	+1·2	+0·5
23·06	243·06	−2·8	+26·5	·988	+1·1	−0·3
24·91	244·91	−3·0	+26·6	·991	+0·6	+0·1
29·90	249·90	+14·4	+8·6	4·000	+5·0	−0·7
30·91	250·91	+13·1	+4·0	·002	−0·9	+0·8
31·95	251·95	+21·8	−1·5	·004	+4·2	+0·1
June 1·91	252·91	+20·9	−4·0	·006	+1·2	+0·3
2·96	253·96	+19·5	−5·3	·008	−1·5	+0·7
4·95	255·95	+18·6	−8·1	·011	−3·2	−0·9
July 22·95	303·95	+18·8	+1·0	·099	+3·0	+0·2

the difference in V magnitude is 1·15 times the ratio (expressed in terms of stellar magnitudes) of equivalent widths, leads to a ΔV of about $1^m{\cdot}3$. To obtain the integrated luminosity of $3^m{\cdot}1$ that has been noted above as stemming from the well-determined parallax we need to take the individual absolute magnitudes as $3^m{\cdot}4$ and $4^m{\cdot}7$. The corresponding spectral types for main-sequence stars, such as the components must certainly be, are F5 and G2. A photometric summation of the tabular[20] UBV magnitudes for those types predicts integrated colour indices $(B-V) = +0^m{\cdot}47$, $(U-B) = +0^m{\cdot}04$. The agreement with the observed[23,24] indices of $+0^m{\cdot}41$ and $-0^m{\cdot}03$ is none too good; the observed $(U-B)$ is appreciably bluer than the table allows for any F star, just as in the case of HD 10262, and we can do no more than note that the discrepancy between the photometric model and the observed value of $(B-V)$ is off by nearly as much in the same direction and is probably equally non-significant. The mass of an F5 V star, such as we are here proposing for the primary component of HD 116127, is supposed[20,21] to be about $1{\cdot}3\ M_\odot$, while the solar-type secondary could be expected to be just $1{\cdot}0\ M_\odot$, giving a mass ratio of 1·3 that accords exactly with the finding from the orbital radial-velocity amplitudes. It is of course something of a relief to find that in this case there is no difficulty over the mass ratio, such as exists in the case of HD 10262, and it reinforces the belief that there must be an astrophysical explanation of that difficulty rather than an attribution to major observational error.

The smallness of the minimum masses found from the orbital elements and given in the informal table above shows that the inclination of the orbit is far from 90°. As we have concluded that the secondary is a star of solar type, with a mass of $1\ M_\odot$ as nearly as can be estimated, its mass as given by the orbit, of $m_2 \sin^3 i = 0{\cdot}070 \pm 0{\cdot}008$, can be equated to unity and used as an equation to give $\sin i$, whose value is thereby found to be $0{\cdot}412 \pm 0{\cdot}016$, yielding $i = 24{\cdot}3 \pm 1{\cdot}0$ degrees.

(The cube-root dependence of sin i upon the mass in the mass function means that i can often be estimated from spectroscopic orbital elements rather accurately when it is well away from 90°.) The *Hipparcos* value of i is 133 ± 31 degrees; its placement in the second quadrant indicates that the astrometric motion is 'retrograde' (clockwise on the sky) — for comparison with the spectroscopic value its supplement, 47°, should be taken. The agreement is not good but it is well within the large uncertainty of the *Hipparcos* value.

The semi-major axis of the *relative* orbit of the two stars, found by summing the quantities a_1 sin i and a_2 sin i and dividing by the value derived for sin i in the preceding paragraph, is about 260 Gm or 1·73 AU. Although from the spectroscopic point of view the orbit is seen almost exactly end-on (ω very close to 90°), the low inclination means that we see it nearly in plan view on the sky, foreshortened only to cos i or 91% of its absolute value. Moreover, the very high eccentricity implies that the system spends most of the time near the apastron separation of $(1 + e)$ times the length of the semi-major axis of the orbit, so the actual separation, projected on the sky, is usually approaching 1·73 × 0·91 × 1·88 AU — almost 3 AU. At the distance of HD 116127, nearly 50 pc, it must subtend 0″·06, so the system, like HD 10262, ought to be readily resolvable by speckle interferometry with a large telescope.

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THOMAS COOKE (1807–1868) — A GREAT ENGLISH TELESCOPE MAKER

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This year marks the bicentenary of the birth of Thomas Cooke, a man whose influence on the manufacture of the astronomical telescope in the mid-to-late 19th Century was profound. Such was the quality of his telescope mountings and lenses that a significant number of Cooke telescopes are still in operation, almost 150 years later. The current status of four of them is reported upon.

Introduction

Thomas Cooke was born in Yorkshire on 1807 March 8. Persuaded from running away to sea by his mother, he opened a village school and, self-taught, supplemented his income by teaching and tutoring in York, whilst studying mathematics and mechanics in his spare time. In about 1830 he made a small telescope and several years later felt sufficiently confident to set up as an instrument maker.

When Cooke started up in business in 1837, the firm of Troughton & Simms was already thriving, but had recently undergone a traumatic episode in attempting to fill an order from Sir James South for a telescope and mounting to accommodate an object lens by Cauchoix of 11¾-inches aperture[1]. Edward Troughton had died in 1835 during the South 'affair' and by a strange coincidence, a similar fate awaited Cooke when he, too, attempted the construction of his biggest telescope.

Cooke began his professional life in York, leasing premises at 50 Stonegate, helped with a loan from his wife's uncle. His first significant commission was a 4½-inch refractor for William Gray FRS[2], and by 1851 he had produced a refractor of 7¼ inches to fill a private order from Mr. H. L. Pattinson of Gateshead. (Coincidentally, Mr. Pattinson's daughter was married to R. S. Newall who would later commission Cooke to build his biggest telescope.) It was Mr. Pattinson's telescope which accompanied Piazzi Smyth to Tenerife when the latter conducted his site-testing experiments starting in the summer of 1856[3].

Business was now brisk and Cooke had to expand his facilities. He bought a plot of land in Bishophill, York, and built the workshops which became known as the Buckingham Works. By 1855 he was employing five or six workmen and one apprentice; those numbers grew to over one hundred by the time of Cooke's death. The private market for large telescopes was vibrant and 21 instruments ranging from 5- to 10-inch diameter were built over the next few years[4]. These included the 10-inch *Barclay* (1860), now sited at Marlborough College, Wiltshire, the 8-inch *Fry* (1862), now at University College London's observatory at Mill Hill, and the *Thorrowgood* (8-inch lens, 1864), now at the Observatories, Cambridge.

The great success of these telescopes lies with the skill and care with which they were made. Cooke was not only a talented mechanical engineer who throughout his life built his own dividing machines for cutting setting circles and micrometer heads but was an excellent practical and theoretical optician. Even his great skills were soon to be tested for in 1860 he was in correspondence with R. S. Newall who wanted Cooke to build a telescope, using existing or projected blanks

PLATE I. The 8-inch *Thorrowgood* refractor at Cambridge, which first belonged to the Reverend William Rutter Dawes and which has been on this site since 1929. This picture was taken by Bob Argyle.

PLATE II. The restored *Fry* telescope in its building at Mill Hill Observatory. Image courtesy of University College London. Donated by Henry R. Fry in 1930, it was extensively overhauled by Mr. R. Holder between 1982 and 1997.

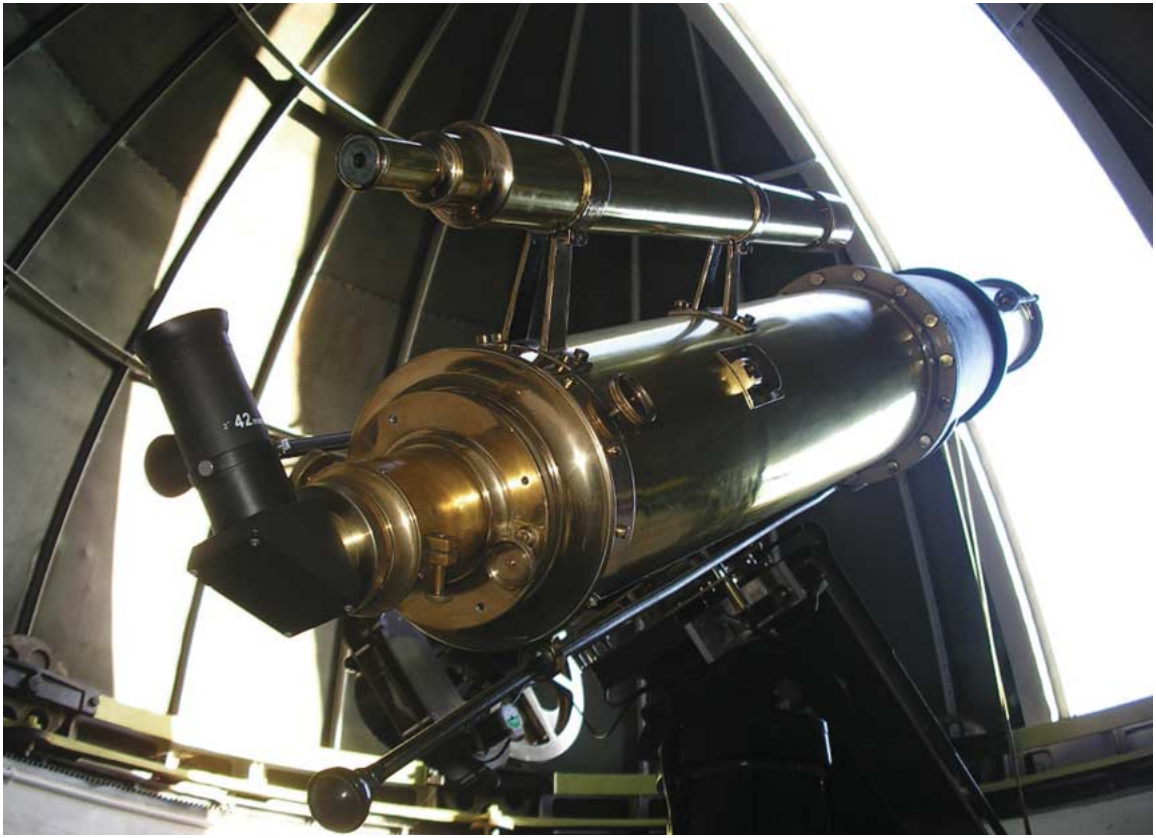

PLATE III. The *Barclay* telescope, first erected in Epping by Joseph Barclay, was later donated to the Radcliffe Observatory, Oxford, but then moved to its present location at Marlborough College some 70 years ago. Picture courtesy of Charles Barclay, Marlborough College.

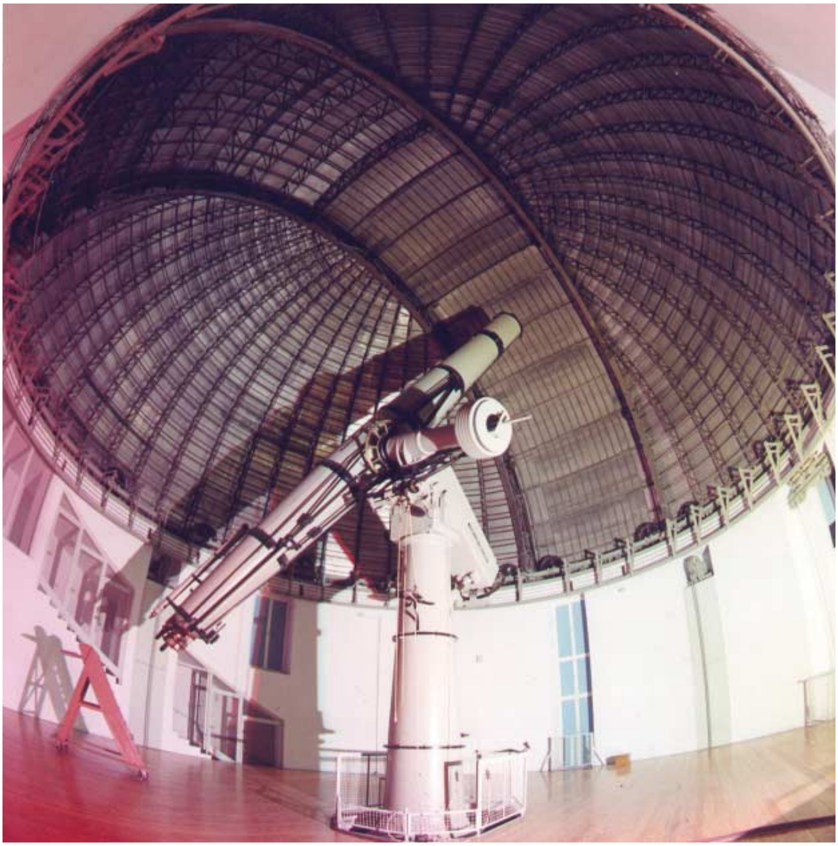

PLATE IV. The 25-inch *Newall* refractor in its dome on Penteli Mountain, 15 km north of Athens. It was originally erected in Gateshead and later moved to Cambridge. Picture courtesy of Mr. Nikolaos Matsopoulos, Institute of Astronomy and Astrophysics, National Observatory of Athens.

of optical glass of 60-cm in diameter or more[5]. At the International Exhibition of 1862, held in South Kensington, London, the glassmakers Chance Brothers had on display a pair of high-quality 25-inch diameter crown and flint blanks. Newall was given first refusal to buy them by Chance Brothers in 1863 for £500 each. Newall asked both Cooke and Grubb of Dublin to quote for the cost of making a complete telescope and dome. (How ambitious this project was may be judged by the fact that Alvan Clark had that very year completed the 18½-inch objective for the Dearborn Observatory in the United States.) At this point Cooke made two serious mistakes: he offered to finish the telescope in a year and, in order to undercut the bid from Grubb for the contract, he charged too little for the work. The main problem was that Cooke had too many other orders to complete and although he did have the assistance of his sons, Thomas and Frederick, the whole project proved too much and Cooke died in 1868 at the age of 61 with the telescope unfinished and Newall a constant irritant. The 25-inch refractor was eventually set up at Ferndene, Newall's house at Gateshead, in 1871.

Towards the end of the Victorian age, the emphasis on telescopes began to wane and the Buckingham Works began to concentrate on other instruments[6] — microscopes, theodolites, and other surveying aids. By the turn of the century Cooke's were turning their hand to more military items such as rangefinders and gun-sights. The end of the First World War saw a large drop in orders for Cooke's products and in 1921 it merged with the firm of Troughton & Simms. As Martin Lunn notes[7], in 1963 Cooke, Troughton & Simms was re-registered as Vickers Instruments Ltd, and in 1989 the business was sold and some of the company archives were deposited at the University of York.

During 2007 March there was an exhibition on Thomas Cooke at the Yorkshire Museum in York[7]. There are plans to put up a permanent exhibition of the work of Cooke.

The Thorrowgood telescope

The *Thorrowgood* 8-inch telescope was built in 1864 at the express order of the Reverend William Rutter Dawes (1799–1868), a double-star expert who had been awarded the Royal Astronomical Society Gold Medal in 1855 and, in the citation read out by the President G. B. Airy, was referred to[8] as having "extraordinary acuteness of vision". In fact the lens that is used with the telescope today is not the original. That was delivered from Cooke with too short a focal length for Dawes' purposes[9]. Cooke admitted his mistake and sent a second objective rather than adjust the length of the tube. Unfortunately the new OG had a focal length 2 inches shorter than Dawes had specified, *i.e.*, 114 inches instead of 116. By this time, however, Dawes was not well and used the telescope only very occasionally. He put it up for sale in 1867 and it came to the attention of J. C. Adams at Cambridge. The asking price was £580 and Adams thought that it would be a useful addition to the telescopes at Cambridge. Indeed, he believed that optically it was superior to the 9·6-inch *Fraunhofer* refractor at Dorpat and John Herschel's 20-foot reflector at the Cape. However, the Observatory Syndicate at Cambridge chose not to approve the purchase. When informed of this decision Dawes wrote to Adams[10], absolving him from any blame and adding "so perfect an 8-inch OG is not an everyday occurrence even at the Buckingham Works". The telescope then passed through a series of private owners including William Henry Maw (1838–1924)[11], a founder member and leading light in the early days of the British Astronomical Association. Maw used it extensively for double-star observations, the results of which appear in *Memoirs* of the RAS. The last private owner was William Thorrowgood (1862–1928)[12], a retired Southern Railway engineer who set up the telescope in Wimbledon but had barely a year's use out of it when he died and left it to the RAS.

In 1929 January it came to Cambridge on permanent loan and has been in regular use ever since (Plate I). In recent years it has been extensively used for solar observations and between autumn and spring is available weekly for public viewing. The author has been employing it for the measurement of double stars since 1990[13] and can readily attest to the continuing quality of the objective for the resolution of close pairs. The original weight-driven clock drive is no longer used and a small electric motor now drives the telescope at sidereal rate. A right-angle eyepiece attachment together with some modern eyepieces make public observing easier and more comfortable.

The Fry telescope

Made in 1862, the telescope, of 8-inches aperture and 126 inches focal length, was presented to University College London at Mill Hill by Mr. Henry Reginald Fry of Barnet in 1930 January[14]. The telescope, according to Fry, was "made with the idea of determining exact positions and is a very massive piece of work". Mr. Fry met most of the cost of its reconditioning and subsequent re-erection. A new small building was erected in 1931 to house the telescope. This building was subsequently demolished to make way for a new three-dome building, completed in 2000, in which the *Fry* is currently housed (Plate II).

A director of Barclay & Fry, printers and tin-box makers, H. R. Fry was a very able amateur engineer and made a number of clocks, cutting the teeth in his own workshop. He also presented Mill Hill with an unmounted 5-inch Cooke refractor which was fitted to the *Radcliffe* 18/24-inch refractor.

The 8-inch *Fry* refractor has been extensively used for student instruction and demonstration to members of the public, and has completed work on the magnitudes of novae, double-star observations, and occultations.

The *Fry* has a traditional German equatorial mounting, incorporating a weight-driven clockwork drive. It is equipped with numerous eyepieces, a visual spectroscope, a narrow-band Hα filter for solar observing, and low-light-level video cameras for solar, lunar, and planetary observing.

Between 1982 and 1997 the telescope was refurbished by Mr. R. Holder and details of the work done are available[15].

The Barclay telescope

Joseph Gurney Barclay was born in 1816 and, to use Allan Chapman's phrase[16], can be included amongst the ranks of the "Grand Amateurs", although to give him due credit he spent more time in the dome than many of his peers who tended to content themselves with adding their names to someone else's work.

His interest in astronomy dates from childhood and in 1854 he purchased a 7¼-inch Cooke refractor and set it up in an observatory in the grounds of Leyton House in Essex, which he had inherited from his father a year earlier. In 1860 Barclay replaced the smaller instrument for a 10-inch aperture Cooke for about £1200. Charles Barclay notes[17] that at that time it was the fourth largest refractor in the UK and Ireland.

In 1856 January he found a faint star about 1 arc minute west of Procyon.

Barclay's resident observer, Romberg, used the new telescope to measure its relative position by micrometer[18]. (Note, however, that this is a background star and is not the star confirmed by Schaeberle at Lick Observatory in 1896, as Charles Barclay records[19]. That was the first sighting of the white-dwarf binary companion — an object far beyond the power of the 10-inch.) The star seen by J. G. Barclay had been first noted by Lamont[20] on 1836 March 5 and is now being left behind by Procyon's considerable proper motion.

Observations continued at Leyton through the offices of C. G. Talmage (1840–1886) and on his death, work at the observatory ceased. Barclay gave the telescope to Radcliffe Observatory, Oxford, in 1886 after the death of Talmage and it was set up in Oxford the following year. With the arrival of a 24-inch/18-inch twin refractor in 1902–3, the Cooke telescope was rather sidelined and when the Radcliffe Observatory site was sold in 1935, the Cooke was transferred to Wiltshire, thanks to the good offices of Sir Basil Blackett on behalf of Marlborough College, where it has been ever since.

The telescope was subsequently used by generations of college pupils but gradually fell into a state of disrepair. In 1997, when Charles Barclay (the great-grandson of J. G. Barclay's uncle) was appointed Head of Physics he also took on responsibility for the Blackett Observatory. In the last 10 years the telescope has been fully furnished and modernized by Norman Walker (Plate III) and is now thought to be the oldest telescope in the world with a GOTO facility[21]. Mr. Barclay's paper[17] in *Antiquarian Astronomer* traces the full history of the *Barclay* telescope and the piece by Mr. K. Goward[22] also contains much useful detail. It is clear that the quality and definition of the objective is undiminished and the telescope remains one of Thomas Cooke's finest memorials.

The Newall telescope

The construction of this "imperial philosophical machine", as Cooke's obituarist termed it[23], caused severe problems for Cooke and his sons. Its location in the north-east of England meant that good clear nights were few and far between and that fact, combined with the lack of opportunity afforded to Newall to observe due to frequent absences, resulted in Newall reporting only one excellent night in 15 years[24].

Newall had appreciated early on in this project that locating the telescope at his home was only a temporary measure. David Dewhirst points out[5] that the dome and its walls were designed (by Newall himself) to be transportable. He began to make efforts to find a suitable site, at one point offering it for a seven-year loan to David Gill at the Cape of Good Hope. Nothing came of this or other efforts and eventually, in 1889, he offered it to Cambridge University. With his youngest son Hugh Newall, already working at the nearby Cavendish Laboratory, willing to act as an unpaid observer, the telescope was finally set up in 1891. Hugh Newall distinguished himself with his practical qualities and retired in 1928, but continued to work until his death in 1944. A more thorough report of the activity of the telescope at Cambridge is given in the paper by Matsopoulos *et al.*[25].

By the middle of the 1950s the *Newall* had become unused and neglected and the decision was taken to donate the telescope to any observatory wishing to accept it. At the IAU in 1955, Professor G. Kontopoulos of the Astronomical Laboratory at the University of Athens heard about the offer and passed it on to the Director of the Greek Astronomical Institute, Professor S. Plakides. Eventually a committee formed by the Athens National Observatory accepted the offer of the telescope and planned to put it on Penteli Mountain, 15 kilometres north of Athens. The telescope was eventually set up in 1958 November but ceased being used scientifically more than a decade ago because of the encroaching city buildings. It is now used by amateur astronomers, for student training, and for public observing nights (Plate IV).

Acknowledgements

I am indebted to Mark Hurn, Librarian at the Institute of Astronomy, Cambridge, for the use of his notes on the Dawes–Adams correspondence and other aspects of the early history of the *Thorrowgood* telescope.

Mr. C. Barclay, Head of the Physics Department, Marlborough College, kindly supplied the image of the *Barclay* telescope, and the image of the *Newall* refractor at Penteli is courtesy of Mr. Nikolaos Matsopoulos, of the Institute of Astronomy and Astrophysics, National Observatory of Greece, Athens.

The image of the *Fry* refractor at Mill Hill is reproduced by permission of University College London.

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CORRESPONDENCE

To the Editors of 'The Observatory'

Declaration Concerning the Evolving Rôle of Libraries in Research Centres

The following declaration reflects the concerns of its drafters at the increasing invisibility of research libraries *vis-à-vis* recent accelerated changes in publishing and reader-access technology. It was drafted subsequent to the colloquium 'Future Professional Communication in Astronomy', held at the Palais des Academies in Brussels on 2007 June 10–13 (see p. 375), although it does not derive directly from that meeting.

The declaration, after a period of consultation and discussion with astronomers and research-centre librarians worldwide, will be presented to the International Astronomical Union through its Commission 5 (Documentation and Astronomical Data), part of Division XII (Union-Wide Activities), with the request that it be considered for adoption as official IAU policy. We hope this important issue will generate discussion among the readership of *The Observatory* and would welcome any support for the declaration or comments on its contents.

Yours faithfully,

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2007 July 27

Declaration Concerning the Evolving Rôle of Libraries in Research Centres

We call on the astronomical community worldwide to address the importance of libraries and their evolving rôle within research centres on the grounds that the technology for generating and sharing information is useless if there is no way to locate, filter, organize, and access it.

Astronomy has a history dating back to antiquity and libraries have served as repositories of research and cultural heritage for many centuries; however, the current pace of technological change and development has led to libraries effectively becoming invisible in the day-to-day running of research centres. The advent of electronic publishing has led to a drastic reassessment of the best ways to promote the communication and storage of research results. The librarian's rôle in these circumstances combines new with traditional tasks of information management. These tasks include:

- The acquisition of new publications to ensure the fullest possible coverage of subject areas.
- Making information available to patrons wherever and whenever required.
- Archiving sufficient printed and on-line material to ensure the continuity of the astronomical record from antiquity to the present day. Electronic publi-

cations are of too recent an origin to compete, in terms of completeness, with the traditional library. In spite of the great efforts to digitize old publications, not everything is on the web, nor is it likely to be in the future.

- Providing scholarly access to information resources in all media and in all formats, both physically available and accessed remotely on the internet.
- Identifying, retrieving, organizing, evaluating, repackaging, filtering, and providing electronic access to digital information sources.
- Facilitating easy access through the purchase of licences and other software.
- Applying expert knowledge and familiarity with information resources alongside a specialized subject knowledge, thereby allowing information to be delivered to patrons in a timely and preferred manner.
- Using administrative expertise to create and manage convenient, accessible, and cost-effective information services (aligned with strategic directions of organization); *i.e.*, enhancing access through the ability to identify and link patrons to their required information needs.

The ease with which today's research workers access on-line databases and bibliographical resources can easily hide from view the efforts of librarians in providing these facilities. We therefore call on librarians to adopt a more proactive stance in making their contribution known to the research communities they serve (*e.g.*, through library tours, seminars, courses, *etc.*). Libraries tend not to be overmanned or to occupy excessive space within research centres, so it is essential that librarians resist misguided attempts at cutting staffing levels and allocating valuable library space to other purposes. Librarians are being asked to perform ever more tasks as part of their duties: they cannot therefore be expected to do more work in less space or with fewer staff.

The main astronomical research journals have tripled in volume and price over the past decade, but this increase in published output and costs has not been addressed by the allocation of library budgets, which have remained static over this period. We call on funding agencies to take the increased volume and cost of astronomical journals into account. We also urge research centres to take into account the rise in both published output and subscription prices when distributing their research budgets. The question is one not solely of funding at source but also of the relative importance given by research centres to the essential rôle of libraries.

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S. Davis (Library, South African Astronomical Observatory)
M. Gómez (Library, Instituto de Astrofísica de Canarias)
U. Grothkopf (Library, European Southern Observatory)
G. Coetzer (Library, Hartesbeesthoek Radio Astronomy Observatory)
P. Vonflie (Library, Strasbourg Astronomical Observatory)
M. Hurn (Library, The Observatories, Cambridge)
M. Bishop (Library, National Radio Astronomy Observatory)
D. Coletti (Harvard-Smithsonian Center for Astrophysics)
S. Bosken (U.S. Naval Observatory)
B. Corbin (U.S. Naval Observatory, retired)
J. Lagerstrom (Space Telescope Science Institute)
S. Stevens-Rayburn (Space Telescope Science Institute, retired)
E. Bouton (Archive, National Radio Astronomy Observatory)

The Ensisheim meteorite unchained

Reading David Hughes' review[1] of the recent Geological Society publication *The History of Meteoritics and Key Meteorite Collections*, I found myself in complete agreement with his assessment of the excellence of the work, as one of those rare 'library' texts of which I have bought a personal copy (not quite so fearsomely priced, given the generous discount offered to RAS members by its publishers).

One sentence, not from the reviewed book, caught my attention: "The French sometimes chained meteorites to the ground where they fell, in case they decided to depart from Earth as swiftly as they arrived." Variants on this statement, usually in the singular and not previously suggesting it as fastened to its fall-spot, can be found quite commonly with regard to the famous Ensisheim, Alsace, meteorite fall of November 7, 1492 (Julian), but only in quite modern works. I have repeated it myself in talks and print within the last 15 years. However, it does not occur in any of the near-contemporary reports of the fall and its aftermath, nor for a long time subsequently.

During some investigations into beliefs surrounding the Ensisheim fall earlier this year, I came upon the detailed discussion prepared for the 500th anniversary of the fall in 1992 by Ursula Marvin[2]. Marvin attributed the idea — that the meteorite was chained up in the parish church at Ensisheim to prevent its escape — to the 1980 translation of Ochiren Namnandorj's *Meteorites of Mongolia* (Field Research Projects, Miami). Certainly I have not located any clear evidence of this aspect prior to *circa* 1980, where the occasional references to chains in respect of the preserved meteorite seem to be all to its means of suspension on display in the local church, not to its 'imprisonment' there.

I am grateful to David for thus providing a 21st-Century example of the continued subtle changing of beliefs about the Ensisheim fall, as this has now provided me with a suitable ending to the article I had prepared on the subject, scheduled for publication as part of the Meteor Beliefs Project next year!

Yours faithfully,

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2007 June 9

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REVIEWS

Hubble: 15 Years of Discovery, by L. Lindberg Christensen & R. Fosbury (Springer, Heidelberg), 2007. Pp. 124, 30·5 × 26 cm. Price £19·95/$39·95/ €29·95 (hardbound; ISBN 0 387 28599 7).

When the *Hubble* telescope was first launched, I felt really sorry for Edwin Hubble, for having his name attached to such a flop. Even though the telescope had sat in a closet doing nothing for four years, awaiting recovery of the ability to launch it, nobody seemed to have thought of looking through it to see if it were all right — and then when it was launched it was quickly found that it *wasn't*. But those who had been in charge of that disaster pulled the chestnuts out of the fire by recognizing what was wrong and putting it right, albeit at the further astronomical expense of what amounted to a rescue mission, and since then the telescope has had a performance of which Hubble or anyone could justifiably be proud.

Although we have become used to seeing pictures taken with *Hubble*, we have to admit that many of them still create an impression — as well as showing colour (not always natural) in objects far too faint to be seen in colour by the eye, they are breath-takingly *sharp*! They demonstrate very cogently what extraordinary advantages were there for the taking through the improvement by an order of magnitude in routinely achieved angular resolution. That does not come as a surprise to me, having obtained an inkling of it through familiarity with what could be seen in good seeing with the 100-inch reflector on Mount Wilson ages ago. Indeed, as long ago as 1973 I published in this *Magazine* a paper[1] asserting that large telescopes should be made to very high optical specifications, and then the seeing would seem a lot better. At the time, people didn't buy that idea at all; when it was put forward at an RAS meeting it was ridiculed from the floor[2] as "a load of subjective rubbish"! But since then large telescopes *have* been made very good, and they *do* give better images than their predecessors, even without the adaptive optics that allows them in some circumstances to compete with *Hubble*.

The new book, a rather thin (124-page) exemplar of the coffee-table *genre*, capitalizes on the excellence of the *Hubble* pictures to show us a selection of them, of objects ranging from the Moon and planets to Galactic and extra-galactic objects, out to the limit of the 'deep field'. Mostly the *Hubble* image appears on one page of a double-page spread while a caption and a related but more discursive description occupies the other. An aspect of the descriptions to which this *cis*-Atlantic reviewer warms is the use of English spelling. Such words as colour, travelling, supernovae, antennae, marvellous, kilometres, aesthetically, are for once correctly spelt! Unfortunately the *captions* have mostly been taken verbatim from their evidently trans-Atlantic authors, so there are inconsistencies even on the same page. The authors also embrace wholeheartedly the modern conceit of leaving hyphenation to the reader's imagination, so we have to apply our own skill and judgement to such offerings as "a 2·4 metre aperture telescope" and "the 3640 km diameter moon".

The authors might have done better to leave the *Hubble* pictures to speak for themselves, or at least to be satisfied with the captions. After all, it is the pictures that will sell the book. Some of the comments are not of the same standard as the pictures. For example, it is highly premature for the authors to claim (p. 36), "And so, through the entire vastness of space, the eternal ebb and flow of life continues." Their assertion on page 53 that when the Sun evolves into a red giant it will "swallow Mercury, Venus and our planet as well" indicates an exaggerated idea of the radius of a red giant. On page 30 they say that the Sun "barely gives out as much light and heat as the full moon."! Even when we see from the context that what they are really trying to say is that a KBO at 100 AU from the Sun barely *receives* from it the amount of energy that *we* receive from the Moon, that is still grossly in error. Another category of features that detract from the book rather than add to it is the 'artists' impressions'. For example, the artist's impression of the Big Bang (with, however, a background of ready-made stars) would have been better omitted. So would one purporting to show the planet HD 209458b in transit in front of its star: the planet is seen in the picture perfectly clearly, but is trailing a great blue comet-like mass that is optically thick and altogether hiding the star, and (presumably by way of explanation) the caption tells us that the planet's atmosphere is evaporating off into space.

By modern standards this is not an expensive book. You get 50 of *Hubble*'s most beautiful pictures occupying most or all of a page each or in several cases the complete double-page spread. Buy it for the pictures, but be wary of the text and the artists' impressions. — R. F. GRIFFIN.

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Origins: How the Planets, Stars, Galaxies, and the Universe Began, by S. Eales (Springer, Heidelberg), 2006. Pp. 284, 24 × 16·5 cm. Price £19·50/$29·95/€29·95 (hardbound; ISBN 1 846 28401 5).

Origins is a great book — it's concise, timely, and instructive. It is about the big origin questions in astronomy and cosmology that have always inspired mankind and kept you and me awake at night: namely, how the Universe and all the planets, stars, and galaxies in it have formed. But it is not only a 'where do we come from' book because it also attempts to address the questions about the ultimate fate of the Universe and its ingredients, as it portrays how scientists uncover the secrets of the formation and evolution of those objects.

It is a very timely book. New instruments in ground-based and space-based observatories bring astronomers closer and closer to answering some of those big questions. The book vividly describes how scientific progress is made at times when major advances in engineering promote the construction of ever more sensitive detectors. The last two decades have witnessed an explosion in the discovery potential of astronomical instrumentation and the book beautifully captures the excitement about the individual results from the most recently built observatories, which are then fused by astronomers and physicists to paint a new and coherent picture of our Universe.

Origins describes the discovery of new planetary systems in the vicinity of our Sun, and the techniques that lead to a better understanding of their formation and evolution. It makes the reader familiar with new types of telescopes and observations. For instance, the reader learns how new detectors peer through massive clouds of interstellar gas and dust where we can watch the first moments in the life of a star. Armed with this knowledge the reader is taken for a stroll across the deepest observations of the sky ever taken with the *Hubble Space Telescope*, where we see the formation of the oldest galaxies in the Universe. Along the way the book dares to explain rather complicated concepts of observational astronomy, such as the photometric-redshift technique that allows astronomers to measure distances to the most remote galaxies.

To attempt an answer for the last big question about the origin of the Universe, the book takes the reader deep into the rabbit hole of understanding the cosmic microwave background and the history of its complicated and meticulous interpretation, combined with other observations. This includes some of the most exciting theories and discoveries of our time, such as dark matter, inflation, the flatness of spacetime, and the accelerating expansion of the Universe propelled by the mysterious dark energy.

The text is kept at a fundamental and basically non-mathematical level that clearly conveys all the physical concepts that are necessary for the understanding of today's front-line astronomy research. The book includes some interesting details and stories about last century's eccentric celebrity astronomers who contributed to major scientific leaps in our knowledge about the cosmos. It is an enjoyable fusion of 'Astronomy 101', the history of fundamental discoveries in astronomy, and the outlook on exciting new experiments that will lay the groundwork for new ideas and expand our understanding of the basic makeup of the Universe we live in. I warmly recommend this book. — THOMAS PUZIA.

Protostars and Planets V, edited by Bo Reipurth, David Jewitt & Klaus Keil (University of Arizona Press, Tucson), 2007. Pp. 976, 28·5 × 22 cm. Price $90 (about £45) (hardbound; ISBN 0 816 52654 0).

In the bad old days there were two populations of astronomers. One worried about the birth of stars, the other about the formation of planets. Before Tom Gehrels came along in 1978 and started this series of seven-yearly *Protostars and Planets* conferences, the two populations hardly spoke to each other. A glimpse at *The Origin of the Solar System* (edited by S. F. Dermott, John Wiley, 1978) will underline how infrequently the word star and planet came together. Oh, how things have changed — and for the better.

For the Dermott book, the thirty or so 'world experts' met in Newcastle for two weeks. And in 1976 no cosmogonist failed to come: thirty was all there were! *Protostars and Planets V* had its 2005 October gestation in Hawaii, with 805 participants meeting for a five-day conference. Fifty-eight reviews were given, and these form the chapters of this new book.

Much has changed in the last thirty years. Today we have found a profusion of extrasolar planets and our Solar System has expanded well beyond Pluto. Multiple members of some systems are now being discovered; huge computers are being used to simulate cluster dynamics, planetary accretion, and early orbital migration; star-forming regions are being probed using wavelengths ranging from the sub-millimetre to the X-ray; high-resolution images are being produced of circumstellar discs; the cosmochemical relationships between early meteorites and the gas and dust in stellar discs are strongly emphasized; and even the basics of the initial mass function, the single/binary star ratio, and cluster-dissipation timescales are beginning to be understood.

The book under review has been produced to the extremely high standard that we have come to expect of this University of Arizona series. It will form the ideal starting point for any pioneering researcher in the fields of interstellar molecular clouds, the first stage of star formation, mass loss by young stars, the structure and evolution of stellar clusters, brown dwarfs, circumstellar discs, the formation of terrestrial and giant planets, the rôle of dust in proto-planetary discs, and planetary system inter-comparison studies. It is clearly an honour to be asked to write a paper for this series and this shows. The standard of the submissions and the thoroughness of the refereeing process are only too obvious.

The outlook is rosy; the subject is blossoming. A host of space missions are soon to be launched that will boost the tally of known planets. Some day we might even see the cosmologist/cosmogonist ratio dropping into single figures! — DAVID W. HUGHES.

Space Exploration 2007, by B. Harvey (Springer, Heidelberg) 2007. Pp. 161, 28 × 21·5 cm. Price £15·50/$29·95/€19·95 (hardbound; ISBN 0 387 33330 4).

Space Exploration 2007 is something of a throw-back to the days of my youth when 'annuals' were popular. It is clearly designed to appeal to the space enthusiast and most likely aimed at the Christmas market. The use of cartoons at the beginning of each chapter may lead you to believe that this is a children's book but that is not the case. Indeed, the material in the book is pitched at a teen- or adult-level readership. Sadly, I have to confess I found the cartoons an unnecessary distraction from the content of the book, which, in general, appears to be of a high standard.

Although the title of the book implies information for 2007, the first chapter is actually a review of space launches and recoveries for 2005. This chapter also provides information on the activities of the various countries involved in space exploration and gives background data on many of the current launch vehicles.

The remaining seven chapters cover a range of topics written by a selection of specialist authors. They include the *International Space Station* and its construction, the exploration of Mars *via* recent landers and orbiters, the joint Russian/European space base at Kourou in Guyana, future lunar exploration by China and India, and *Kliper*, the next generation of Russian partly-reusable spacecraft.

Chapter 4 has several sections dealing with the exploration of the Solar System. The *Messenger* mission to Mercury is described and a history of the exploration of Venus is provided. Summaries of the Galilean Moons of Jupiter are given and the *Cassini* mission to Saturn and Titan is also reviewed. Recent rendezvous missions to comets and asteroids are also discussed. Chapter 5 takes a look into the future of both manned and unmanned spaceflight.

In conclusion, I am not sure whether the 'annual' format used for this book is the right one, nor do I think the cartoons are a good idea. I also prefer to see real pictures of spacecraft rather than artists' impressions. Nevertheless, the articles in the book are informative and generally well written, there are copious illustrations, and the price of the book is modest. I would say that this book is worth considering for the space junkie in your family. — STEVE BELL.

Deep-Sky Companions: Hidden Treasures, by S. J. O'Meara (Cambridge University Press), 2007. Pp. 584, 26 × 18·5 cm. Price £25/$45 (hardbound; ISBN 0 521 83704 9).

Anywhere on Earth labelled "hidden" or "undiscovered" can brace itself for an influx of visitors. The "hidden treasures" described in this book will undoubtedly experience an upsurge of interest too, the difference being that you can visit them all without seriously enlarging your carbon footprint. Firstly, what this book does not contain: you will find no objects from Charles Messier's catalogue or Patrick Moore's *Caldwell Catalogue*. Even so, virtually all the entries have some existing designation, mostly from the NGC or IC catalogues, although O'Meara 1 (an asterism in Pisces named by the author) may be unfamiliar to most. Not all the objects can truly be considered "hidden". For example, the Coma Star Cluster (Melotte 111), the Alpha Persei Cluster (Melotte 20), and the Coat-hanger asterism (Collinder 399) are well-known binocular highlights, and Barnard's Star, while perhaps difficult to pinpoint, is scarcely obscure, although the author admits that he did not first see it until 2003.

All the objects are stated to be visible with 100-mm aperture. Remember, though, that O'Meara observes from Hawaii and is noted for his acute eyesight, so most of us will require considerably larger apertures. But that is all part of the observing challenge that he sets us. O'Meara pursues a piratical theme, metaphorically waylaying, boarding, and opening the hatches of his quarry, accompanied by pirate-type maps of his own construction in which 'X' marks the spot of the treasure. My attempts at locating objects with these sketches demonstrated the need for additional charts, and I soon went back to more familiar ones.

Mimicking the Messier and Caldwell catalogues, O'Meara's list contains 109 objects — but he could not resist adding an appendix of 20 more. One marvels at his patience and dedication as he describes the many hours he has spent observing them. It should be noted that around a third of the total are too low to be seen easily from the UK, or are permanently below the UK's horizon. The result comes to almost 600 pages, nearly twice as long as the same author's book on the Messier objects. Given the size, it is remarkable that the publishers have kept the price down to an affordable level.

As with so many CUP books, the text can be read with profit by trainee sub-editors and proof readers — the hyphenated "leg-end" is itself a hidden treasure for collectors of typographical classics. — IAN RIDPATH.

Galaxies in the Universe: An Introduction, 2nd Edition, by L. S. Sparke & J. S. Gallagher, III (Cambridge University Press), 2007. Pp. 431, 25·5 × 18 cm. Price £70/$130 (hardbound; ISBN 0 521 85593 4), £35/$65 (paperback; ISBN 0 521 67186 8).

Galaxies in the Universe is the second edition of an earlier volume, published in 2000. At that time there were few modern, wide-ranging, yet informative books on galaxies suitable for undergraduates. Despite a little activity in the marketplace, this is still the case, so it is therefore good to see a revised edition.

The new edition maintains the high standard set previously, along with the clear style. Two of my criticisms of the previous volume regarded an index that was a little sparse, now improved, and insufficient material on the then fairly new idea of a dark-energy-dominated Universe. This has now been remedied thanks to the main updates in the areas of the high-redshift Universe and the first galaxies. These, together with a now-distinct chapter on galaxy groups and clusters, have improved an already good book. The early Universe is obviously a fast-paced research area, dominating the activities of an increasing fraction of astronomers these days — despite the reservations of at least one of the Editors of this *Magazine* (see **127**, 139, 2007). Scarcely a month passes without some dramatic claim, usually by a large collaboration, for having discovered the first, the brightest, or the biggest objects in the post-dark-ages galactic zoo. It is still the case, however, that we have not reconciled all of the data with the standard cosmological model, so more is yet to come. The authors provide a fair summary of the current state of play in a modest space.

In summary, this book remains an excellent undergraduate text at a modest price. Highly recommended. — PAUL O'BRIEN.

The de Vaucouleurs Atlas of Galaxies, by R. J. Buta, H. G. Corwin, Jr. & S. C. Odewahn (Cambridge University Press), 2007. Pp. 344, 28·5 × 22·5 cm. Price £70/$135 (hardbound; ISBN 0 521 82048 0).

Galaxy classification has a long, distinguished, and scientifically productive past and is still valuable. The two systems which developed, and still form the basis of current digital/automated analyses, are essentially based on the Hubble sequence, taken in one branch to its logical limits by Sandage, and defined and preserved in Allan Sandage's marvellous *Carnegie Atlas*; its alternative development, enhanced over many years by Gerard de Vaucouleurs, is now published posthumously in updated illustrated form in this volume by Buta, Corwin & Odewahn, his students and collaborators.

In 1995 I reviewed in these pages *The Carnegie Atlas of Galaxies* in glowing terms (**115**, 278). That review started "This magnificent two-volume atlas is a brilliant synthesis of the fruits of a lifetime of study by one of the greatest astronomers of the twentieth century, Allan Sandage, ably complemented by the photographic expertise of John Bedke". My review later became more enthusiastic and admiring still, ending "I have not previously reviewed ... using remotely as many superlatives as I have here". That comparison remains valid a decade later.

I was able to find those quotations thanks to the wonderful ADS, a product of the rapid recent digitization of life and astronomy. The present atlas, in addition to presenting the de Vaucouleurs classification system, uses the digitization of imaging as its basis. The book notes "Each Atlas illustration began with a FITS image ...", and this underlies its strengths and limits. The strength is that multi-colour and colour-gradient images are readily available, thus allowing the physical features underlying the classifications to be made evident. This is a conspicuous advance, in that potential galaxy classifiers will be able to create their own similar images, and match their data to this atlas reliably. The authors are to be congratulated for this effort, and encouraged to put this atlas on-line. The limit is of course that digital images have exceedingly few pixels compared to a Sandage/Bedke image, so the pictures here — all printed grey-scale — will never justify a space on a coffee table, let alone a quiet astro-porn drool. Nonetheless, this is a valuable contribution to the field, contains a wealth of information, and justifiably brings one of the major contributions of a great astronomer to the modern research community in a useful, and useable, form. The *Carnegie Atlas* delivered 750 pages of large-format (35 × 45 cm) high-quality photography for $92. The present grey-scale lowish-resolution book of 344 pages costs $135. *O tempora, O mores*. — GERRY GILMORE.

Cosmic Catastrophes: Exploding Stars, Black Holes, and Mapping the Universe, 2nd Edition, by J. C. Wheeler (Cambridge University Press), 2007. Pp. 339, 23·5 × 15·5 cm. Price £25/$40 (hardbound; ISBN 0 521 85714 7).

J. Craig Wheeler is a high-energy astrophysicist, meaning both that he works on bang-up events and that he is a person of remarkable vim and vigour. And it has been a long time since anyone confused him with J. A. Wheeler. The book is a second edition, intended for use in classes for non-scientists. The University of California at Irvine has a 10-week course on high-energy astrophysics as part of a large set that can be mixed and matched to fulfil a breadth requirement. And next time it is my turn at Physics 20D, I shall ask the students to save their 4000 pennies (plus tax) and acquire *Cosmic Catastrophes*.

The core of the material covered remains supernovae, Wheeler's own scientific focus — how stars, single or binary, get into that sort of fix, the physics of the explosions, what we see, and what the various products do in the way of neutron stars, black holes, and nucleosynthesis. The second edition has an expanded treatment of the use of supernovae as distance indicators for cosmology; of gamma-ray bursts and their connection with supernovae; of wormholes and the possibility of time machines; and of strings, quantum gravity, brane worlds, and other frontiers between theoretical physics and observational cosmology.

There are some more personal stories — how Craig saw SN 1987A from the cockpit of a Qantas flight and what we might see when Betelgeuse blows. Both singular and plural pronouns of all three persons are used freely, and very much the same way I would, so you will not be surprised to hear that I think the book is exceedingly well written, a viewpoint endorsed by reviewers for *Sky & Telescope* and other publications. Binary stars get their own chapter, still not as much as they deserve, of course, but more than they get in most astronomy books. If you have time for only one section, I recommend the one on Roche lobes, with its oath of secrecy. Nor does the author gloss over cracks in the sidewalk, like the detail that the stars responsible for the vast majority of supernovae (8–15 solar masses at birth) are not the ones responsible for most of the heavy-element production, which are more massive. Oh, and be sure to keep an eye out for Jerry Ostriker's theory of gamma-ray bursters! — VIRGINIA TRIMBLE.

Active OB-Stars: Laboratories for Stellar & Circumstellar Physics (ASP Conference Series, Vol. 361), edited by Š. Stefl, S. P. Owocki & A. T. Okazaki (Astronomical Society of the Pacific, San Francisco), 2007. Pp. 573, 23·5 × 15·5 cm. Price $77 (about £38) (hardbound; ISBN 1 583 81229 6).

These proceedings report what looks like a very successful conference held in Sapporo two years ago. The active OB stars include classical Be stars, B[e] stars, and structures in the winds of OB stars. The influences of rotation, pulsation, binary companions, magnetic fields, and mass loss on the formation and destruction of circumstellar discs are extensively discussed. Perhaps naïvely, I hadn't realized how many unsolved problems the spin-up of Be stars and the origin of their circumstellar structures present — indeed, how uncertain our knowledge of stellar rotation, especially near critical velocity, still is. Amongst new developments reported, there are several contributions discussing high-resolution interferometric observations of Be stars and their environments with instruments like *VLTI* and CHARA's interferometer, and the evolutionary status of Be stars. Evidently, there is much more to be done in both these areas, and we can expect to see progress at future Be-star meetings. Altogether, the angles are pretty well covered, although I would have liked to have seen a bit more on radio emission from Be stars and dust emission from the B[e] supergiants.

The proceedings follow the familiar format: invited reviews, other contributions, and poster summaries. The discussions following the invited reviews and contributions are, with very few exceptions, reported in verbatim style, and the editors have commendably inserted names and other clarifications to help the reader. In addition, the six extended discussion sessions covering major themes of the conference are fully reported. I found them fascinating reading for their picture of where the uncertainties lie and often valuable qualifications of the conclusions in the formal contributions. If there is a single reason for reading and buying volumes of proceedings, it is for discussions such as these. Of the invited reviews, I particularly liked that by Owocki, a comprehensive survey which gets the book off to an excellent start, and those by Rivinius and Chesneau — but this is not to diminish other contributions, all of which I found to be informative and well written. The three pages allotted to each of the poster summaries makes this a more useful section of these proceedings than is sometimes the case, and I found some nuggets here too. The conference concluded with a comprehensive summary by Baade, which I found excellent reading, and the proceedings are finished off with extensive author, object, and subject indices. Overall, this book provides a very good overview of processes in massive active stars and is warmly recommended. — PEREDUR WILLIAMS.

The Seventh Pacific Rim Conference on Stellar Astrophysics (ASP Conference Series, Vol. 362), edited by Y. W. Kang *et al.* (Astronomical Society of the Pacific, San Francisco), 2007. Pp. 322, 23·5 × 15·5 cm. Price $77 (about £38) (hardbound; ISBN 1 583 81230 X).

The Pacific is the world's largest ocean, so perhaps we should not be surprised that this 7th conference included not only participants from China, Japan, South Korea (the host), Australia, and Thailand, but also contingents from Germany, Ukraine, and India. The proceedings open with reminiscences by Helmut A. Abt — who attended all of the previous six, one in a wheelchair — and close with a one-page summary by R. H. Koch that manages to identify six highlights in four paragraphs. For the nostalgic there are papers on distances to eclipsing binaries by Robert E. Wilson and cooling of neutron stars by Sachiko Tsuruta, subjects on which each first wrote more than 40 years ago. If you prefer the not-quite-yet-seen, there are predictions of emission from strange stars (K. S. Cheng & T. Harko) and of X-ray flare spectra from proto-stars (T. Kawamichi & K. Shibata). The primary territories covered include binaries, especially cataclysmic variables, compact stars, and star formation. Like any conference volume, this one includes a few papers of enduring value, one or two of which probably contain ideas that will not be published elsewhere, and rather more papers of lesser importance. Now if only I could be sure which was which. — VIRGINIA TRIMBLE.

The Future of Photometric, Spectrophotometric and Polarimetric Standardization (ASP Conference Series, Vol. 364), edited by C. Sterken (Astronomical Society of the Pacific, San Francisco), 2006. Pp. 633, 23·5 × 15·5 cm. Price $77 (about £38) (hardbound; ISBN 1 583 81232 6)

This volume reports events at a conference held at Blankenberge, Belgium, in part to honour the dedication of Arlo Landolt to *UBVRI* standardization. Publication has been prompt.

Part 2 of the volume concentrates on selected modern photometric systems and includes an exemplary presentation of the Walraven photometry by Pel and Lub. There are seven contributions in Part 3 concerning photometric sky surveys, and the detail in the calibration of two wide-field mosaic imagers by Monelli *et al.* is at the thoughtful level shown by the Dutch authors. In Part 6, infrared standardization is treated separately from the visible band and it seems clear that not every-one accepts the counsels of perfection expressed by Milone and Young concerning filter design. There is also an excellent description of the physics and engineering of hollow-cathode lamps for rest wavelengths. Parts 4 and 5 deal with spectrophotometry. In these pages, Dodd offers an accomplished propagation of measures and errors from an undimensioned spectral-energy distribution into one with absolute units, and other authors express the impact of the spin rate and pole aspect of Vega on their models. The polarization papers in Part 7 are significant for their attention to rigour of definition and convention and for the nice investigation of errors and variability of potential stellar standards by Bastien and several co-authors. The editor's first theme, that standardization is excitement and satisfaction for the scrupulous, is evident in all of these and other pages.

Some remarks are necessary about publication values. The reader will note a burden of typos and solecisms, and the editor's contributions in Part 1 show that it is unreasonable to expect him to find and correct them. There is a lengthy and useful tally of acronyms but the index of celestial objects has a number of erroneous page attributions. The subject index appears correct for the 25 or so entries that I checked but its reverse use has limitations. From p. 267, for example, 'Rayleigh scattering', 'ozone', 'aerosol', and 'Chappuis bands' do not appear in that index. There are also instances of captions referring to internal colour coding in busy black-and-white figures.

Enduring value of the volume as a reference handbook (the editor's second expectation) seems unlikely. Rather, a recruit to astronomical standardization is going to immerse himself in the web pages of groups active at the time. These will contain more and more detailed information than this text does. — ROBERT KOCH.

Our Universe: An Introduction, by Patrick Moore (Facts, Figures & Fun, Wisley), 2007. Pp. 128, 19 × 12·5 cm. Price £6·99 (hardbound; ISBN 1 904 33241 2).

The book starts with a clever disclaimer regarding the cost of perfection; however, I still did not expect to see "… Earth is only one of seven principal planets" in the third paragraph. The chapter headings are: 'The Universe around us'; 'The Moon'; 'Mercury'; 'Mars'; 'Asteroids'; 'Jupiter'; 'Saturn'; 'Uranus', 'Neptune and beyond'; 'Comets and meteors'; 'The Sun'; and 'Stars and the constellations', indicating that Venus is the missing item, although it does appear — in the chapter about Mars! These chapter headings also give a good indication of the main emphasis of the book — there is much more about the Solar System than I would expect from the title.

In general the layout of the book is good, although it does not have an index and the glossary is only 13 entries in the first chapter. There are many tables and a collection of photographs and line drawings (all black and white), although very few of these are referenced or even labelled. Another oddity is that the units are imperial throughout except for temperatures, where Celsius is allowed. There are one or two typographic errors (such as Comet Poms-Winnecke on p. 93, and I have no idea what 'Max Ni Magnitude' might be on p. 9) but these are trivial and the book is easily understood.

Anyone could read this book and learn something from it. The character of the book's author shows through, and many points are enlivened by stories of the personalities involved, often from the author's own experience. There are also scathing comments about some people that I was surprised to see printed — it's worth buying the book for those alone! — RITA WHITING.

Solar Polarization 4 (ASP Conference Series, Vol. 358), edited by R. Casini & B.W. Lites (Astronomical Society of the Pacific, San Francisco), 2006. Pp. 477, 23·5 × 15·5 cm. Price \$77 (about £38) (hardbound; ISBN 1 583 81226 1).

Conferences on solar polarimetry seem to be occurring more frequently. This tome presents the collection of papers of the Fourth Meeting of its type held at Boulder, Colorado, in 2005 September, just two years after the previous gathering. The contents of the papers reflect the breadth of activity in regard to observational practices, measurements, and interpretations of the fascinating polarimetric signatures within spectral lines of the light originating in solar surface disturbances and at the limb of the Sun, with a drive to measure and interpret data obtained at higher and higher spectral and spatial resolution. There are some 65 papers on esoteric details of solar spectropolarimetry but no substantial reviews. The subject continues to advance at great speed, pushed along by a large army of researchers — as is evident from the large list of attendees. In addition there are a few papers related to stellar spectropolarimetry, these being loosely connected to the study of the 'second spectrum' of the Sun. — DAVID CLARKE.

Supersymmetry and String Theory: Beyond the Standard Model, by M. Dine (Cambridge University Press), 2007. Pp. 515, 25·5 × 18 cm. Price £45/\$80 (hardbound; ISBN 0 521 85841 0).

Particle physics is about to enter a new era with the start-up of the *Large Hadron Collider* at CERN. From 2008 on, a flood of new data will put our ideas of physics beyond the Standard Model to a serious test. This book provides a broad and well-founded introduction to the main theoretical concepts: the Standard Model, non-perturbative aspects of gauge theories, grand unification, supersymmetry, extra dimensions, and string theory. It also briefly describes General Relativity and essential issues in cosmology. The sections on string theory discuss string compactifications and string dualities from the perspective of an expert in the field. The comprehensive list of state-of-the-art topics presented makes Dine's book an almost unique text. The parts on supersymmetry and string theory especially contain a wealth of material, often showing deep physical insight. The book is not always an easy one. Problem sets at the end of each section help the reader to get familiar with the ideas presented. A website with updates and errata is available as well. This book is a valuable resource for anybody who learns and teaches particle physics. For the active researcher it also provides the tools necessary to develop new models in an exciting area of physics. — STEPHAN HUBER.

Electromagnetic Interactions and Hadronic Structure, by F. Close, S. Donnachie & G. Shaw (Cambridge University Press), 2007. Pp. 499, 25·5 × 18 cm. Price £85/\$160 (hardbound; ISBN 0 521 84420 7).

If, as has been claimed in connection with a Hawking runaway best seller, the readership of a book is cut by a factor two for every equation, then this volume will have 10^{-164} fewer readers than Hawking did. Probably most readers of *The Observatory* will not be among them, but you never know. The three named authors are in fact the senior ones of a team of 13, coming from almost as many high-profile institutions in a handful of countries. All belong to the high-energy, elementary-particle-physics community, both theoretical and experimental, and the emphasis of the book is on the phenomenology of proton structure, diffractive photoprocesses, chiral perturbation theory, and other current topics in the field. And by the time I reached the last chapter on, "colour transparency", I already knew this was not going to be about pictures for projection. The intended readership is graduate students and researchers in the field of particle physics and electromagnetic interactions, and if your institution or department includes physicists in these territories, then the library should probably save its pennies (not, however, by cancelling its *Observatory* subscription) and buy this 2007 addition to the Cambridge Monographs on particle physics, nuclear physics, and cosmology. And if you wish to argue that something with 13 authors cannot be a "mono"graph, I'm sorry. That battle has already been fought and lost. — VIRGINIA TRIMBLE.

SINS — Small Ionized and Neutral Structures in the Diffuse Interstellar Medium (ASP Conference Series, Vol. 365), edited by M. Haverkorn & W. M. Goss (Astronomical Society of the Pacific, San Francisco), 2007. Pp. 360, 23·5 × 15·5 cm. Price \$77 (about £38) (hardbound; ISBN 1 583 81233 4).

As the editors remark in their preface to this excellent conference volume, their choice of the acronym by which the topic of the conference was summarized turned out to be unfortunate in the age of email, as spam filters often eliminate emails with the word "SINS" in the title. So you may possibly have missed hearing about the meeting in advance (as I think I did) or may not have seen information about this book. If so, that's a pity. This is an important volume, that rare thing — a valuable report of what seems to have been a useful and productive conference on a topic that deserves a much higher level of attention than it generally receives.

Observations of what has become known as tiny-scale atomic structure (TSAS) in the diffuse interstellar medium have been discussed for at least three decades. The phenomenon has become broader and now includes not only atoms but also molecules (TSMS) and partially-ionized structures (TSIS). This book contains a wealth of information on past and recent observations of atomic and molecular lines that reveal these structures, and on the scintillation patterns and other indications of ionized structures. The implications seem quite extraordinary; for TSAS and TSMS, for example: at face value the implied structures may have size scales on the order of an Astronomical Unit, must be much denser than the ambient interstellar density, and — if so — are grossly over-pressured and so must be transient. This is the significance of this topic; it's telling us that we don't understand the dynamics of what we thought was the simplest region of space in the Galaxy. How is energy dumped into the gas and how is it dissipated?

As well as presenting the current observational situation, much of this book is taken up with attempts to develop theoretical understanding of the phenomenon. At the end of the book are two remarkable summaries of the observations (Carl Heiles and Dan Stinebring) and theories (Steven Spangler and Enrique Vazquez-Semadeni). These list some possible ideas for the origin of the structures: unusual morphology or causes of over-pressure in the case of objects assumed to be real; or simply apparent structures caused by line-of-sight effects through a turbulent medium. There's still plenty of scope for imaginative speculation in this developing topic!

The book is well organized, the papers are concise and well-written, and the expert summaries are valuable. As the editors explain, the topic is one that Lyman Spitzer was trying to understand during the year before his death. If you have the courage to undertake a solution of these long-standing, fascinating, and potentially very significant problems, this is the book you should buy and read before you begin! — DAVID A. WILLIAMS.

Revealing the Molecular Universe: One Antenna is Never Enough (ASP Conference Series, Vol. 356), edited by D. C. Backer, J. L. Turner & J. M. Moran (Astronomical Society of the Pacific, San Francisco), 2006. Pp. 314, 23·5 × 15·5 cm. Price $77 (about £38) (hardbound; ISBN 1 583 81224 5).

Jack Welch has been an essential member of the Berkeley Radio Astronomy Laboratory at the University of California (of which the Hat Creek Observatory is part) since the early 1960s. This volume is the published version of the papers at a two-day meeting (inevitably called the *Jackfest*) in 2005 September, attended by many of his colleagues and former students. It was in celebration of what one speaker called his "pseudo-retirement"; it is clearly understood that the end of formal teaching commitments does not mean the end of a scientific career.

Naturally there are lots of memories and stories, and there are talks on the telescopes (past and present) as well as the science — most of which concerns molecular astrophysics and the need, foreseen by Jack, for more resolution than you can get with a single dish. I don't get the impression that this is just a book of reminiscences, though there are lots, but that there is plenty to set the reader thinking (particularly in the context of *ALMA*). Jack was clearly right: more resolution (and the sensitivity to go with it) is crucial to studies of this sort. Quite expensive to put on your own bookshelf, but a good buy for the library. — GUY POOLEY.

Radioastronomical Tools and Techniques, by N. S. Kardashev & A. Dagkesamanskii (Cambridge Scientific Publishers, Cambridge), 2007. Pp. 405, 25 × 18 cm. Price £65/$111 (hardbound; ISBN 1 904 86829 0).

This book has the feel of a series of conference-type reports, ranging in length from three or four pages to the longest, covering interplanetary scintillation, which is about 30 pages. There is a long history of radio astronomy in Russia, and the work done there is probably less well known in the West than it deserves, so this volume is to be welcomed on that basis. It is all translated into acceptable English, though the publisher should have employed a native English-speaker with knowledge of the field to knock off a few of the rough edges that still distract the reader.

The volume is in two parts: nearly half is devoted to aspects of space projects, mainly *Radioastron*, the Russian-led space-VLBI satellite project which has been some time in preparation. These sections are frequently very detailed: the first one considers the orbital parameters for the *Radioastron* satellite and the consequential constraints on observations, for example. Those thinking that this book might be of a similar nature to *Tools of Radio Astronomy* (Rohlfs & Wilson) will be disappointed: it is not really a text-book in that style.

Part 2 is titled 'Ground-based telescopes, tools and techniques' and also reads like a series of reports on work-in-progress, mostly describing the technical work involved but sometimes including some real data.

On the back cover of the book, the publishers claim: "This volumes [*sic*] provides a useful and timely reference text for postgraduates and researchers in radioastronomy". Parts will be useful; is any of it "timely"? I skimmed through the lists of references on the individual chapters: in only a couple of cases did I spot anything later than 1999. The technical side of things has moved on, and the references to tape-recording of the VLBI signals, for example, are now irrelevant. And the great majority of the references are to papers in Russian, and although this is clearly stated in the reference lists it does reduce the value for the presumed readership of the book. I am not clear whether this collection has been published in a similar form in Russian. Would I recommend you to buy this out of your own pocket? No, I don't think that I would. Should your library get a copy? I'm sorry to say that this is also doubtful at the list price although it should be pointed out that this particular publisher will give significant discounts to academic libraries. — Guy Pooley.

The Comet Sweeper: Caroline Herschel's Astronomical Ambition, by Claire Brock (Icon Books, Cambridge), 2007. Pp. 292, 20 × 13·5 cm. Price £9·99 (hardbound; ISBN 1 840 46720 7).

The blurb on the cover of this book opens with the statement that Caroline Herschel's "rediscovery is long overdue". Rediscovery? This most celebrated woman astronomer of all time has never been lost or forgotten. The author soon makes clear that what is meant is 'rehabilitating', or reinterpreting Caroline's life and work in the context of women's place in the history of science. She chooses as her main theme — and also as the subtitle of her book — Caroline's ambition, which she sees as the driving force of her heroine's career. As a young girl growing up in Hanover, Caroline longed to be independent, to earn her own living and to make something of her life. All these aims she eventually achieved, in spite of obstacles and disappointments, finding her vocation at last as an astronomer.

According to the author, Caroline Herschel has been badly served by her previous biographers who represent her chiefly as the selfless assistant of her brother William, a reputation posthumously constructed from unspecified selective quotations from her correspondence. Her rightful place, she claims, is as a discoverer of objects, which in the feminist hierarchy ranks two places above that of expositor of science (or "Mediatrix"). Caroline's cometary discoveries, on which her fame popularly rests, were indeed remarkable; but in the longer perspective, her most valuable contribution to astronomy was "her share in the immortal labours of her brother William Herschel" (her own words as inscribed on her tomb, though unfortunately not quoted in the present book). The author, a non-scientist, fails to appreciate the central rôle of William in Caroline's story and dismisses out of hand the work of distinguished historians of astronomy.

She is on safer ground, however, when it comes to viewing Caroline from another angle, as a woman who, in an age when women were largely confined to the domestic sphere, strove fiercely to break away from it. The book adds no new facts to what is known of Caroline Herschel's life and astronomical career, but it provides a powerful portrait of an ambitious, highly intelligent, and unshakeably determined woman who succeeded far beyond the governess-level aspirations of her youth, and who became, as she remains, an important feminist icon. — Mary Brück.

Sundials: History, Art, People, Science, by Mark Lennox-Boyd (Frances Lincoln, London), 2006. Pp. 144, 31·5 × 26 cm. Price £30 (hardbound; ISBN 0 711 22494 3).

There is something extremely 'green' and eco-friendly about a sundial. This, the oldest of scientific instruments, is utilitarian, rational, and does not require a power socket. In the vast majority of cases, it is also a thing of beauty and provides one of the few tenuous threads between science and applied art. Here we have a robust instrument that not only obeys the rules of celestial mechanics, and applies trigonometric mathematics to a functional need, but also satisfies the eye and intellect. On sunny days it provides a constant reminder of the passing of time, the continual movement of the heavens, and, more prosaically, the imminence of death.

Sir Mark Lennox-Boyd has advanced (in our eyes) from the law, the Houses of Parliament, and the Foreign Office, to become an *aficionado* and designer of sundials. His stunning book abounds with enthusiasm, erudition, appreciation, and joy. Do not worry if you don't know the difference between a hemicyclium and a hemispherium, and have difficulty orientating your scaphe. Do not fret if you confuse an analemmatic dial with a universal equatorial ring dial. All is made clear.

Lennox-Boyd treats the subject chronologically. We start around 1500 BC with the earliest sundials of the Egyptian pharaoh Tuthmosis III. We pass through the times when no city square, church, or mosque was complete without its utilitarian dial, to the present, when dials are mainly garden ornaments or sculptural commemorative pieces. We are introduced to the famous dialers: Marcus Antistius Euporus, Emperor Augustus, Ulugh Beg, Nicolaus Kratzer, Gemma Frisius, Christopher Schissler, Egnatio Danti, Father Emanuel Maignan, Christopher Wren, Jean-Louis Sieur de Vaulezard, Francesco Bianchini, William Oughtred, and the Maharajah Sawai Jai Singh II. We revel in the wonders of the modern proponents. The Egyptian vertical needles are eventually replaced by the medieval Arabic slanting styles and gnomons. We see simplistic marking eventually augmented by explanations of the intricacies of the Equation of Time.

Throughout the book we are treated to a host of splendid colour photographs, illustrations, and descriptive figures. There is even a short mathematical appendix for those who wish to produce their own sundials. This book is an absolute, no-expense-spared joy and is a first-class introduction to the dialing art and dial collecting. — David W. Hughes.

THESIS ABSTRACT

The Dusty Circumstellar Envelopes of Post-AGB Stars

By Kim Lesley Clube

Post-AGB stars are transition objects between the asymptotic-giant-branch (AGB) and planetary-nebula (PN) stages of stellar evolution. This is a relatively short (10^3–10^4 years) phase during which the star is surrounded by an expanding dusty shell. One of the questions raised about this stage of stellar evolution is why do nearly all PN have asymmetric structures, usually axisymmetric, while outflows from AGB stars are largely spherically symmetric? When does this shaping first occur and what causes it? Studies of individual stars in this transitional phase of their evolution will help to answer these questions, and a small sample of objects in this transitional phase has been imaged with the mid-infrared camera, *OSCIR*,

mounted on the 8·1-m *Gemini North Telescope*. The sample includes both O- and C-rich stars. The spectral-energy distribution (SED) from UV to sub-mm wavelengths is fitted, for each object, using a 2-D dust-radiation-transport code. The code also produces model images which are fitted to the *OSCIR* images to determine the degree of axisymmetry in the dust shell.

Each of the objects studied here shows axisymmetric structure. The mid-IR images of IRAS 22223+4327 show two peaks, which are probably the limb-brightened peaks of a dust torus. The images suggest that there is more dust in one of the peaks. The modelling suggests that this object is at least 2·8 kpc away. IRAS 19500–1709 is shown to be at least 4 kpc away by the modelling. This object is C-rich, like IRAS 22223+4327, and the dust shells of both of these objects are fitted with a dust-grain model composed of amorphous carbon, silicon carbide, and magnesium sulphide. IRAS 19475+3119 is the O-rich object in this sample and the SED is fitted with a dust-grain model composed of amorphous silicates, crystalline silicates, and crystalline water-ice-coated silicates.

Each of the objects in this sample shows evidence of a brightness asymmetry. The cause of this is uncertain but it is likely to be due to the presence of a binary companion or planet, and comparison is made with other similar objects. Long-term monitoring of the radial velocities of these objects is needed to confirm the presence of any companion.

Detailed radiative-transfer modelling of the circumstellar envelopes, along with well-resolved mid-IR images, is shown to be a highly effective way of determining the morphology and properties of the dust surrounding post-AGB stars. — *University of Hertfordshire; accepted 2007 July.*

NOTES

Good Homes Required

Dr. David Dewhirst has kindly offered the Editors of *The Observatory* his personal set of the *Magazine*, which includes Volumes **64** (1941) to **117** (1997); of these volumes, 64–82 are bound. His main concern, and that of the Editors, is that they should go to a good home. Therefore Bob Argyle or Mark Hurn (Librarian at the Institute of Astronomy, Cambridge) will be pleased to hear from anyone who can offer them suitable accommodation (with transportation costs only required to be met).

A set of Palomar Observatory Sky Survey first-epoch glass copies in two colours (O and E) is also available to a good home, along with a custom set of shelves designed to store them. Those interested will need to collect these items from the Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA. Contact Bob Argyle (rwa@ast.cam.ac.uk) or telephone (01223) 337524 for more information.

Here and There

STRAY DOG

[NGC 1502] is a cluster of about 45 stars that turn perpetually around the Pole Star in the neighbouring constellation of Canis Minor. — *The Daily Telegraph*, 2007 February 5 (February Night Sky).

A GALAXY WITH A VERY HIGH PROPER MOTION

… Camelopardalis is filled with faint background galaxies. One of the best known is the Pinwheel Galaxy, M 101, … — *The Daily Telegraph*, 2007 February 5 (February Night Sky).

THE BIG COUNTRY (WITH A SKY TO MATCH)

Powys, Wales: At this time of year, you should be able to see 400 constellations. — *The Observer Magazine*, 2007 February 18, p. 49.

OCCIDENTAL MISTAKE

Today, the vernal equinox marks the arrival of spring in the Western Hemisphere. — *Victoria Times-Colonist* (BC, Canada), 2007 March 20, p. A8.

IT'S TRUE — SUMMER REALLY IS COMING EARLIER

The Sun reaches its most northerly position on the ecliptic on June 2, the date of the Summer Solstice — *JBAA*, **117**, 154, 2007.

THANKS FOR NOTHING

… the 200-inch optical telescope at Mount Wilson. — (who thanks — for checking). — *AN*, **328**, 428, 2007.

IS THERE ANY?

Correlation between metallicity and Mg II equevalent with in DLAs and sub-DLAs. — *MNRAS*, **376**, 674, 2007.

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… the data presented in Fig. 5 are certainly consistent with, and are even weekly supporting, the conjecture … — *A&A*, **422**, L37, 2004.

ESO RELOCATED

Andover, MinnEuropean Southern Observatoryta, USA — *Very High Angular Resolution Imaging* (IAU Symposium 158) (Kluwer, Dordrecht), 1994, p. xvi.

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