

alithic sites appear to have astronomical associations. Chronologically, Indian megalithic sites date between 2,500 BCE and CE 300.

After this archaeoastronomical focus the book moves forward in time and examines aspects of Indian ethnoastronomy. This occurs in Chapter 4, “Astronomical Myths of India”, which begins with an analysis of the Banjaras, the Gonds and the Kolams from central India. These are among the oldest tribes of India, and were studied by Mayank Vahia and his anthropological associates. Particularly interesting are Tables 4.2 and 4.3, which compare the astronomical and meteorological perspectives of the three tribes and show that

Most of the [astronomical] observations of the sky relates [*sic*] to the sky seen in the period close to the monsoonal season—from March till July. They seem to assume that the sky is the same at other periods or do not bother to look at the sky. This indifference to the sky is also interesting in the sense that even though visually striking, these societies do not seem to be impressed by it as a matter of curiosity. (page 58).

As the authors point out, this contrasts markedly with the situation in prehistoric southern India, where the megalithic sites reveal that there was a profound interest in astronomy. Vahia, Yadav and Menon then shift their attention to the Hindu and Jain religions, and spend the next 15 pages of this chapter recounting ‘Astronomical Stories’ (and verses) relating to astronomy, time and the origin of life.

The penultimate chapter in this little book is titled “Astronomy and Civilisation”, and begins by identifying four different evolutionary phases in astronomy:

- (1) The Initial Phase
- (2) The Settlement Phase
- (3) The Civilisation Phase
- (4) The Technology Based Phase

Vahia, Yadav and Menon then devote the next 28 pages to explaining these, using India as their case study. In the process they spread their net widely to illustrate their scheme, snaring examples drawn from rock art, megalithic sites (with some inevitable repetition from Chapter 3), Vedic astronomy, the Harappan civilisation, ‘Modern Astronomy’, and so on. They emphasize that a great deal has already been published relating to Phases 2 and 4. Re the former, the *Vedanga Jyotisa*, an astronomical appendix of the *Rig Veda*, is particularly apposite. Although this interesting four-phase paradigm for astronomical evolution is developed here specifically for Indian astronomy, it has international applications and should be tested in other geographical regions.

Rounding out this book is a 2-page “Con-

clusion”, with the following comment and challenge:

We are sure that we have only touched rather limited perspectives of astronomy in this little book but we hope that it will instigate our readers to think of other perspectives and enjoy the journey and exploring those ideas. We have deliberately explored less-travelled avenues of thought in the hope that some of the readers may carry these ideas forward and confirm or negate them. (page 104).

After this are 8 pages of references.

All in all this is an interesting book, and the repeated reference (both here, and in the book itself) to it as a “little book” is slightly misleading. Admittedly, the cover is of modest dimensions, and the book spans a mere 116 pages, but most of these pages are jam-packed with text (rather than diagrams)—in small print—so the amount of reading and the information imparted, is by no means ‘little’. Thus, the book contains many thought-provoking ideas and passages. Admittedly, I had encountered some of these previously, for much of the book’s contents has appeared in earlier publications (including in this journal), but there is merit in bringing this scattered material together under one cover.

The National Council of Science Museums (of India) is to be congratulated on agreeing to publish this book. It is a free publication and so is excellent value, especially for those with an interest in Indian ethnoastronomy and/or archaeoastronomy. Copies can be ordered from: National Council of Science Museums, 33, Block - GN, Sector - V, Bidhan Nagar, Kolkata 700 091, West Bengal, India.

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***Catchers of the Light. The Forgotten Lives of the Men and Women Who First Photographed the Heavens*, by Stefan Hughes. Two Volumes (Paphos (Cyprus), ArtDeCiel Publishing, 2013), pp. [xviii] + 735, and [vi] + 736–1612 + [i]. ISBN 978-1-4675-7992-6 (hard copy), 215 × 302 mm, US\$199 (e-book \$39.99).**

The emergence of astrophysics during the nineteenth century is one of the great achievements of international astronomy, as spectroscopy and photography collectively revolutionised our discipline.

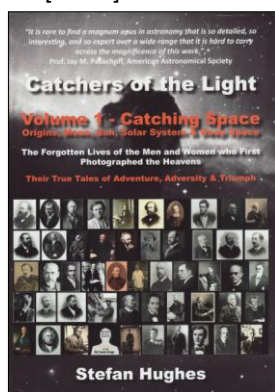
John Hearnshaw produced the classic tome on the history of astronomical spectroscopy long ago, and a second edition recently appeared (Hearnshaw, 2014), but until Stefan Hughes published *Catchers of the Light ...*, no detailed

historical account of astronomical photography existed.

But to call his work a “... detailed historical account ...” is a gross understatement, for Dr Hughes has produced not one, but two massive large-format volumes totalling well over 1,600 pages, each volume chock-a-block with historical photographs.

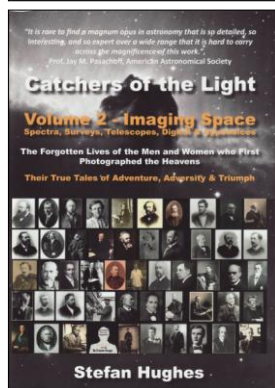
In the front pages of the first volume Stefan Hughes speaks of the “... many thousands of hours of exertion, necessary to finish this magnum opus of Astronomy.” (page v), which on the previous page he had fondly described as

... a ‘Family History’ of Astrophotography ... [which] tells the story of the lives and



achievements of the great pioneers of Astrophotography.

Volume 1 is about “Catching Space. Origins, Moon, Sun, Solar System & Deep Space”, and is composed of five Parts, which deal respectively with “Firstlight”, “Moonlight”, “Sunlight”, “Planets & Comets” and “Starlight”. There are 26 chapters in these five Parts.



Volume 2 is about “Imaging Space. Spectra, Sky Surveys, Telescopes, Digital & Appendices”, and is composed of four Parts, which deal respectively with “Spectra”, “Cartes du Ciel”, “Astrograph” and “Amateur”. The 17 chapters in these four Parts are followed by 8 appendices, a list of abbreviations and an Index.

Individual chapters deal with people who were seminal either to the development of photography itself (Part I, Chapter 1) or astronomical photography, but the last chapter in each of the Parts is typically a review relating to the theme(s) of that particular Part.

The biographical chapters are very well illustrated—with many images that I have never seen reproduced previously—and end with genealogical data, followed by Acknowledgements and then Notes (sometimes pages of them, filled with amazing detail). The final chapters in each of the Parts lack the genealogies but instead include one or more summary tables, before the Acknowledgements and Notes. Thus, the final chapter in Part 1, on “Astronomical Photograph-

ic Processes & Technologies”, has a 3.25-page table on “Photographic Processes Chronology”, which spans the period 1800–2004 and from 1969 focuses on CCDs, while the end of Chapter IV.5 (“Wandering Stars’. Imaging the Solar System”) has a 2-page table that provides a “Solar System Photography Timeline” for the period 1851 to 1956.

Near the start of his book Stefan Hughes advises that

The reader can choose which part to read either in sequence, in the order that takes their interest or any chapter of their choosing. They will lose nothing no matter how they read the book or in what order.

[Furthermore] ... the book can be used at a number of levels; either as a biography of the lives of the pioneers of astrophotography; a source of reference for a student or researcher; and finally as a technical compendium on the historical development of photographic equipment, processes, technologies and techniques, that are relevant to Astrophotography. (page iv).

These comments highlight the fact that this massive two-volume work is more like an encyclopaedia of astronomical photography than a ‘regular’ textbook, and I suspect that most astronomers will use it for reference purposes as demand inspires or inspiration demands.

This is precisely what I did with Volume 1. With research interests in solar, Solar System and cometary astronomy and galactic astrophotography, I carefully read Parts II, III, IV and V (after skimming chapters in Part I), and—as expected—ran into many familiar names, including E.E. Barnard, William Cranch and George Phillips Bond, Warren De La Rue, Henry Draper, Benjamin Apthorp Gould, Paul and Prosper Henry, Jules Janssen, James Keeler, Maurice Loewy, William Pickering, Isaac Roberts and William Wilson.

In the process of reading these chapters I also encountered familiar objects and instruments, like two photographs (on pages 272 and 439) of one my favourite comets, C/1881 K1 (Tebbutt), otherwise known as the ‘Great Comet of 1881’ (see Orchiston, 1999). I was a little surprised, though, to see that Schaberle’s 40-ft Camera was missing. This was the instrumental mainstay of the Lick Observatory’s solar eclipse expeditions from 1893 onwards (Pearson et al., 2011), and during totality produced what at the time were unprecedented images of the chromosphere, prominences and the corona (see Pearson and Orchiston, 2008).

I also really enjoyed reading the Janssen chapter, and about his observations of the 1868 total solar eclipse and the 1874 transit of Venus. Since Dr Hughes researched this book, evi-

dence has emerged to show that Norman Pogson, Director of the Madras Observatory and founder of the visual magnitude scale, is the one who, during the 1868 eclipse, should be assigned most of the credit for noting an anomalous emission line in the solar spectrum that later would be associated in the laboratory with the element helium. Biman B. Nath (2013) provides details of this in his recent book.

After finishing with Volume 1, I found Volume 2 equally rewarding. Again there were chapters on very familiar astronomers, including Andrew Common, Henri Crétien, David Gill, Edwin Hubble, Sir William and Lady Huggins, Milton Humason, Ernest Mouchez, William Parsons (the 3rd Earl of Rosse), Edward C. Pickering, George W. Ritchey, Lewis Rutherfurd, Bernhard Schmidt, Angelo Secchi and Hermann C. Vogel, and the range of supporting photographs, sketches, maps, plans and other diagrams was impressive. When coupled with relevant entries in the *Biographical Encyclopedia of Astronomers* (Hockey et al., 2014) and Hearnshaw's (2014) authoritative tome on astronomical spectroscopy, these chapters in *Catchers of the Light* will provide readers with a 'complete picture' of these famous astronomers.

But Volume 2 has more to offer, for there also are the informative review chapters at the ends of Parts VI–VIII ("Imaging Astronomical Spectra", "Mapping the Heavens" and "Telescopes in Astrophotography"), plus two chapters in Part IX ("Amateur"), one on "Pioneers of Amateur Astrophotography" and the other on "Modern Astrophotography". The first of these final two chapters identifies the Hungarian, Eugene von Gothard, as one of the first to open the eyes of professional astronomers to the research potential of astronomical photography:

On the 1st of September 1886, he obtained a photograph of the famous planetary nebula in the constellation of Lyra known as the 'Ring' Nebula (M57). It was a remarkable photograph not only for the fact it was the first ever taken of this beautiful 'smoke ring' in space, but more importantly it showed its 15th magnitude central star.

The significance of this was not lost on all who saw Von Gothard's photograph. This star at that time could only be seen [visually] under the best conditions with only the largest of telescopes, but for it to stand out like a tiny bright torch amid the black velvet of the night sky and be revealed so easily by a mere 10-inch mirrored telescope must have caused many a missed heart beat of Observatory Directors across the world (page 1272).

In addition to his astrophotographic prowess, von Gothard also was one of those who pioneered astronomical spectroscopy and photometry (see Vincze and Jankovics, 2012).

In just 64 pages, "Modern Astrophotography", the final chapter in this amazing book, takes us from the nineteenth century, through the development of various films suitable for astronomical photography, to affordable telescopes and CCD cameras for amateurs, image-manipulation software, and electronic catalogues. This well-illustrated chapter, and the preceding one, is mandatory reading for all current or budding amateur astrophotographers, as are Appendices A and E, on "Astrophotographic Resources" and "Charge Coupled Devices", respectively.

The other Appendices deal with "Important Astronomical Photographs", "Chemistry of Photographic Processes", "Telescope Optical Systems", "Useful Astrophotography Formulas", "A Brief Glossary of Terms" and "Astrophotographer Family Pedigrees". This last-mentioned 81-page Appendix contains photographs and genealogies that complement those found earlier in the various biographical chapters.

After 2 pages listing abbreviations used throughout the book, Volume 2 closes with a 66-page Index that will greatly help those readers who wish to find information about particular astronomers, telescopes, and even astronomical objects.

Like my colleague Jay Pasachoff, who wrote the Foreword, I am in awe of Stefan Hughes, the amount of research that went into this enormous book, and the wealth of text and images he offers readers. Although the printed version may be outside the price range of some individuals I hope that astronomical libraries worldwide will purchase this book. It is an incomparable resource, and will long remain the standard reference in this field.

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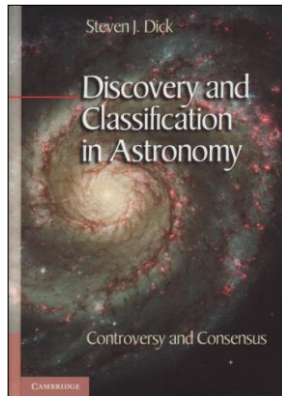
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***Discovery and Classification in Astronomy: Controversy and Consensus*, by Steven J. Dick (New York, Cambridge University Press, 2013), pp. xviv + 458. ISBN 978-1-107-03361-0 (hard copy), 180 × 255 mm, US\$45.00.**

Steve Dick, NASA's former Chief Historian, is



well known for his books on astrobiology and the history of astronomy, and it is a great pleasure to see yet another book penned by him. But this one is a little different from his earlier tomes, in that it is about discovery and classification in astronomy.

As stated in the first of the front pages,

Astronomical discovery involves more than detecting something previously unseen. The reclassification of Pluto as a dwarf planet in 2006, and the controversy it generated, shows that discovery is a complex and extended process – one comprising various stages of detection, interpretation, and understanding.

This book is composed of five Parts, titled “Entrée”, “Narratives of Discovery”, “Patterns of Discovery”, “Drivers of Discovery” and “The Synthesis of Discovery”. Each Part contains anywhere from one to four sections, that in total contain 36 short chapters.

Given the reference to the ‘Pluto affair’ in the first of the front pages it is fitting that Pluto’s discovery as the Solar System’s ninth planet in 1930, and its demotion to dwarf planet status in 2006, are the focus of the first and last chapters in Part I, “Entrée”. Like, Steve Dick, I was there at the Prague General Assembly of the IAU and voted on Pluto’s fate. Moreover, I was one of the rather sizable minority group that voted to retain Pluto as a planet, but when the outcome of these deliberations entered the public domain, all of us were tarred with the ‘destruction of Pluto’ brush and, like Steve, I too personally received abuse from members of the public and amateur astronomers. Everyone erroneously assumed that all (or almost all) of those at the Prague General Assembly wanted to demote Pluto.

Part I includes two other chapters, one about Pluto’s satellite, Charon, and the other on the discovery of Kuiper Belt objects.

Part II also starts with the Solar System (“Moons, Rings, and Asteroids: Discovery in the Realm of the Planets”) before examining stars and nebulae in our Galaxy (“In Herschel’s Garden: Nebulous Discoveries in the Realm of the Stars”, and “Dwarfs, Giants, and Planets (Again!): The Discovery of the Stars Themselves”) and then “The Galaxies, Quasars, and Clusters: Discovery in the Realm of Galaxies”).

In the various chapters in Parts I and II, Dick takes us on a ‘Cooks’ tour’ of the Solar System, our Galaxy and the distant reaches of the Universe, and covers all of the key astronomical discoveries.

This astronomical focus is replaced in part in the remaining Parts of the book by philosophical themes. Thus, Part III has sections on “The Structure of Discovery”, “The Varieties of Discovery” and “Discovery and Classification”; Part IV on “Technology and Theory as Drivers of Discovery”; and Part V on “Luxuriant Gardens and the Master Narrative” and “The Meaning of Discovery”. Some of the chapters in these sections contain material that will be new to many historians of astronomy, and this is one of the great strengths of this book: the mixing of history of astronomy and philosophy of science. Thus.

... we have noticed that ... a discovery is not an event at a discrete moment in time ... it has a structure, and this structure consists most often of detection, interpretation, and multiple stages of understanding ... discovery is sometimes preceded by a “pre-discovery” phase, and (less surprisingly) is always followed by a “post-discovery” phase, both of which delimit the structure of discovery itself in both time and space. (page 177).

This is largely inspired by Thomas Kuhn’s ideas, as best outlined in his well-known book, *The Structure of Scientific Revolutions*, and Steve Dick then proceeds to recount various examples drawn from the annals of astronomy.

Dick then discusses the microstructure of discovery:

A study of the microstructure of each component would likely be even more revealing, uncovering particular forms of detection, interpretation, and understanding, as well as the problems associated with each, such as the problematic nature of observations ... Even more importantly, the conceptual elements we have emphasized so far inevitably had technological, social, and psychological components, revealing even more about the nature of discovery. (pages 190–191).

In discussing the social dimension of astronom-