Looking now to the future — say, 2040. If exobiologists and bioastronomers are correct, between now and then it is possible there will be news of confirmation of simple life on Mars and of confirmed signals from an ETI civilization. Regarding life on Mars, back in the 1960s Iosif Shklovskii pointed out even the simplest form would prove the existence of other technological civilizations in the Galaxy. News of such discoveries would obviously oblige us to re-speculate about our past and our future. New ideology, philosophy, and religion will emerge. Ramifications, especially those related to an ETI technological society, depend on what sort of signal we intercept. Should the translation of the signal provide no exact details about the biology, philosophy, and social system of the ETI broadcaster, it will limit our scope for new thinking. Even so, confirmation of extraterrestrial life will surely bring about a new humanism. Intellectually, it will diminish our anthropomorphism and bring us to terms with the fact of having no experience to deal with a society that biologically or technologically could be superior or unrelated to our own. Clearly, this will be a new milestone for our species.

Yours faithfully
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2000 June 24

Reference

(1) J. Tarter, *SETI News*, **8**, Nr. 2, Third Quarter 1999.

REVIEWS

NavPac and Compact Data 2001–2005, by C. Y. Hohenkerk & B. D. Yallop (The Stationery Office, Norwich), 2000. Pp. 132 + CD ROM, 24·5 × 19 cm. Price £40 (paperback: ISBN 0 118 87311 3)

It has been a pleasure to review this new version of a work I reviewed five years ago, and try it in the company of another previous reviewer. The series has here reached its fifth manifestation and has changed its title to put the NavPac program first, presumably due to success in the number of implementations achieved, including use by the British Admiralty, who have allowed a chapter from the *Manual of Navigation* to be included on the CD ROM which replaces the previous version's floppy disk. All the previous data are still available on this and will allow practice examples to be preserved for those using it for tuition. The availability of robust computers for use on board will encourage the program to be used for continuous monitoring of position as an ellipse of probability incorporating running fixes as sights are obtained, but the raw data are still available in the book for sights to be worked up from first principles with a scientific calculator, or even more laboriously by hand and brain. It also allows eclipse times to be obtained literally on the back of an envelope as an exercise to escape the mundane!

The size of the previous edition has been preserved, taking little space on the

navigator's bookshelf, and the cost of £40 is still a considerable saving on the five-year cost of the traditional *Nautical Almanac* and associated publications. Other compact publications are available which give some ease of calculation, but none I am aware of allow such access to the raw data for purposes of practice or interest beyond maintaining a check of current position, for which purpose the use of a PC with NavPac provides unrivalled convenience outside of GPS — which does not always provide the useful astronomical information such as rising and setting times, azimuths for compass checking, *etc.*

The time seems to me to be ripe for the development of an electronic-photonic sextant with more sophisticated sensors than the Mk I human eyeball to input to this system; nevertheless I shall be taking my traditional sextant and the hard-copy book with me to high latitudes shortly — if only to keep my hand in for backup to GPS; I hope to be able to follow the development of this publication over the next five years. — JOHN MAGRAW.

The Accelerating Universe, by M. Livio (Wiley, Chichester), 2000. Pp. 274, 24 × 16 cm. Price £18·50 (hardbound; ISBN 0 471 32969 X).

Until recently, most astronomers and cosmologists would have bet money that the expansion of the Universe was slowing down. In the standard cosmological models based on Einstein's general theory of relativity, cosmic deceleration is a simple consequence of the attractive nature of gravity. Over the last few years, however, various astronomical observations, particularly studies of supernovae outbursts in galaxies at high redshift, have suggested that the Universe has expanded by a larger factor than these standard models suggest. This has led many to argue that the inferred acceleration requires a change in the standard cosmological model. To achieve this within the confines of Einstein's theory requires the addition of a cosmological constant term or, equivalently, a cosmological energy density with negative pressure. The resulting models appear more complex and, perhaps, 'uglier' than the decelerating models they are now displacing as the standard paradigm.

This book, by Mario Livio, is partly an attempt to explain these developments and their wider ramifications to a non-technical audience. I have to admit that my heart sank a little when I saw the title of this book. It seems to me still premature to accept cosmic acceleration as 'fact'. For example, the popular media have taken considerable interest in the high-redshift supernova measurements, but have tended to present them as cast-iron despite the considerable uncertainties that remain. This book displays the same tendency. It is true that the accelerating models do provide the best available fit to a whole range of cosmological observations. Nevertheless, as one famous astronomer put it, any model that agrees with all the observations must be wrong because, at any particular time, some of the data are bound to be wrong!

However, the subtitle "Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos" makes it clear that the scope of the book is much wider than possible cosmic acceleration. Although the central thread of the narrative does indeed concern the expansion of the Universe and attempts to measure changes in its rate, there are many enjoyable digressions into topics as diverse as aesthetics, philosophy, and biology. The author flies along these tangents with great enthusiasm. The eclectic nature of the material, the insightful approach, and the lucid writing style make this well worth reading. Highly recommended. — PETER COLES.

Variable Stars as Essential Astrophysical Tools, edited by C. İbanoğlu (Kluwer, Dordrecht), 1999. Pp. 825, 24·5 × 16·5 cm. Price £215/$344 (hardbound; ISBN 0 792 36083 4).

Turkey is a pleasant place for conferences, so it is perhaps not surprising that quite a few NATO Advanced Study Institutes are held there. They are intended to provide an intense period of study for young research workers, mainly graduate students, so the talks are a mixture of review and new work. Published versions should therefore be a useful source of background material for anyone approaching a new topic or wanting (like me) to refresh their knowledge. Does this one succeed? Should you recommend this book for your library (for no individual is likely to buy it at the usual inflated Kluwer price)?

There is certainly a lot of material here, and some of it is excellent. I particularly enjoyed the masterly initial two chapters on stellar structure, pulsation, and helioseismology by Christensen-Dalsgaard, Dziembowski, Däppen and Guzik. These occupy about 20% of the book and beautifully set the scene for the rest of it. In all there are sixteen chapters, covering such a broad sweep of variable-star research that the only way to convey this is by listing the titles of the other 14: Astrophysical equation of state and opacity; Asteroseismology of δ Scuti stars; Evolution and hydrodynamics of rotating stars; Collection, reduction and analysis of data of pulsating stars; Ap stars, roAp stars and the asteroseismology of roAp stars; Asteroseismology of Cepheids; Theoretical models of γ Doradus variables; Trend analysis of long-period variables; Pulsating white dwarf stars; The O-C diagram; Binary stars; Cool close binaries and RS CVn stars; High-energy binaries and exotic objects; Satellite observations. Each 'chapter' actually consists of several papers (from one to as many as ten). With such a large range of topics, it would seem impossible to produce a book with a coherent argument running through it, and this one certainly has clear discontinuities. Oddly, the sections/chapters are not as clearly delineated in the text as in the list of contents, and the discontinuities jar a bit as a result. Another feature that jars is the lack of editing for English grammar; some of the papers by non-native English speakers (although by no means all) are quite hard to read.

The papers are a mixture of broad reviews and shorter, more specialised papers. I felt that only the reviews really succeeded. However, the general level of the reviews is high, with the following ones appealing particularly to me. Däppen and Guzik give a careful account of the most recent equation of state and opacity calculations, distinguishing usefully between the OPAL and Opacity Project approaches (this sits oddly with a later very useful review of Cepheid calculations by Iben, which makes no mention of the new opacities). Kurtz gives a splendid introduction to Ap and roAp stars, including an interesting history of Przybylski's star. Matthews finds that *Hipparcos* parallaxes are larger than predicted by asteroseismology for roAp stars. Kawaler provides an excellent review of pulsating white dwarfs, noting that asteroseismology can provide clues to the composition beneath the surface and hence to the previous evolution and age. Sterken gives a broad critical overview of the use of the O − C diagram to analyse period changes, while Ribas *et al.* demonstrate the use of apsidal motion in detached eclipsing binaries to provide evidence for overshooting near the end of main-sequence evolution. Tout gives a comprehensive review of cataclysmic variables, with an emphasis on magnetic effects.

The book is nicely produced, but beware of the interesting article by Niarchos on gravity-darkening, which has been hit by gremlins: pages 639 and 640 have

been printed in the wrong order, and Figs 1 and 2 have each other's captions (to make matters worse, Fig. 2, which is attached to the caption for Fig. 1, has also been rotated anti-clockwise by 90°!).

So: should you recommend this book for your library? It is probably unique in the breadth of its coverage of topics, and as such will remain useful for some time. However, the number of people who need such a broad coverage is quite small and there are probably better ways of getting an up-to-date picture of each of the individual specialised areas. If your library is short of money (and which one is not these days?), it could manage without this expensive volume. — ROBERT CONNON SMITH.

The Cambridge Planetary Handbook, by M. E. Bakich (Cambridge University Press), 2000. Pp. 336, 25·5 × 19·5 cm. Price £19·95/$29·95 (hardbound; ISBN 0 521 63280 3).

In this book the author has risen to the challenge of doing for the planets what he previously did for the constellations in *Cambridge Guide to the Constellations* (Cambridge University Press, 1995). The result is an attractively produced volume with a wealth of information ranging from historical material, some of which is not readily accessible, to the latest planetary-probe findings. The first two parts comprise sets of handy tables arranged alphabetically by parameter (from *albedo* to *wind speed*) for the planets and satellites. The meat, however, is in the third part, with over 200 pages dedicated to the planets. There is much historical information that it would take considerable effort to marshal from other sources. But science is not given a back seat, and there are abundant descriptions of the latest researches in planetary science at a popular, but non-trivial, level. There is an appendix of astronomical biographies and a fairly complete glossary.

The use of black and white throughout serves, if anything, to add a touch of historical continuity to the illustrations, which are a skilfully selected blend of hand-drawn telescopic observations through to modern space-probe images (the quality of some of the reproductions could do with some improvement, though).

The problem with this sort of work is getting every fact right and achieving total consistency of cross-referencing. Mistakes are inevitable, and regrettably there are quite a few in the text and tables. The 2000 November transit of Mercury is listed as occurring on both the 4th (p. 20) and 14th (p. 97) of that month. The maximum terrestrial wind speed is given (p. 59) as a somewhat nerve-racking 1739 m s^{-1}. Antoniadi is variously described as Greek- and Turkish-born. There are also a few historical clangers: Heraclides (fourth century B.C.) is referred to as a "Turkish-born Greek astronomer," and Galileo's observations of the phases of Venus are exaggeratedly claimed as the "strongest possible evidence for the validity of the Copernican theory" (they disprove the Ptolemaic theory but are entirely consistent with the Tychonic system). It was Swift's Laputans, not his Lilliputians, who knew of the two moons of Mars! A book dedicated to the planets might also offer a better definition of *planet* than that given in the glossary.

In spite of these comments, I would not wish to leave a negative impression of the book, which is a bold and successful departure from the usual run of popular works on the planets and is a useful addition to popular literature on the subject. — TERENCE J. MAHONEY.

New Perspectives in Astrophysical Cosmology, by M. Rees (Cambridge University Press), 2000. Pp. 158, 23·5 × 16 cm. Price £16·95/$24·95 (hardbound: ISBN 0 521 64238 8).

This book is based on a set of lectures which Martin Rees originally delivered in Milan in 1993. The subject matter was updated for this edition. In 140 pages of text Rees gives a very clear and readable account of the current view of the astrophysics of cosmology — galaxies and galaxy formation, cosmic structure, quasars, what can be said about very high-redshift phenomena — and finally he asks some fundamental questions about the very early Universe. The book is largely directed at physicists and Rees is to be congratulated in getting over so many of the salient arguments in such a limited space. The book will be widely read and used.

Of course the book is based on a complete acceptance of the standard paradigm — early inflation, expansion from a hot dense phase, the dominant matter component being some unseen form of non-baryonic matter, and the idea that all structure was formed by gravitational amplification of initial density fluctuations arising from quantum zero-point fluctuations during inflation.

What is bothersome to me about this is that nowhere is there any hint that perhaps the whole approach is in error and that there are other ways to go. Rees bets odds of 10 to 1 in favour of the general hot Big Bang concept. If we could agree on the terms of the bet I would be happy to bet against him.

Why do I believe that this general approach is unlikely to be correct? Because, in this business we must have very good, if not overwhelming observational evidence and no viable alternatives before we move forward. A century ago all of the authorities (of whom Martin is now one) believed that the Universe was static. It was the observational discovery of the redshift–apparent-magnitude relation that led to the belief in an expanding Universe. The *observational* evidence for an initial hot Big Bang, however, is ambiguous at best. Andrew McKellar discovered the microwave background radiation long before Gamow and his colleagues and others postulated the existence of a compact hot early Universe. They did predict that the radiation as it expanded would have a blackbody form, but the temperature could not be predicted, and as Michael Turner, one of the strongest believers in the Big Bang has written, "We have no firm explanation as to why the universe even has a temperature" (M. Turner, *Science*, **212**, 861, 1993). The observed abundances of D, ^{3}He, and ^{4}He are attributed to primordial nucleosynthesis and this is claimed to be the other strong piece of evidence for an initial hot Big Bang. But agreement between theory and observation in this case is only obtained by first fixing the initial ratio of baryons to photons, which Gamow did, and everyone else has copied. More recently a second large fudge factor which is now, to make it respectable, called non-baryonic matter (hot, cold, or warm depending on your theory of galaxy formation) has been put in. But it is a *fudge factor* — there is no evidence for it except that it is needed to get the right answer, *i.e.*, the one that the majority believes in.

An alternative explanation for the CMB and the light elements is that they all ultimately arose from discrete sources involving hydrogen burning in stars. As far as quasars are concerned, there is much observational evidence which suggests quite strongly that significant components of the redshifts have nothing to do with distance, so that they cannot even be used for cosmology.

But none of this is mentioned. Since I can only review what Rees has written I cannot criticize the book on this basis. I reiterate, the book is very, very good

as far as it goes. And it deserves to be widely read. I only wish that the author and other opinion makers in modern cosmology would look more carefully and critically at the observational bases for their beliefs. Books like this can only discourage and work against astronomical observers and even physicists (if there are any) who are not sure, and theorists (and there are some) who believe that there is still new physics to be learned from astronomy, but certainly not in the context of a hypothetical very early Universe. — GEOFFREY BURBIDGE.

A Different Approach to Cosmology: From a Static Universe through the Big Bang towards Reality, by F. Hoyle, G. Burbidge & J. V. Narlikar (Cambridge University Press), 2000. Pp. 357, 25·5 × 18 cm. Price £35/$59·95 (hardbound; ISBN 0 521 66223 0).

Cosmology is undergoing a revolution. It is experiencing the growing pains of the transition from an esoteric subject based on conceptual elegance to data-driven science.

In such times of upheaval it is not uncommon for communities to become closed-minded and defensive. To quote a colleague, modern cosmology now resembles civil law, where only a preponderance of evidence is required to keep the standard homogeneous hot Big-Bang cosmology, typically based on inflation, the resident lore. Criminal-law standards, where ideas must be proven beyond a shadow of a doubt, are reserved for competing theories.

It should therefore come as no surprise that the quasi-steady-state cosmology (QSSC) presented in *A Different Approach to Cosmology* is widely viewed as anathema. The authors, Hoyle, Burbidge and Narlikar, are respected, veteran researchers in astronomy and cosmology, yet the QSSC figures in no conference programmes, in no ongoing debates, and to work on it would be politically highly injudicious for any young scientist.

One may therefore look at this elegantly produced book in a number of ways. As an extensive review of the bumpy historical course of cosmology and as a poignant warning to those entering cosmology of the dangers of challenging the establishment, it is both useful and interesting; as a source of unexplained data typically ignored by Big-Bang cosmology it is challenging; and as a unified presentation of the rival QSSC theory it is extensive.

While the book does sling a fair bit of mud at the establishment, its historical insights and different approach make it unique in the recent cosmology literature. Personally I find the QSSC significantly less attractive and simple than the hot Big-Bang model but recognise that partly this is due to the vast difference in polishing that the two theories have received.

Nevertheless, the first and secondary peaks seen in the recent *BOOMERanG* and *MAXIMA* cosmic microwave background (CMB) data — which were released after the book was published — may prove the death-knell of the QSSC. It is difficult to understand why a characteristic scale of one degree, together with secondary oscillations, should arise in the CMB within a quasi-steady-state theory.

The book does not, however, flinch from any evidence available at the time of writing. Perhaps more importantly, the book will give young scientists the chance to sharpen their wits and challenge the QSSC for themselves, as the scientific method demands, for Kuhn reminds us that major scientific advance typically occurs by revolution and that, in the end, the establishment is almost always wrong. — BRUCE BASSETT.

Corotating Interaction Regions, edited by A. Balogh *et al.* (Kluwer, Dordrecht), 2000. Pp. 411, 24·5 × 16·5 cm. Price £107/$172 (hardbound; ISBN 0 792 36080 X).

Interplanetary space is filled by the supersonic outflow of solar plasma that we call the solar wind. When the Sun is quiet, this comes in just two main forms — a high-speed (700–800 km s^{-1}) wind escaping from the polar regions of the Sun and a low-speed (400 km s^{-1}) wind arising near the Sun's equator. Corotating interaction regions (CIRs) arise where these two plasma winds interact. They are distinct structures that are characterised by enhanced plasma number density, thermal pressure, and magnetic-field strength as well as the flow-speed shear that is implicit in their formation. They are dynamic phenomena. They evolve as they propagate outwards from the Sun and, in particular, usually develop magnetic shocks on their leading and trailing edges.

This book is the output from a 1998 workshop, hosted by the International Space Science Institute, which aimed to consolidate the current scientific understanding of CIRs in the light of recent observational and theoretical advances and thus to indicate the key open areas for future research. The observational advances include the first out-of-ecliptic measurements by *Ulysses*, the extensive set of outer heliosphere measurements now available from *Pioneers 10 & 11* and *Voyagers 1 & 2*, as well as new inner-heliosphere measurements from missions such as *ACE*. The availability of data over this wide range of heliospheric locations is critical because it allows us to observe the evolution of CIRs as they propagate outwards from the Sun and to compare observations against models of that evolution.

The book is divided into two main parts. First, a set of nine introductory papers that were given as plenary presentations at the workshop and, second, reports from the seven working groups that met during the workshop. The latter reports synthesise the new approaches that occurred during the workshop and indicate areas for future research. The book also has a very useful concluding section that includes a glossary of the principal terms used in CIR research together with a list of acronyms used in the book.

number density, thermal pressure, and magnetic-field strength as well as the evolution as they propagate out from the Sun. Next is a paper on the development and effects of plasma turbulence associated with CIRs. This is followed by a series of four papers on the energetic particles generated by CIRs. Finally, there is a paper on the modulation of cosmic rays at solar minimum. The working-group reports cover the same topics but with a different balance. The first report discusses the origin and formation of CIRs while the second discusses their properties in general. The next two reports discuss the behaviour of CIRs in regions of special importance for understanding their evolution — namely the high-latitude heliosphere and the outer heliosphere. This is followed by a report on CIR modulation of cosmic rays. Finally there are two chapters concerned with the origin, injection, and acceleration of particles at CIRs — one report on observations and one on theory.

This book is an excellent review of the current state of CIR research and will be an essential reference work for researchers in the field. This is an important area of research in space-plasma science. CIRs are a natural, indeed dominant, feature of the quiet solar wind, so a proper understanding of their formation and evolution is central to our understanding of the heliosphere and thus has potential application to other stellar systems. Our understanding of CIRs is also

of practical significance in the emerging field of space weather. They play a significant rôle in the transport of momentum and magnetic flux away from the Sun and are both a source of energetic particles and a modulator of other important particle populations such as cosmic rays and Jovian electrons.

I would commend the efforts of all those scientists who contributed to the book and also the support provided by the International Space Science Institute (ISSI). It is an excellent example of the value of ISSI in providing a stimulating environment in which scientists from around the world can work together and consolidate their ideas. — MIKE HAPGOOD.

The Scientific American Book of the Cosmos, edited by D. H. Levy (Macmillan, London), 2000. Pp. 408, 25·5 × 20 cm. Price £20 (hardbound; ISBN 0 333 78293 3).

There's a kind of review, abhorrent to the Editors of *The Observatory*, which merely lists, or *précis*, the contents of the book in question. Reviewers for this journal are, indeed, specifically enjoined not to write such reviews. When I first saw the *Scientific American Book of the Cosmos*, I thought it might be difficult to avoid falling into this trap. After all, it is largely a collection of reprints from the magazine *Scientific American*. Since we all know the level, style, and accuracy of these articles, there seemed little else to do except to describe the fields covered by the various authors. But I was wrong.

This latest collection of *Scientific American* material is very much influenced by the association of the magazine with *Nature* and Macmillan. It is not the kind of *Scientific American* collection that we are used to. The bad news is that this means we are deprived of most of the illustrative material, especially the lavish colour diagrams that do so much to enhance our understanding of material in the magazine itself. I was surprised at how much this reduces the impact of the text; the articles seemed much more superficial than I remembered them from their original incarnation, although they are still, of course, clear and readable. The good news is that the editor has not just stuck the articles together in a sensible order but has grouped them by subject, with the addition of new material to sum up and put in context each of the main areas covered.

At the risk of offending the Editors, it is appropriate here to give some indication of the breadth of this volume. After something of a false start with some historical material, which is all very well but not really appropriate, the book gets into its stride by telling the story of the cosmos in the traditional way from the Big Bang onwards. Contributions come from some of the big names in astronomy such as Jim Peebles, but are mostly from the younger generation — at least they seem young to me, just as most policemen do nowadays. The bonus, unusual in books of this kind, is the section on the microverse, which satisfactorily introduces the discussion about inflation and brings the story bang up to date.

Professional astronomers are unlikely to learn anything new from all of this, although it is good to have such a breadth of material put in perspective between one set of covers. In terms of value for money the book scores well, as it should do given that presumably the publishers have not had to pay heavily for this reuse of material. The likely readership seems to me to be very much the same as the readership for the magazine itself, including people with a dilettante interest in science, young students contemplating a career in astronomy, or old fogies desperately trying to keep up with the latest developments in fields adjacent to their own. — JOHN GRIBBIN.

The Hy-Redshift Universe: Galaxy Formation and Evolution at High Redshift (ASP Conference Series, Vol. 193), edited by A. J. Bunker & W. J. M. van Breugel (Astronomical Society of the Pacific, San Francisco), 1999. Pp. 680, 23·5 × 16 cm. Price $52 (about £32) + $15 airmail shipping (hardbound; ISBN 1 583 81019 6).

These proceedings provided me with some consolation for missing a meeting that I very much wish I could have attended. I have known Hy Spinrad all my professional life, and it is impossible to imagine what the world of research on distant galaxies would have looked like without him. These days, galaxies at redshift 1 are considered local, but in the early 1980s there was not a single spectroscopically confirmed object at such a distance. Hy broke that barrier with his work on the 3C catalogue of radio galaxies, and has continued setting records ever since (also breaking the redshift 5 barrier). An appropriately large meeting was held in Berkeley in 1999 June to celebrate Hy's 65th birthday, and this book is the result.

Although Hy Spinrad has a large number of friends, the ASP is only likely to make a profit if the 'Hyfest' proceedings succeed in capturing the excitement and key issues in the field of high-redshift galaxies. The omens are good, for several reasons: the meeting was timely, given the advances generated by *HST*, *Keck*, and the Lyman-break technique; the large attendance by a high fraction of the leading experts has produced a comprehensive volume, with 88 separate contributions, including 41 invited reviews. Normally, I have an instinctive dislike of books with so many diverse small contributions, but I have to say this one seems not so objectionable. Perhaps this reflects both how rapidly the book has been produced, and also a certain feeling of fatigue with the mainstream literature. Now that preprint servers regularly subject you to over 500 papers per month, it really is very hard to keep up; trimming a 50-page main-journal monster to the more modest space afforded by a proceedings yields something that can actually be absorbed quickly, and this makes the difference between learning something and missing the paper altogether.

As a result of these factors, I found the Hyfest book a very informative read, although not at all easy to summarize. It is well structured, being split into eight sections: (1) Radio galaxies; (2) Stellar populations; (3) Field surveys; (4) Cluster studies; (5) Structure-formation theory; (6) The history of star formation; (7) The first objects; (8) Future instrumentation. Seeing this material all in one place emphasizes just how much we have learned in the past rather-few years, and it is especially nice to see a number of papers presenting the views of different authors on some of the contentious issues. A completely biassed list of such highlights would include spectrophotometric models and the ages of high-z galaxies; the relation of UV-selected and sub mm-selected starbursts; clustering as a function of redshift and of galaxy type; and searches for galaxies at $z > 5$.

It is hard to believe that the field can advance at the present rate for much longer. There will probably soon come a time when the previous generation of simple questions concerning formation and evolution of galaxies are settled, and research will move on to a more long-term phase of detailed studies. A cynic might doubt this, and it is certainly interesting to note that the current plethora of data has yet to provide a definite proof or rebuttal of the key idea that galaxies form *via* hierarchical mergers. Still, this is no reason not to have a go at extrapolating the future. A paper by Rogier Windhorst does this very nicely,

proving conclusively that all major developments in astronomy correlate with events in baseball; as a result, he is able to conclude that Hyfest II will be held in 2014, at which time the maximum redshift will be 20, and the annual budget of the Dodgers will exceed that of NASA. No doubt the book of that conference will also be well worth reading. — JOHN PEACOCK.

Dictionary of Minor Planet Names. 4th Revised and Enlarged Edition, by L. D. Schmadel (Springer, Heidelberg), 2000. Pp. 1319 + CD ROM, 24 × 16 cm. Price £86/$148 (hardbound; ISBN 3 540 66292 8).

The naming of asteroids is relatively free and easy compared to the naming of other astronomical objects. Historically the discoverer has had the right to suggest a name and this continues to the present day subject to the stamp of approval from the Committee on Small Body Nomenclature of the IAU. The result is something of a jumble.

The definitive guide through this diversity is the *Dictionary of Minor Planet Names*, now in its fourth edition. A short but informative introduction sets out the ever increasing pace of minor-planet discovery and numbering. To get a minor planet numbered, at which point it can be named, now requires observations over at least four oppositions. Even so, automated professional patrols and a small army of CCD-equipped amateur observers have greatly increased the numbering rate. This book records a total of 10666 numbered asteroids of which half have been numbered in the past seven years. This is astonishing when compared to the effort put in over the previous 190 years to detect and refine the orbits of the first half. The 20000 point is now expected to be reached in 2004.

The main body of the book is a listing of each of the numbered asteroids with discovery details and a citation for named asteroids giving the derivation of the name. The appendices at the back of the book give listings of discoverers and discovery places and classify names by category. A CD-ROM that accompanies the book makes the database searchable.

Although it must be said that the majority of the names are worthy but dull, there are also many curiosities that repay browsing. Miguel Itzigsohn so admired Eva Peron that he named no less than five asteroids after her starting with (1569) Evita — is this a record? Sherlock Holmes fans will be delighted to find their hero at (5049) Sherlock along with (5048) Moriarty and (5050) Doctorwatson. Cats are well represented, with (4257) Ubasti dedicated to all observatory cats, (2309) Mr Spock, named after a cat not a Vulcan, and (6042) Cheshirecat (not to mention (2322) Kitt Peak). Tooting has a minor planet (8380) named for it, whose provisional designation, 1992 SW17, matches its postcode SW17. That millennial character Hal has asteroid (9000) named in his honour. Originally it was proposed that (10000) be assigned to Pluto but such was the controversy that the naming committee backed down and (10000) Myriostos, which is Greek for ten thousandth, now honours all those astronomers who contributed to the achievement of getting to 10000. Another curiosity is (7767) Tomatic named in honour of A.U. Tomatic, a remarkably youthful and computationally talented assistant at the Minor Planet Center.

This book is an essential reference work for anyone interested in asteroids. It will also appeal to those who want to seek out entries named after friends and colleagues or indeed to anyone who combines an interest in astronomy with a passion for *Trivial Pursuit*. — STEPHEN LAURIE.

Stellar Rotation, by J.-L. Tassoul (Cambridge University Press), 2000. Pp. 256, 25·5 × 18 cm. Price £45/$69·95 (hardbound; ISBN 0 521 77218 4).

Depending on your point of view, rotation, along with pulsation, magnetic fields, maculation, *etc.*, is either an important basic property of stars, or a nuisance perturbation that obscures the fundamentally time-independent, spherically-symmetric, hydrostatic state that embodies their essential astrophysics. Unfortunately for those who prefer the easy life, it is becoming increasingly clear that, for many classes of star, rotation *is* an essential property; to compound this misfortune, the additional physics introduced by rotation is more complicated than one might hope. Characterizing this physics in a tractable way is a continuing issue, and, to underpin an attack on this problem, Tassoul has approached the issues of stellar rotation largely from the viewpoint of fluid dynamics. This is a field which has been developed further in geophysics than in astrophysics (in no small part because we can easily perform spatially-resolved, three-dimensional *in-situ* measurements in the oceans and atmosphere), and he draws extensively on the geophysical and meteorological literature to develop the key fluid-dynamical results. The occasional non-geophysical insight may assist understanding, as in this homely illustration: "the azimuthal motion in a cup of tea decays much more rapidly through Ekman pumping than by mere viscous diffusion of momentum".

Transferring the microphysics of fluid-dynamic processes to the macrophysics of stellar structure and evolution is a largely unsolved problem; the large-scale internal motions of a star result from a combination of rotation and meridional circulation, and the associated barotropic and baroclinic instabilities generate eddy motions across a wide spectrum of linear scales, which in turn interact with the meridional flow. Notwithstanding the fluid-dynamics foundations, the only pragmatic way to handle the resulting complexity at present is to parameterize the effects of small-scale motions with friction-like terms, and there's the rub: the coefficients of those terms are very poorly determined, with two principal protagonists (Tassoul and Zahn) obtaining quite different results. In spite of these problems, Tassoul develops solutions for the meridional flows under various simplifying assumptions, including Sweet's well-known zero-viscosity case. This is where an observer might hope for results that might be applied directly to the interpretation of real data, but the theoretical approach offers little succour here, the bottom line being that "very little is known about the intensity, length and time scales" of the eddy motions. Nonetheless, *Stellar Rotation* enlarges on the application of the theory of rotating stars in four chapters given over to observations of the Sun and of early- and late-type stars, and even to the issue of synchronization in binary systems.

It should be clear that there still exists a considerable gulf between phenomenological and physical descriptions of many matters relating to stellar rotation; this book offers a comprehensive summary of that situation, from the perspective of a theoretician who has worked in the area for over three decades, striving for rigour wherever possible. The volume is topped by a selective review of the observational basis, and tailed by thorough subject and author indices. (A word of warning: anyone interested in magnetic braking in late-type stars will have to know to look it up under 'Schatzman mechanism'.) Extensive references are given for each chapter, with each listing organized by topic; although some (including this reviewer) will find this a less convenient arrangement than a global, alphabetically ordered, reference list, it does facilitate the extensive annotation and commentary which the author provides. — IAN D. HOWARTH.

On Tycho's Island: Tycho Brahe and his Assistants 1570–1601, by J. R. Christianson (Cambridge University Press), 2000. Pp. 451, 23·5 × 16 cm. Price £30/$34·95 (hardbound: ISBN 0 521 65081 X).

The rôle played by Tycho Brahe in the creation of modern astronomy, the critical use of instruments, and the concept of the observatory as a scientific research institution is well known, and has been studied by numerous scholars since J. L. E. Dreyer's *Tycho Brahe* (1890). Yet Professor Christianson has produced a book of great originality dealing at length and in meticulous scholarly detail with an aspect of Tycho's organisation scarcely touched by previous scholars: Tycho's *familia*, or the extended household of co-workers, assistants, students, and ingenious artisans who built and equipped Uraniborg and did the day-to-day observation and mathematical work. The most famous of all these *famuli*, of course, was Johannes Kepler, who worked not at Uraniborg, but at Prague, during Tycho's exile from Denmark, though he was only one of many scores of men who worked with Tycho over a 30-year period. The listing of these individuals, indeed, occupies a 30-page 'Biographical Directory' within the book, and, according to Christianson, represents the very genesis of his study of Tycho's staff, which began back in the 1960s.

Of especial significance is the insight *On Tycho's Island* gives into the daily workings of Europe's first major astronomical research institution. It is interesting to remember that in 1576, when Uraniborg was founded, scientists had, just as today, to negotiate for funds, technical resources, and public recognition if they wanted to prosper. As a high-ranking Danish aristocrat, Tycho took full advantage of his personal friendship with the intellectually-minded King Frederick II to obtain funding for his great enterprise. This enterprise, moreover, was much more than just an observatory; it was, rather, a complete Neoplatonic academy, the most important one north of the Alps, with its intellectual roots in a metaphysical philosophy which bonded learned men, the vital powers of the Earth and the heavens, and the perfection of numbers into a transcendent *amicitia* of interconnected sympathies. Uraniborg, furthermore, was also one of the jewels in the crown of Renaissance Denmark, and its scientific collections, gardens, publishing house, and symbolic *motifs* were used to entertain and impress visiting royalty and diplomats.

Tycho's staff came from all over northern Europe, including several Scotsmen and one Englishman, John Hanson, who was there in 1587. Rather like modern-day postgraduate students, they stayed for only a few months or years, in order to work with the astronomical instruments or in the Alchemical Laboratory, and to absorb the spirit of the celestial *amicitia*, before going on to careers elsewhere. As is the case today, the scientific community was a mobile one. And by the mid 1580s they were contracted to work for a specific period of time (short-term contracts?), for board and lodging only, in Europe's first scientific graduate school. They dined twice a day at the common table with Tycho, slept in attic dormitories, and were expected to be able to sing, play the lute, tell stories, and make polished conversation with visiting dignitaries. These young men would not necessarily expect to become astronomers in their later careers, though some did. Instead, they became academics, senior clergy, civil servants, or medical doctors, though it is clear that their one-time membership of Tycho's *familia* gave them a cachet which they would take to their graves.

On Tycho's Island is a fascinating and original book, beautifully written and without jargon (though I must admit that I wish the word 'coworkers' had been hyphenated, so as not to make one think subconsciously of 'cow-workers'!). It

is based on primary archival sources, including Tycho's own surviving domestic documents, in the Royal Library, Copenhagen, and elsewhere. It is a must for anyone interested in how Renaissance science was conducted on a daily basis. — ALLAN CHAPMAN.

Spectrophotometric Dating of Stars and Galaxies (ASP Conference Series, Vol. 192), edited by I. Hubeny, S. R. Heap & R. H. Cornett (Astronomical Society of the Pacific, San Francisco), 1999. Pp. 335, 23·5 × 16 cm. Price $52 (about £32) + $15 airmail shipping (hardbound; ISBN 1 583 81018 8).

Stars can be age-dated either from their position in some colour-magnitude diagram or by estimating their effective temperature and gravity from spectrophotometry. Improved parallaxes from the *Hipparcos* mission now provide a broad data base for checking one with the other. For distant galaxies, the situation is more complicated, since it is necessary to compute synthetic spectra for composite stellar populations based on a variety of assumptions, and the answer does not need to be unique. Current developments in these fields were presented at a workshop held in the historic Charles Carroll House at Annapolis, in 1999 April.

The proceedings are divided into four sections, each introduced by a moderately long (~ 10 pages) review: Young stars and star-forming systems (Leitherer); Intermediate-age stars and galaxies (Gustafsson); Star clusters, globular and not (Demarque); and Elliptical and dSph galaxies (Chiosi).

In the first section we learn how to date young populations from (rest-frame) UV and optical spectra, the result depending on whether one sees an ageing single burst or on-going star formation. Wolf-Rayet galaxies are most readily modelled assuming the former, but in 30 Doradus where HR diagrams are now available thanks to *HST*, there are separated pockets with different ages. The trouble with young populations is that their light tends to swamp any underlying old ones. It took *HST* HR diagrams reported here by Laura Greggio, Regina Schulte-Ladbeck *et al.* to show that an underlying population anywhere between 0·5 and 10 Gyr old is present in all blue compact galaxies (including I Zw 18) near enough for it to be detected. Maybe no young galaxies then!

A contentious issue in the intermediate range concerns the ages of elliptical galaxies at significant redshifts ($z \simeq 1 \cdot 5$), with implications for the redshift of formation, which Jimenez argues must be more than 5, while Yi, Heap *et al.* apply other models compatible with as little as 3. Observations by Williger *et al.* of a cluster at $z = 2 \cdot 38$ tend to support the larger estimate.

A major issue relating to globular clusters is the nature of the 'second parameter' affecting horizontal-branch morphology, and there are papers both asserting and denying that it is mainly age (although even age advocates admit that there are other factors as well, and Sweigart describes effects in metal-rich clusters that defy canonical explanations). The application of Strömgren photometry to globular clusters by Grundahl represents a notable advance.

Elliptical galaxies suffer from the dreaded age-metallicity degeneracy, discussed here in some detail by Worthey and others. The degeneracy was supposed to be broken by use of Balmer lines and mid-UV fluxes, but both are affected by uncertainties in the rôle of blue horizontal-branch stars, which can upset the whole thing if a modest amount of metal-poor population (not so much as to avoid the 'G-dwarf problem' in the near UV) is present. So the age spread, if any, is still uncertain. Another approach is through abundances,

notably the (nominal) Mg/Fe ratio, which should be highest in populations formed on the shortest time-scale. Unfortunately, as Thomas & Kauffmann describe, the data are wildly different from hierarchical clustering predictions.

While something of a mixed bag, with quite a few departures from what might have been considered to be a logical ordering of the papers, this volume can be warmly recommended for the information that it provides on these and other issues. — BERNARD PAGEL.

Cosmology: The Science of the Universe, by E. R. Harrison (Cambridge University Press), 2000. Pp. 567, 25·6 × 18 cm. Price £32·50/$54·95 (hardbound; ISBN 0 521 66148 X).

This is the second edition of *Cosmology*, which was first published in 1981. The book covers a vast range of topics within the general subject area, and sets the more recent ideas within a broad historical context. That historical context is well described and a number of chapters are dedicated to it. Modern cosmology is introduced through the Newtonian system which leads readers gently to the more difficult concepts.

There is a considerable amount of straightforward description covering the vast range of material (including the historical account) and also some mathematics in parts. A lot of the mathematics appears in the 'Reflections' sections at the ends of the chapters, which are set in italics so that they do not form the main body of the text. For this reason I am not sure who is the intended readership. The range is probably too broad for an undergraduate course, although some of the main chapters would form suitable reference material.

Because of the range the book attempts to cover, some topics are, by necessity, somewhat superficial, and occasionally a little misleading. For example, there is a whole chapter on Stars, which, of course, are of importance in the early stages of galaxy formation. However, Harrison does not mention this, but instead gives a very broad-brush description of stars as they are today. The expansion of the Universe is clearly of considerable importance in cosmology, yet even in the chapter entitled 'Observational Cosmology' there is minimal explanation of how extra-galactic distances are measured.

I was surprised, too, that there is no mention anywhere of the important computer-simulation work being undertaken around the world, particularly for galaxy formation and large-scale structure. There is a whole chapter entitled 'Galaxies', in which the description of galaxy formation is extremely brief.

There are a number of important discoveries in cosmology that are not included, because they occurred after submission of the text. (For example, Harrison does not refer to the values of the cosmological parameters, particularly the cosmological constant, obtained within the last two years from high-redshift Type Ia Supernovae data.) Harrison makes no mention of superstring theory, which has a good deal to say about the earliest of times; in a book covering such a broad range, I believe that at least some mention would have been beneficial, even if the theory is still in its infancy.

The main body of the book, which I have taken to be the modern cosmology parts, is well written. For example, there is a good description of redshifts, and thorough descriptions of the various (simple) cosmological models.

This is a useful book for the bookshelves, although there are more rigorous texts I prefer. This is a pity, because the author has gone to considerable trouble in constructing a book covering a big subject. — ANDREW J. BARBER.

Unsolved Problems in Stellar Evolution, edited by M. Livio (Cambridge University Press), 2000. Pp. 303, 25·5 × 18 cm. Price £50/$69·95 (hardbound; ISBN 0 521 78091 8).

Imagine! You've just started your graduate studies. You're looking for a thesis topic and this book arrives on your library shelves like an answer to prayer. No more repetitive strain injury as you click your way through the NASA Astrophysical Data System abstracts. The office ozone levels plummet as the laser printer starts to cool. Just read this book, and you'll have it, the perfect PhD thesis, the pathway to fame and... Get real!

The Space Telescope Science Institute Symposium on 'Unsolved Problems in Stellar Evolution' took place during 1998 May 4–7. The published proceedings consist of fifteen review papers of between ten and twenty-five pages and four shorter papers on more specific topics. The preface contains a comment that these represent "a part of the invited talks that were presented" leaving some uncertainty as to what was omitted and why. Let us hope that it was editorial discretion and neither chance nor negligence which has determined survival to the printed page.

An introduction and concluding remarks are provided by two distinguished theoreticians: Edwin Salpeter, who helped to lay the foundations of stellar nucleosynthesis, and Icko Iben, who did just about everything else. As 'Advice To Young Players', Salpeter recommends being at the right place at the right time — an epithet given by too many successful colleagues — illustrated by reference to Ernst Öpik's generally overlooked description of the triple-alpha reaction a year before Salpeter's own.

In between lie a series of excellent and readable reviews. If accolades are awarded for the identification of truly 'unsolved problems', a front runner would be the early evolution of stars (Stahler). On the other hand, Kudritzki gives the impression that all is solved, at least as far as hot stars are concerned. There are problems that may not actually be problems (Eggleton: Why do stars become red giants?) and problems in danger of relegation to the 'detail zone' (shear mixing, meridional circulation, *etc.*) or possibly of promotion from it (Maeder). We are reminded that the detail zone is now crucial for understanding nuclear physics (Bahcall: solar neutrinos), accurate dimensions of stars in binaries (Andersen) and from *Hipparcos* data (Lebreton), and abundance anomalies across the HR diagram (Pilachowski). Asteroseismology, at least for solar-like stars, has a long way to go (Brown) before it can really test these details. When it comes to brown (Liebert) and white (Winget) dwarfs, observational inaccessibility perpetuates the mysteries surrounding low-mass stars at both ends of their long lives. Meanwhile the possibilities of angular-momentum loss, mass exchange, and merger make the outcomes of binary-star evolution difficult to count, let alone identify with real objects (Podsiadlowski).

It was interesting to note the recurring imperative: "important progress will result from advances in stellar atmosphere theory" (Andersen and others). More fundamentally, after a premature aside that "There are many unsolved problems in stellar evolution, but unfortunately no one is working on them!", Iben's conclusion recognises the continuing cycle of evolution that processes matter through stars to the interstellar medium and back again. *Unsolved Problems...* identifies many of the fascinating problems still waiting for a PhD student to solve, and highlights the excitement of studying the whole cycle of stellar evolution. Excellent value.

By the way, if you only read the on-line literature, you probably won't notice

the arrival of this book on the bookshelves; but then you probably won't be reading this review either! — C. SIMON JEFFERY.

Atlas of the Lunar Terminator, by J. E. Westfall (Cambridge University Press), 2000. Pp. 292, 28 × 22·5 cm. Price £30/$49·95 (hardbound: ISBN 0 521 59002 7).

So many lunar atlases have appeared in recent years that it may be asked why there is room for another. The answer is obvious as soon as this new atlas is opened. It is unlike any other, and is clearly the result of many years of painstaking, accurate work.

What the author has done is to concentrate upon the Moon's terminator zone. The Earth-turned hemisphere is shown at 47 different illuminations, from 1·7 days after New Moon to 1·9 days before, and the main emphasis is on the regions over which the Sun is just rising or just setting. The views are made up of mosaics of CCD images, and each is accompanied by a very clear map, making it very easy to identify the various formations. Observe the Moon at any time, and you will be able to find an image in this book where the angle of solar illumination differs by no more than a few degrees from what is actually seen through the telescope.

Many of the images — indeed, most — are obtained with a 28-cm Schmidt-Cassegrain telescope. Obviously they are not so crystal-sharp or so detailed as those obtained by using different methods and larger apertures, but this is not the intention of the *Atlas* — and it is remarkable that the images bring out many features which are at best obscure when shown in conventional atlases. This is a tribute to the author's ingenuity and to his encyclopædic knowledge of the lunar surface.

The text itself gives a full and detailed description of the surface features; there is a long introduction which 'sets the scene'; the Appendix includes physical ephemerides from the years 2000 to 2010, plus a Bibliography and a list of named formations. Errors and misprints are conspicuous only by their absence.

Author and publisher are to be congratulated upon producing a major contribution to the literature. Anyone who is at all interested in the Moon should make haste to obtain a copy of this immensely valuable and interesting *Atlas*. — PATRICK MOORE.

The Stellar Content of Local Group Galaxies (IAU Symposium No. 192), edited by P. Whitelock & R. Cannon (Astronomical Society of the Pacific, San Francisco), 1999. Pp. 529, 24 × 16 cm. Price $95 (about £63) + $15 airmail shipping (hardbound; ISBN 1 886 73383 1).

The ASP's takeover of the IAU publishing contract was initiated with a flurry of related Symposia (190 on the Magellanic Clouds, 191 on AGB stars, 192 on the Local Group, 193 on WR stars), none of which was as cheap or as promptly published as hoped for. This volume is special in that it records the first IAU Symposium held in Africa. It also emphasises the fascination and importance of the Local Group (even excluding the Magellanic Clouds, which are almost unmentioned here!): the Local Group provides us with an example of (almost) every Hubble type of galaxy, and what we hope is a typical mid-sized piece of the Universe. Thus it is by default the place of choice to attempt serious astrophysics, to study star formation, stellar populations, chemical abundances, dark matter..., and to establish quantified templates to allow analysis of more distant,

less-accurately observed phenomena. It is the current state of that ambitious programme which is well-reviewed here. Current activity, which this volume fairly represents, concentrates on star-formation histories: directly, counting massive stars; less directly, from CMD analyses; indirectly, from chemical-abundance modelling; by guesswork, from stellar-population syntheses; and so on. The evidence for a coordinated start to star formation across the whole Local Group volume (rather small, at the time, of course) is becoming robust. The other big *local* excitement is dynamics, with local dwarfs being uniquely the places to determine the scale length, and so the temperature, of cold (tepid/warm/...) dark matter. It is a conservative prediction that the great breakthrough in quantifying the nature of matter will come from Local Group observations, rather than from more distant objects.

The volume ends with exciting prospects for the near future, with future satellites and telescopes; in fact, publication was slow enough that the anticipated *XMM* and many of the 8-metre telescopes have already arrived. But of specific relevance here is a description of *SALT*, the next great step in welcoming Africa to the international astronomical fold. I wish *SALT* well, and, on the evidence of the many exciting opportunities introduced at this African international symposium, its scientific harvest will be rich. — GERRY GILMORE.

Third Advances in Solar Physics Euroconference: Magnetic Fields and Oscillations (ASP Conference Series, Vol. 184), edited by B. Schmieder, A. Hofmann & J. Staude (Astronomical Society of the Pacific, San Francisco), 1999. Pp. 354, 23·5 × 16 cm. Price $52 (about £32) + $15 airmail shipping (hardbound; ISBN 1 583 81010 2).

There is no surprise in the fact that oscillations occur in magnetised astrophysical plasmas. After all, magnetic fields have elastic properties when embedded in a plasma and respond to compression or bending of the field lines to produce waves. In the magnetohydrodynamic view of an astrophysical plasma, such as occurs in the Sun or in the Earth's magnetosphere, sound-like compressions or rarefactions of the medium result in two sorts of wave: a slow magnetoacoustic wave which propagates subsonically and sub-Alfvénically and a fast magnetoacoustic wave which propagates super-sonically and super-Alfvénically. These terms refer to the two characteristic speeds of the magnetised medium: the Alfvén speed (proportional to the magnetic-field strength of the medium and inversely proportional to the square root of the plasma density) and the familiar sound speed. Additionally, a wave may propagate, without compression, at precisely the Alfvén speed. A decade or so ago there was only limited evidence for the detection of these waves in space plasmas, and in the specific case of the Sun — the area covered by this conference — only some objects (*e.g.*, sunspots) had been studied in any detail from the viewpoint of oscillations.

All that has very recently changed, not least because the greater the spatial and temporal resolution that new instruments have achieved, the more likely it is that oscillations are detected. It is now widely recognised that a variety of solar objects support waves or oscillations, and their study is opening new insights into the physics of the solar atmosphere.

This conference volume sets out the latest work, examining oscillations in magnetic flux tubes, sunspots and active regions (including their seismology), the chromosphere and its network, and in coronal loops. Complementary to the various invited reviews and contributed papers on oscillations that form Part 1

of the proceedings are two less extensive parts dealing mainly with observations from the *Solar and Heliospheric Observatory* (*SOHO*) and various observing techniques (including preparations for the 1999 solar eclipse).

Oscillations in the solar atmosphere is a topic that has suddenly come of age, with important developments likely to ensue: oscillations may be involved in plasma heating of the corona, and oscillations provide seismic information about the medium in which they reside. Their study is thus both important and exciting. This volume gives the reader an insight into that excitement. — BERNARD ROBERTS.

Globular Clusters, edited by C. Martinez Roger, I. Pérez Fournón & F. Sánchez (Cambridge University Press), 2000. Pp. 355, 26 × 17·5 cm. Price £50/$69·95 (hardbound; ISBN 0 521 77058 0).

This book presents the lectures of the tenth Canarian Winter School, a series of schools with an excellent record for timely and topical subject choices. Globular clusters are certainly timely and topical: recent advances in numerical and computational performance approach the capability to calculate the exact evolution of a real cluster, including all dynamics correctly, and the stellar and binary evolution of every star explicitly. In the next few years we will calculate and begin to understand better the rich sets of processes by which energy is interchanged between the cluster core and individual orbital energies, leading to core collapse; by which tides evaporate and eventually destroy clusters; by which mass segregation following energy equipartition floats a scum of M dwarfs on the surface of a cluster, ripe for tidal skimming; by which close binaries form, creating stellar exotica and modifying core evolutionary timescales; and the rich panoply of *N*-body Newtonian dynamics. Even more, globular-cluster systems are a microcosm of galaxy evolution and formation, and are also nice and easy to study, relatively speaking. Clusters are old and metal poor, are young and metal rich, and every other possibility. They form today in mergers, yet no young or intermediate-age clusters exist in our Milky Way: "is the obvious no-merger conclusion valid?" is just one of very many relevant questions yet to be answered definitively. On top of all this, clusters provide large samples of stars differing primarily in mass at a similar distance, underlying their use as test-beds for stellar evolution, of both main-sequence and especially post-main-sequence evolution.

This volume attempts to cover all this richness, with more or less success. The articles on stellar evolution are both excellent, while describing basic processes which are relevant to clusters only in that they are convenient for observational tests. The phenomenology of pulsating stars is described well, as is the chemistry. Somewhat overly-elementary introductory articles put the topic in context. The formation overview (Harris) is typically excellent, truly achieving his aim to relate observable features of globular-cluster systems to the competing hypotheses for galaxy formation. Perhaps the most intrinsically interesting aspect of rich clusters is their dynamical evolution. Poignantly for this reviewer, this topic is described by Becky Elson, in what is her last major article. Her description of the work we shared for the last few years is a worthy memorial to her breadth of knowledge and capabilities. Overall this volume is a complex curate's egg: it suffers from attempting too many subjects with only incidental commonalities while it benefits from its rich and diverse approach. Well worth study by a new entrant to any part of the field. — GERRY GILMORE.

Here be Dragons; the Scientific Quest for Extraterrestrial Life, by D. W. Koerner & S. LeVay (Oxford University Press), 2000. Pp. 264, 24 × 16 cm. Price £19·99 (hardbound; ISBN 0 195 12852 4).

Astrobiology has been defined as a science without a subject — no convincing evidence yet exists for life beyond the Earth. However, there is now a rapidly growing interest in the field, driven by substantial progress in the constituent sciences. There have been advances in our knowledge of biology, of the early history of life on Earth, and of the wide range of habitats on Earth where life exists. There has been progress in the searches for signs of life in meteorites from Mars, and in the searches for habitats in the Solar System, and in planets orbiting other stars. This has stirred a wide scientific community into joining in the action. Six hundred researchers attended a recent astrobiology conference.

Many of the readers of this *Magazine* will approach this field from a background of astronomy, physics, and mathematics, and they will thus be invigorated by the excitement of boning up on the messy sciences — biology, geology, chemistry — although some, such as your reviewer, will also be a bit daunted at having to deal with subjects they had left with a sigh of relief before going to university.

This wide range of sciences covered poses problems and opportunities for the writers of introductory books such as this one, aimed at both interested scientists and the general public. There has also been a spate of such books. How can an author find a new way of making a browser in a bookshop decide to buy their book? The tactic hit on here is 'the human angle'. The ten chapters, each on a different scientific aspect, say evolution or finding extrasolar planets, start with an encounter between one of the authors and an expert in that subject. Fortunately for the authors, they could find such experts either in the US state in which they live, or in a neighbouring state. This certainly must have saved time and money, although in two cases they had to venture further afield by means of the telephone. The interviews are all very interesting and provide a gentle introduction to their subjects. But unfortunately, to get some real substance into each 25-page chapter, the learning curve is fairly steep and in fact the book would be too difficult for a member of the general public. However, it should be at just the right level for many of the readers of this *Magazine*, in total providing a pleasant read and being neither too technical nor too superficial. It is a good introduction to the science of the origin, evolution, and distribution of life in the Universe. — ALAN PENNY.

June 8, 2004: Venus in Transit, by Eli Major (Princeton University Press, Chichester), 2000. Pp. 186, 22 × 14·5 cm, Price £14·50 (hardbound: ISBN 0 691 04874 6)

What have the years A.D. 1639, 1761, 1874, 1882, 2004, and 2012 got in common? They are Venus-transit years.

The first scientist to record accurately this crossing of the solar disc was Jeremiah Horrocks, observing from Carr's House, at Hoole, near Preston. By 1716, Edmond Halley informed the Royal Society that "scarce any problem will appear more difficult than that of determining the distance from the Sun to the Earth". He suggested that timing the start and end of a transit of Venus to a precision of one second of time, from many accurately-known positions on Earth, could lead to a value of the astronomical unit accurate to one part in 500.

The year 1761 saw the first truly international scientific endeavour, with transit results being obtained at some 70 stations around the globe. Unfortunately the dreaded black-drop effect was only too apparent. This makes the observed dark planet reluctant to break away from the irradiant solar limb, and ensured that Halley's accuracy was never achieved. By the late 19th century other techniques were being used to estimate 'the yardstick of the Universe'.

Eli Major, a professor of mathematics at Loyola University, Chicago, has produced a snappy, enjoyable, and eminently readable historical account of Cytherean transit observations and uses. The book is ideal for the general readership, and sits neatly on the same shelf as, say, Dava Sobel's best-seller, *Longitude* (Walker & Co, New York, 1995). I am convinced, however, that well before 2004 Tuesday June 8, 05 hr 13m 27s (Geocentric Universal Time), when the next Venus transit starts, the more serious students of astronomy will need a book that delves deeper into this fascinating topic, and leans slightly less heavily on secondary sources. — DAVID W. HUGHES.

Tools of Radio Astronomy. Problems and Solutions, by T. L. Wilson & S. Hüttemeister (Springer, Heidelberg), 2000. Pp. 162, 23·5 × 15·5 cm. Price £20·50/$34·95 (paperback; ISBN 3 540 66802 0).

Tools of Radio Astronomy is a modern classic which has already reached its third edition. The absence of problems or exercises from what is otherwise such a thorough textbook has always seemed surprising to me. With the publication of the present volume of *Problems and Solutions* the plot is now clear. Students wanting the best modern education in radio astronomy must pay a 'top-up' fee of 20 pounds. For this sum they will receive a comprehensive set of 244 problems together with detailed solutions. Armed with the textbook and the problems book you could indeed teach yourself radio astronomy to postgraduate level. A few bottles of whisky would probably help, for there is a lot of hard work here.

The problems are grouped according to chapters in the original textbook, with 147 of them concerning techniques (Chapters 1 to 8) and 97 of them concerning radio astrophysics (Chapters 9 to 14). There are numerous short calculations of the kind which most radio astronomers make every day, when writing telescope proposals or estimating the right orders of magnitude in astrophysical calculations. These might properly be called exercises. Radio astronomers need to know their Janskys and their Fourier transforms just as musicians need to know their scales and arpeggios. Other problems, marked with an asterisk, are more challenging and either extend the relevant chapter of *Tools* or provide a complementary view of a topic from a different perspective. Here you are encouraged to verify many statements of the 'it can be shown that' variety, and also to sharpen your tools on hard concepts.

Most radio astronomers would learn something from studying this set of problems, and for self-study there really is no modern alternative. However, I cannot avoid commenting on the price which Springer are asking for what is after all a supplementary volume. For a similar price you can buy a complete textbook on radio astronomy from a well-known publisher based in Cambridge, UK. Sadly the present volume is likely to be an essential purchase only for libraries or for those spending other people's money. This is a great pity, for the problems really do enhance the textbook. By publishing the problems separately the publishers are restricting their readership and at the same time saddling the

authors with a tricky job of cross-referencing to multiple editions of the main text. I sincerely hope that Springer will unite these problems and solutions with the textbook at the earliest opportunity, and offer us the complete package in paperback at a price modern students can afford. — JIM COHEN.

The Galaxies of the Local Group, by S. van den Bergh (Cambridge University Press), 2000. Pp. 328, 25·5 × 18 cm. Price £45/$69·95 (hardbound; ISBN 0 521 65181 6).

This book gives a fact-filled tour of the galaxies in the Local Group, by one of the Nestors in the field. The layout of the book is such that most chapters concentrate on one galaxy in particular, and the first half of the book is taken to review the best-studied galaxies, M31, the Milky Way, M33, the LMC and SMC, while the second half deals with the rest of the galaxies and ends with an overall view of the Local Group. The chapters all follow a similar structure, starting with a discussion of distance determinations, followed by an overview of what we know about the stellar populations, variable stars, *etc.*, concluding with an overview of the properties of interstellar matter and high-energy radiation from the objects.

I had great pleasure reading this book, and it is a good introduction to the study of the Local Group from the observational point of view. I would in particular recommend it to those, like myself, whose main interests lie in the properties of more distant galaxies, as its size and readability makes it a very manageable overview of the current knowledge about the Local Group set in a solid historical context with many references to original works in the field.

This praise does not, however, mean that the book is without faults or that it will satisfy everyone. The book feels at times very 'descriptive' with long listings of facts about galaxies without setting many of them in a theoretical context, and this might put some people off. The historical aspect of the book does also sometimes detract from discussions when old works on the subject that have been superseded by recent studies get a disproportionate coverage.

Another aspect which might either be counted for or against the book is the fact that the chapters are all semi-independent. While being convenient when looking up information about one galaxy, this is occasionally annoying when reading the book in a linear fashion.

Overall, however, I would like to recommend this book to anyone interested in galaxies and their stellar populations. It complements nicely more specialised books and reviews on the Milky Way, M31, and the Magellanic Clouds, and is a rich source of reference material. In the preface the author states that the spirit of the book is 'things in the Local Group that interested me' — luckily his interests span widely enough to offer something for most here. I just wish there was a soft-back version of the book as £45 is a rather substantial price. — JARLE BRINCHMANN.

PAPERBACK RELEASE

Cosmic Strings and Other Topological Defects, by A. Vilenkin & E. P. S. Shellard (Cambridge University Press), 2000. Pp. 517, 24·5 × 17·5 cm. Price £29·95/$49·95 (ISBN 0 521 65476 9). Reviewed **115,** 266.