

## Reviews

*Great Comets*, by Robert Burnham (Cambridge University Press, Cambridge, 2000), x + 228 pp., £14.95, \$US21.95 paperback, 253 x 202 mm.

For those of us living in the southern hemisphere the term 'Great Comet' immediately conjures up images of a number of nineteenth century favourites: C/1843 D1 with a tail that stretched almost the full length of the sky and was visible in broad daylight; our old friend 1P/Halley which was conspicuous in 1835; C/1858 L1 (Donati) and C/1874 H1 (Coggia) with their impressive tails; C/1861 J1 and C/1881 K1 that were both discovered by Australia's foremost nineteenth century astronomer, John Tebbutt; and successive sun-grazers of the 1880s, C/1880 C1, C/1882 R1 and C/1887 B1. I also have memories of those dual visitors, C/1956 R1 (Arend-Roland) and C/1957 P1 (Mrkos), which left such a vivid visual impression on my teenage mind back in 1957. With the arrival of Burnham's book I was expecting to see vivid accounts of all of these comets, and others, so it was a little surprising to discover instead a book that skipped over these and other Great Comets, in order to focus instead on two much more recent, yet spectacular, visitors, C/1996 B2 (Hyakutake) and C/1995 O1 (Hale-Bopp).

Once over the initial shock I began wading into Burnham's book, and found it to be very readable – and so it should be, for the author is no newcomer to astronomy. An active amateur astronomer since the mid-1950s, Robert Burnham was an editor-in-chief of *Astronomy* magazine between 1992 and 1996, and is the author of many books, including *Comet Hale-Bopp: Find and Enjoy the Great Comet* which was published in 1997. Perhaps it was this volume which inspired him to spread his net wider, resulting in his latest book.

*Great Comets* is entertainingly written, and its 238 pages are packed with excellent illustrations, many of them in colour. This, indeed, is one of the great strengths of the book. Another is the final chapter, "Staying Current With Comets", which not only provides a basic sample of published works for those seeking further information but also a liberal listing of relevant web sites.

So what else does *Great Comets* offer? In his "Introduction", Burnham identifies three themes that he wishes to pursue: to celebrate the beauty of comets (and particularly Great Comets); to introduce the "... new knowledge that Great Comets have brought to planetary scientists and ... all of mankind ..."; and to "... explore mankind's relationship with comets, which has long been troubled."

Chapter 1, titled "Great Comets and Astronomy", is by far the longest chapter in the book (at 46 pages), and it needs to be as it sets the scene for what follows. In it we review mankind's changing views on comets from ancient times through to the present day, examine current thinking on the composition and behaviour of comets, discuss where comets fit in to the overall picture of the solar system's formation and evolution, and learn about the naming of comets.

All this leads up to an interesting chapter on what makes a comet 'Great', and Burnham opts for David Hughes' five familiar criteria plus one added by Don Yeomans. A Great Comet must

- (1) have a large nucleus and coma,
- (2) have a large active surface area,
- (3) reach perihelion near the Sun,
- (4) pass close to the Earth,
- (5) provide good viewing opportunities for observers, and
- (6) be conspicuous to the naked eye in the night sky.

Sometimes a Great Comet can make a major contribution to cometary astronomy by appearing at a particularly auspicious time in astronomical history. Hyakutake and Hale-Bopp both fall into this category, as Burnham clearly demonstrates, but an earlier comet for which such credit is generally not given is C/1881 K1, one of Tebbutt's two discoveries. This Great Comet just happened along at a time when important developments were taking place in astronomical photography and spectroscopy, and as a result it was the first comet for which successful photographs and spectrograms were obtained. In addition, the behaviour of its head

and tail built on data provided earlier by C/1858 L1 (Donati) and C/1874 H1 (Coggia). That famous nineteenth century chronicler of astronomical history, Agnes Clerke (1893:425-426), reports that "Tebbutt's comet ... was, in the opinion of some, the finest object of the kind since 1861." More recently, ways in which this 1881 Great Comet aided our understanding of cometary science have been detailed in a paper published in the *Irish Astronomical Journal* (see Orchiston, 1999).

Burnham concludes chapter 2 with an all too briefly examination of one of the key topics in contemporary solar system astronomy: "When is a comet not a comet?" He points out that "... some objects follow comet-like orbits but show no evidence of cometary activity. And other objects, traveling in asteroid-like orbits, have developed gas and dust comas and even display small tails. Finally, there is at least one inert object whose orbit matches that of a meteor stream ..." (p. 74). His discussion of Centaurs, asteroid-comets and comet-asteroids occupies a mere two-and-a-half pages and provides but a tantalizing taste – how I yearned for more.

Our two most recent Great Comets, Hyakutake (1996) and Hale-Bopp (1997), occupy chapters 3 and 4 respectively, and collectively span 59 pages filled with all sorts of interesting information and a succession of stunning photographs. C/1996 B2 (Hyakutake) offered two main surprises: unexpected X-ray emission, and an abundance of methane, acetylene and ethane. Not to be outdone, C/1995 O1 (Hale-Bopp) entertained professional and amateur astronomers for almost two years, revealing an unusually large nucleus, the first-ever sodium tail and the first cometary detections of eight different molecules.

If we wish to engage in really close-up investigations of comets then we must rely on space missions, and this is the topic of Chapter 5. Not only are we told about the five different space craft that provided invaluable information on 1P/Halley in 1986 and earlier space craft and orbiting observatories that supplied data on other comets, but there is a very useful diagram on page 140 that lists the different probes that are due to rendezvous with various comets over the next eleven years. The coming decade promises to be an exciting era for cometary astronomy.

With chapter 6, Burnham leads us on a new path, to explore the ways in which comets – and particularly Great Comets – have impacted on cultures over the ages. Beginning with Greek, Roman and Chinese perceptions, including the 'harbinger of doom' scenario, we speed past familiar names like Newton and Halley and enter the nineteenth century, with its never-ending cavalcade of Great Comets. Burnham reminds us that in 1910, "Regular doses of Halleyana became a feature of public discussion." (page 183) as 1P/Halley assaulted the human psyche. Editors, cartoonists, music publishers, advertisers and telescope-salesmen had a field day, but then public panic set in when it was realised that the Earth would pass through the tail of the comet, with its deadly cyanogen gas. However, as Burnham could have pointed out, to set their minds at rest all people had to do was reflect on Tebbutt's Great Comet of 1861 (C/1861 J1) when exactly the same situation occurred yet no-one perished (see Orchiston, 1998). Today's public is supposedly more scientifically literate, yet in March 1997 we read with dismay of the Heaven's Gate disaster with its tenuous link to Comet Hale-Bopp.

Burnham's final chapter also focusses on Great Comets and culture, but in a totally different context: the potential they have to end culture as we know it here on planet Earth. In "Danger From the Sky" he regurgitates the now-familiar 'nuclear winter' scenario associated with a major cometary or asteroidal impact, lists recent near misses, discusses the annual incidence of meteorite falls and introduces us to the Spaceguard Survey. Despite this somewhat pessimistic stance I finished the book feeling somewhat reassured, for Burnham points out on page 215 that the probability of my meeting death through a major celestial impact event is comparable to my chances of dying in an aeroplane crash, that is, about 1 in 20,000. But despite these rather favourable odds, it is reassuring to know that increasing numbers of observatories worldwide are taking up the search for NEOs (Near Earth Objects). This is money well spent; it may prove to be an investment in our very future.

So to a final assessment. I believe that Burnham has achieved all of the goals that he spelled out in his "Introduction". But he has done more than this: notwithstanding the somewhat misleading title, he has produced an excellent general introductory work, with plenty of historical perspectives for those of us with a penchant for astronomical history. There are

many books about comets on the shelves of my library, but this particular volume proved to be one of the most readable and enjoyable. And at just US\$21:95 it is very affordable, so why not add it to your library.

Wayne Orchiston

#### References

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- Orchiston, W., 1998. Illuminating incidents in Antipodean astronomy: John Tebbutt and the Great Comet of 1861. *Irish Astronomical Journal* **25**:167-178.
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*Sur les traces des Cassini, Astronomes et observatoires du sud de la France*, actes du 121<sup>e</sup> Congrès des sociétés historiques et scientifiques, section d'histoire des sciences et des techniques, Nice, octobre 1996, sous la direction de Paul Brouzeng et Suzanne Débarbat (Sodis, Editions du CTHS, Ministère de l'éducation nationale, de la recherche et de la technologie, France, 2001), 360 pp., ISBN 2-7355-0425-5, FR 203,35 €31, soft cover, 240 × 160 mm.

The Dark or Medieval Ages (5th to 15th centuries – Europe) was notable for a crushing of cultural progress and stagnation of trade and commerce. However a rebirth or Renaissance of human endeavour commences with intellectual awakening – scientific knowledge and experience of the divine arise, as a great creative effort of a new era of Humanism. Copernicus (1543) publishes *De Revolutionibus*, asserting the Sun as centre of the solar system, orbited by planets. New optics technology yields the telescope (1609), microscope (1610) and their application to scientific research develops human insight of the infinitesimal and the infinity of the Cosmos. Printing in the sixteenth century with vernacular teaching and discourse, vastly enriches literature and the sciences.

With this material readers embark in the footsteps ("Sur les traces des Cassini") of the Cassini family dynasty and since several generations of Cassinis occupied key positions at the Observatory of Paris, a national observatory established in the years 1667 to 1671, their history also describes well that of the institution and astronomy itself in France. As a matter of interest, Leiden Observatory, Holland, began in 1637, Copenhagen 1657 and the Royal Greenwich Observatory (RGO) was established 1675.

The Golden Age of Science, first evident in Italy, crosses borders to other states to flourish throughout Europe and is based on observational confirmation of theoretical models and not mysticism nor astrological predictions. Universities and other institutions arise to teach science, medicine and philosophy. Art and technology are important for revival of knowledge. In France observatories and universities yield intellectual awakening and new knowledge in astronomy. The Cassini dynasty arises and contributes vastly.

An Italian-born French astronomer, Giovanni Domenico Cassini was born 1625 June 8 in Perinaldo near Nizza (Nice) and died 1712 September 14 in Paris. In 1650 he became professor at Bologna and from 1669, summonsed by Louis XIV, he took charge of the observatory in Paris, then under construction and organized its activities. Cassini was a zealous and successful astronomical observer. He discovered (among other things) the rotation of Jupiter, the division named after him in the rings of Saturn and four of the moons of Saturn, determined the rotation of Mars, co-operated in determining the solar parallax, and is claimed to have made the earliest systematic observations of the zodiacal light. Cassini's son, Jacques (1677-1756), his grandson, Caesar Francois (1714-1784), and his great-grandson Jacques Dominique (1748-1845) succeeded him in turn as Directors of the Paris observatory.

At the 121<sup>st</sup> Congress of the National Society for history of science and technology at Nice, France, 1966 October 26-31, 32 presented papers by different authors honour the achievements of French astronomers, their research and astronomical facilities. Edited by Paul Brouzeng and Suzanne Débarbat, *In the footsteps of the Cassinis* is five Chapters of rich and original archival material, arranged as themes:

1. **Astronomy at the Cassinis, a family affair:** Three natives of Perinaldo, Astronomers of the Paris Observatory; G. D. Cassini, Pupil of the Jesuits; Perinaldo, countryside of astronomers

(who) rediscover their Cassinis; Jean-Dominique Cassini, the last director of Paris Observatory under L'Ancien Régime, told by himself.

2. **The contributions of Cassini to the science of Astronomy:** Astronomical Research by G.D. Cassini at Bologna, 1649-1669; J.-D. Cassini and his English Colleagues; J Cassini, J Gregory, C Huygens – their distance determinations, Sirius to Earth; The Perfect Engineer, author Cassini III.

3. **Use of fruitful heritage, the Cassini school:** The Chart of Cassini, Scientific Work and the Exigencies of its Use; On Correspondences received by the Cassinis and the Maraldis; Notara, a Pupil of Cassini; A descendant of the sister of Jean-Dominique Cassini (1625-1712); The wealth of the Library of the Observatory of Paris.

4. **Research and discovery:** The first astronomical discoveries made at Marseilles: Pythéas le Massaliote; A Marseilles astronomer travels: Father Louis Feuillé in the South Seas 1704-1771; The scientific voyage in Italy of G Rayet and the establishment of Bordeaux Observatory; Voyage to South Sea by Amédée Frézier: navigation rules and longitude correction; Francis Xavier of Zach and astronomy in Southern France; Work & observational results on the solar diameter at Côte d'Azur Observatory.

5. **Site selection and establishment of observatories:** Astronomy and astronomers in Languedoc in the eighteenth century; The erudite astronomers of Provence: Peïrese and Gassendi; G. Rayet, Founder and First Director of the Observatory of Bordeaux; establishment and history of the Observatory of Bordeaux at Floirac; Observatory at Pic du Midi of Bigorre: Men and missions; The birth of the Observatory of Nice.

An interesting and typical example is the paper by Christiane Demeulenaere-Douyère, "The Cassini Family and the Academy of Sciences", being their successive association over several generations in the French Royal Academy of Sciences. The Cassini-Maraldi family merits particular examination and the study begins, naturally enough, with the foundation of the dynasty. And that by F. Grossi, Engineer: Three natives of Perinaldo, astronomers of the Paris Observatory, "At Perinaldo, a community located 20 kms north of Vintimille, there is a dwelling above whose door one reads an inscription: here were born G.D. Cassini on the 8<sup>th</sup> of June 1625, died in Paris 14<sup>th</sup> September 1712, G-F Maraldi on the 17<sup>th</sup> April 1709, died at Perinaldo on the 14<sup>th</sup> November 1788". The castle Maraldi of Perinaldo, as it is called, was the birthplace of three astronomers who in the second half of the seventeenth century and the first half of the eighteenth century, have illumined the observatory of Paris. The study relies upon the archives of the Maraldi and Scribani Rossi which allow the tracing of the sister of Cassini I, become Maraldi then Grossi and Manuel-Gismondi, up to 1854." Another example is that written by J. Casanovas, Astronomer, Vatican: "G. D. Cassini, Pupil of the Jesuits: Following an experimental period, the teaching of mathematics in Jesuit schools was fixed by the *Ratio Studiorum*. Mathematics comprised geometry, arithmetic, music and astronomy. It was in this context that G.D. Cassini was a student of the Jesuits at Genes."

Colloquium participants visited the actual birthplace of the Cassinis and Marinaldos courtesy of the Compté de Nice, also viewing their town and two churches, town hall, as well as the Exposition which the community of Perinaldo installed during 1994 as a homage to one of their most illustrious sons, Jean-Dominiques Cassini (1625-1712) and to his descendants. Their previously unpublished documents reveal the role played by the prestigious dynasty of the Cassini family in the appointment of explorers, navigators, and scientists whose initiatives and projects – exploration, construction of observatories (particularly in the South of France) – were inspired by methods used by the greatest figures of science. They are of immense value to students of history and science alike. Indeed this 121st Congress of the Historical and Scientific Society was convened at Nice, at the invitation of the group for history and techniques, to acknowledge the scientists and the institutions of this region.

This book will be well appreciated by those for whom French is a first or second language. It may well be promptly translated to English, however note the delay of four years from the Congress at Nice to production as text in the original tongue. The style is elegant and clear, as befits the original language of science.

Importantly, the name of Cassini remains honoured by science. In 1655 Huygens discovered Titan, the second largest moon (only Jupiter's Ganymede is bigger) in our solar system. Launched 1997 October 15, ESA/NASA jointly will use an orbiter (Cassini) and a

probe (Huygens) to investigate Saturn's giant moon Titan – commencing 2004 July 1, four centuries after Cassini the Elder developed Paris Observatory for King Louis XIV. [*note: Cassini's first and second flybys of Titan occur 26 October and 13 December. As the Cassini Orbiter orbits Titan's cloud tops at an altitude of 65 000 km the Huygens Probe will be released towards Titan 25 December for an entry into the moon's atmosphere 22 days later, 2005 January 14. While Cassini continues to explore Saturn and its rings, the Huygens probe is now released to parachute through Titan's thick orange atmosphere – considered to resemble that of the very early Earth*]

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