BOOK REVIEWS

Masters of the Universe: Conversations with Cosmologists of the Past, **by Helge Kragh. (Oxford: Oxford University Press, 2015), pp. [viii] + 285. ISBN 978-0-19-872289-2 (hardback), 133 × 215 mm, US$49.95.**

This rather unconventional book presents a fascinating picture of the progress of cosmology and the attitudes of cosmologists over the first two-thirds of the twentieth century. Why unconventional? It takes the form of interviews conducted by an imaginary relative of the author with fourteen scientists, mostly theoretical physicists, who did research in cosmology. Although the conversations are invented, they are accurate portrayals of what could have occurred. The scholarly notes, which, with brief biographies, comprise 40% of the book, show that in many cases the interviewee uses words he actually wrote or said.

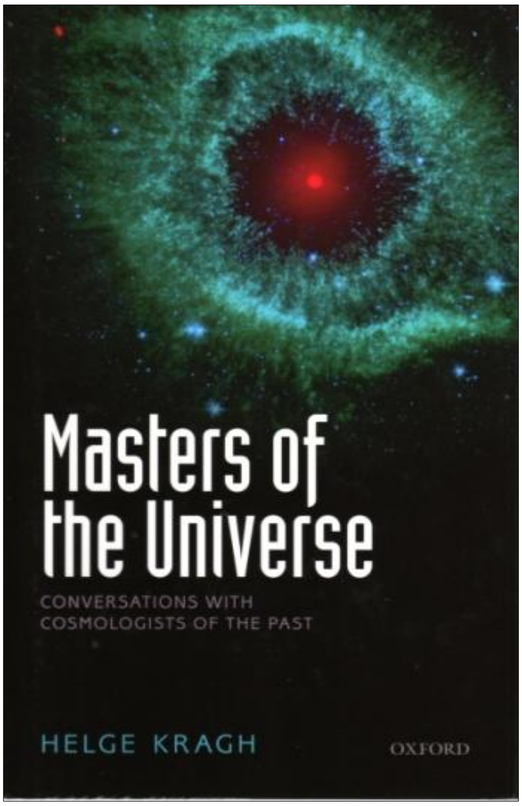
As Professor Kragh points out in the foreword, "My granduncle CCN could have existed." This man was, like Kragh, a Dane. An engineer who read and thought a lot about cosmology, he 'lived' in Denmark, Germany and the United States at different times and conducted interviews in several languages. The one great mystery in the book is the identity of the person shown in a photograph with an equally unidentified woman and labeled as the interviewer.

The first two interviewees are a bit of a surprise. Kristian Birkeland (1867–1917) was a Norwegian physicist who investigated the aurora and geomagnetism. In his 1913 interview he advocates a Universe in which interstellar space is filled with a tenuous plasma and electromagnetic forces are as important as gravitational ones.

Svante Arrhenius (1859–1927), the Nobel Prize-winning physical chemist now best-known for his prediction of global warming due to the greenhouse effect (which he thought a good thing, as it would make Sweden more comfortable), is interviewed in 1916. The Director of the Nobel Institute for Physical Chemistry considers himself a physicist now, working in many branches of science, even immunology. He advocates a Universe that is infinite in space and eternal in time, an early type of 'steady state' Universe. Light pressure plays a major role in his Universe, but the relatively new quantum ideas of Planck and Bohr are rejected as irrelevant.

Our protagonist conducts the remaining interviews with scientists familiar to those with an interest in physics and astronomy, although several are best known for their work in fields other than cosmology.

CCN's second 1916 interview is with Karl Schwarzschild (1873–1916). It is held at his Potsdam home just two months before the great astrophysicist died of an illness contracted while serving on the Russian front. Schwarzschild discusses his work on the possible curvature of space and, briefly, his papers of that year on general relativity and quantum mechanics. The chapter contains a wonderful quotation from a 1913 lecture by Schwarzschild that was published in Eddington's (1917: 319) obituary:



> Mathematics, physics, chemistry, astronomy, march in one front. Whichever lags behind is drawn after. Whichever hastens ahead helps the others. The closest solidarity exists between astronomy and the whole circle of exact science.

CCN interviews German statistical astronomer Hugo von Seeliger (1849–1924) after the Great War is over, in 1920. Seeliger has recently published the result of his life work: an investigation of the distribution of the stars in space. He has developed much of the theory of statistics of stellar distributions. He and his friendly rival, Jacobus C. Kapteyn (not interviewed), have been counting stars for decades. Seeliger's conclusion is quite similar to Kapteyn's: that the stellar system is ellipsoidal and ~10 kpc in diameter, and that the Solar System happens to be located quite near the center. Asked about the recent proposal of Harlow Shapley, that the system of globular clusters outlines a much larger galaxy centered many kiloparsecs away in the direction of Sagittarius, Seeliger states that he considers it 'plain wrong'. He says, "I suspect it's just another example of American sensationalism and tendency to megalomania." In common with Kapteyn and Shapley, he says that he has considered interstellar absorption of starlight and concluded that it is negligible. The septuagenarian Seeliger is quite conservative regarding such radical ideas as an infinite Universe or one that changes with time. He also rejects General Relativity.

The next interview, in 1928, is with Albert Einstein (1879–1955) himself. By this time CCN declares that

> … it had become clear to me, somewhat belatedly, that cosmology had entered a new phase that differed significantly from the subject as studied by classical astronomers such as Kapteyn and Seeliger. The new cosmology was essentially rooted in the general theory of relativity … (page 67).

The creator of General Relativity spends some time talking about beauty "... or perhaps sublimity is a more appropriate term ..." of the equations. He says that he has not spent much time on cosmology in recent years and that he still believes in his original model, a closed, finite, eternal Universe. He recalls informing Georges Lemaître the previous year of Alexander Friedmann's priority in finding additional, time-varying solutions to the equations of General Relativity when applied to the Universe, but stresses that he does not accept these models. This interview is timed to be just before Edwin Hubble changed cosmology forever.

The year 1933 finds CCN in Leiden, interviewing Willem de Sitter (1872–1934). By this time much has changed. Hubble's velocity-distance relation has provided evidence for an expanding Universe, and Lemaître's evolving Universe models, first published in 1927, have finally reached the influential cosmologists. The interview is far-ranging and quite interesting. It even includes a mention of Einstein's unpublished attempt at a steady state Universe with continuous creation, a model discarded by its author in 1931 and made known to the public only recently when it was discovered, translated, and published by Cormac O'Raifeartaigh and his colleagues (2014).

In 1934 CCN wisely moves from Germany to the United States. Four years later he interviews Lemaître (1894–1966) during a cosmology conference at the University of Notre Dame. The interview provides insights into the Belgian priest's views on the differences between his independent solutions to Einstein's equations and the earlier ones of Friedmann, the importance of quantum mechanics and radioactive decay to his work, and his emphatic rejection of the suggestion that his religious views affect his scientific research. There is even a mention of Lemaître's translation of his own 1927 paper into English for publication in the *Monthly Notices of the Royal Astronomical Society* in 1931, a fact only discovered after much controversy in 2011 (see Livio, 2011).

The interview with Arthur Stanley Eddington (1882–1944) was the most disappointing to me, not that it is in any way inaccurate, but because it takes place so late in Eddington's life. Had he been interviewed in the 1920s Eddington would have come across as the dominant figure in astrophysics and the most important promoter of General Relativity to scientists and the public in the English-speaking world. By 1938 he is lost in his mystical approach to the Universe, convinced that he has calculated the fine structure constant (exactly 137) and the total number of electrons in the Universe. He even spouts such nonsense as "According to my theory [the Universe] must be finite. Observations cannot give us an answer, but theory can." (page 133).

The only purely observational cosmologist interviewed is, of course, Edwin Hubble (1889–1953). The interview takes place in 1951, very near the end of Hubble's life. Hubble states that in the 1920s he kept up with developments in cosmology mostly through conversations with Caltech theoretical physicists Richard Chace Tolman and Howard Percy Robertson (who left Caltech in 1929). Hubble says

> My work of 1929 was important because it demonstrated for the first time the law of redshifts, but I did not actually conclude that the universe is expanding, and for that matter, I still feel it is premature to see in the redshift law a proof that the universe is in a state of expansion. (page 148).

and also:

> It's the privilege of the observational astronomer that he can afford the luxury of staying neutral in theoretical controversies, and it's a privilege I value. (page 149).

Our intrepid interviewer visits theoretical nuclear physicist George Gamow (1904–1968) in 1956. By this time Gamow is renowned for the theory of alpha decay, for many popular books about physics and astronomy, and especially for his strong advocacy of what Fred Hoyle has dubbed the 'Big Bang' model of the Universe. Gamow's student, Ralph Alpher, has written a famous doctoral dissertation, *On the Origins and Relative Abundance of the Ele-*

ments, in 1948, and the two, together with Robert Herman, have published several papers on the early Universe and nucleosynthesis.

In the interview Gamow refers to the early Universe as "... nature's own nuclear laboratory ..." and describes himself as a 'nuclear archaeologist' trying to reconstruct the early Universe from the current abundances of the atomic nuclei. Gamow makes it clear that his work has nothing in common with Lemaître's and that he considers only his model to be quantitative and based on nuclear reactions. He cites evidence that the Universe is infinite and hyperbolic in geometry. He is open to the possibility of a Universe that contracted before it expanded (only once) and says that we may never know. Gamow mentions the prediction of the cosmic radiation that may still be around, conveniently forgetting that he did not believe it when it was first proposed by Alpher and Herman in 1948. He takes pride in the calculations of the abundances of hydrogen, deuterium and helium, which are in reasonable agreement with observations, and concedes that it may be necessary to conclude that the heavier elements are made in stars. (Hoyle and his colleagues had just suggested this and the monumental paper by E.M. Burbidge, G.R. Burbidge, W.A. Fowler, and F. Hoyle (1957) was in preparation, although Gamow may not have been aware of it.) In common with most non-British scientists, Gamow finds it difficult to take the steady state cosmological model seriously.

The only joint interview is with Fred Hoyle (1915–2001) and Hermann Bondi (1919–2005) in 1958. There is discussion of the differences between the Bondi-Gold version and the Hoyle version of steady state cosmology. The former retains General Relativity, while the latter modifies it. The two agree on many questions, and both Hoyle and Bondi believe they have made cosmology more scientific. They disparage evolutionary cosmologies and call Lemaître and Gamow 'creationists'. Hoyle refers to the big bang as "… an irrational process outside science." Bondi is more inclined to consider philosophy and takes pride in the falsifiability of the steady state theory. They also discuss Martin Ryle's claims that radio source counts are inconsistent with a steady state Universe and Hoyle's ongoing work on nucleosynthesis in stars. The uncertainty in the ages of the oldest objects and their possible inconsistency with the Hubble time are also topics of discussion.

Historians of astronomy seldom think of Paul A.M. Dirac (1902–1984) as a cosmologist, but Kragh, who has written a major biography of Dirac, includes him among the interviewees, concentrating on Dirac's 'large number hypothesis'. In 1963 CCN travels to Cambridge to interview the founder of relativistic quantum mechanics on his cosmological research. Dirac believes that since the ratio of the electrical force to the gravitational force between a proton and an electron is of the same order of magnitude (10^{39}) as the ratio of the age of the Universe to the atomic unit of time (e^2/mc^3), that this must be a permanent law of physics, implying that the strength of the gravitational force decreases as the age of the Universe increases. He calls his assumptions "... reasonable and natural ...", although few have agreed. Dirac also says that to him 10^{-39} and 10^{-44} are of the same order of magnitude. There are definite echoes of the numerical claims made by Eddington in his last years. And the Dirac of the interview lives up to his reputation of often giving one-word answers to lengthy questions.

Our interviewer conducts his last interview at age 78 when he visits Robert Dicke (1916–1997) in 1965. Dicke is fascinated that CCN started his interviews before Dicke was born and talked with Einstein before the expansion of the Universe was known. Famous for his work on microwave radar during WWII, Dicke has achieved success in both experimental and theoretical physics at Princeton University. He heads a research group on gravity, and he and his student, Carl Brans, have developed a scalar-tensor theory that generalizes General Relativity. Dicke has explored consequences ranging from plate tectonics to a slightly different shape of the Sun.

CCN wants to know more about the microwave radiation just discovered by Arno Penzias and Robert Wilson and interpreted by Dicke, P. James E. Peebles, Peter G. Roll, and David T. Wilkinson (1965), as the cosmic background they had just 'predicted' and were preparing to search for. They seemed totally unaware that Alpher and Herman had predicted it in 1948. The Princeton physicists, or at least Dicke, considered a cyclic Universe that expanded and contracted forever, thus avoiding the creation of something out of nothing. The interview includes discussion of the history leading up to the famous back-to-back papers by the Bell Labs team (Penzias and Wilson, 1965) and the Princeton team (Dicke, et al., op. cit.) and the neglect of Alpher and Herman's earlier prediction.

I highly recommend this book. The author uses the fictitious interviews to present much factual information, revealing the personalities and attitudes of some of the principal players in twentieth century cosmology. Kragh is clearly an expert on the subject. The references include no fewer than six books and twenty-one scientific articles and book chapters by the author (three of them with coauthors), as well as two papers he posted on arXiv.

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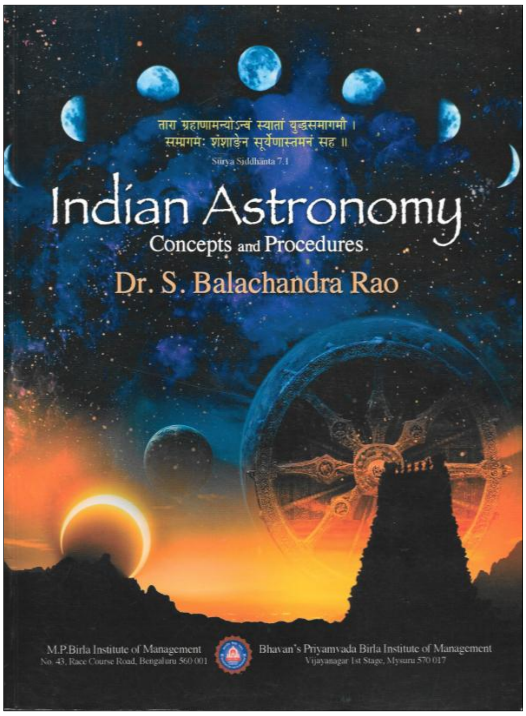
***Indian Astronomy: Concepts and Procedures*, by S. Balachandra Rao (M.P. Birla Institute of Management, and Bhavan's Gandhi Centre of Science and Human Values, Bengaluru, 2014), pp. [xiv] + 332. No ISBN (paperback), 180 × 240 mm, US$45.**

Indian astronomy stands apart from astronomy of other cultures due to its emphasis on precise calculations of motions of transient objects in the sky rather than discussions of stories and myths of constellations and zodiacs. Like most other cultures, it originally began with the realisation that twelve full moons brought the Sun close to its original zodiacal sign and hence twelve months make (nearly) a year—with a shortfall of 11 days. It therefore developed a concept of two intercalary months to be added to the lunar calendar every 5 years to synchronise the luni-solar calendar. This period was called a *Yuga* which was expanded significantly in later literature.

Since the exact time of the year and day was important for several ancient rituals, this initial arithmetic went on to take a complex root and the *Panchanga* or Indian almanac was born. *Panchānga* literally means 'having five limbs'. The five elements are:

(a) The *Tithi*, which is the time taken by the Moon in increasing its distance from the Sun by 12°. Since the motions of the Sun and Moon are always varying in speed the length of a *tithi* constantly alters;
(b) The *Nakshatra*, which marks the path of movement of the Moon. In one synodic revolution, the Moon travels through 27 stars fields that were said to form the 27 *Nakshatras* (lunar mansions);
(c) The *Vara*, or day of the week;
(d) The *Yoga*, the period of time during which the distance between the Sun and Moon is increased by 13° 20′ (~1 day); and
(e) The *Karana*, is half the *tithi*¸ during which the difference of the longitudes of the Sun and Moon is increased by 6°.



While the first three units are still in use, *Karanas* and *Yogas* are hardly used in day-to-day life.

Different aspects of these early concepts are found in some of the early astronomy, and *Tithi* and *Nakshatras* can be found in the earliest text of the *Vedanga Jyotisha* (the component of astronomy to the Vedas), which dates to about 1,000 BC. This text includes details of how to calculate solstices and other parameters that were needed for various rituals.

Since then works like the *Surya Siddhanta* (which dates to around 600 BC) significantly advanced our understanding of the skies. The *Surya Siddhanta* gives the method that should be used to determine the true motions of the planets, the Sun and the Moon. It gives the locations of several stars other than the *Nakshatras*, and it explains how to calculate the occurrence of solar eclipses as well as the solstices. The Earth's diameter and circumference also are given. Lunar eclipses, and the colour of the eclipsed portion of the Moon, are mentioned.

Building on this, Indian astronomers went on to define a complete coordinate system, and make precise calculations of the true motions of the Sun, the Moon and the planets, including occultation of stars. The mathematics they evolved for this was based on algebraic equations that needed sine and cosine functions for which reference tables were created. These calculations also needed accurate synchronisation with observations. The complete methodology and procedure was formulated around AD 500 by Aryabhata.

The methods of calculation are unique and interesting and give very accurate results for the period during which they were computed. They are of great significance to historians of Indian and world astronomy. Unfortunately there are very few well-written and concise books giving details of the methods of computation in English which can be easily accessed by a student who is new to this field. Dr Balachandra Rao has tried to fill this gap.

Rao is a very distinguished researcher in the mathematical subtleties of Indian astronomical calculations, and he has written several books on various aspects of astronomical calculations in ancient Indian texts. The present tome is designed as a text book for students of Indian astronomy, and it explains several aspects of these calculations in a systematic manner with examples and explicit solutions to several problems to help a student understand the complete intricacies of the working of the mathematical aspects of Indian astronomy.

The only problem with this book is that it gives a complete coverage of Indian mathematical astronomy without providing finer historical markings. The history of the subject is only covered in the first few pages, and the book then gets down to explaining various subtle terms used in these calculations and their context. This emphasis is made clear by the subtitle of the book: *Concepts and Procedures*. The book takes great care to refer most of the terms used in Indian astronomy to modern or English terms, and therefore is an excellent introduction for a student desirous of understanding how to calculate various astronomical terms. It will prove invaluable for this purpose alone. While discussing the calculations, Rao continues to use Indian terms, so a glossary of Sanskrit terms and (where possible) English translations would have been very useful.

This book is even more significant for scholars in its attempt to exhaustively cover all aspects of calculations that can be undertaken. The book has discussions on calculations of transits of Venus and Mercury, and occultations of stars and planets by Moon. It also discusses the evolution of the methods of calculation to improve the process of calculation over time. All this makes the book one of the finest for students who wish to learn astronomical calculations in ancient India.

In conclusion, Rao has produced an excellent and a very readable treatise on the concept and procedures used in Indian astronomical calculations and this will provide a very useful guide to all students wishing to learn about the subject.

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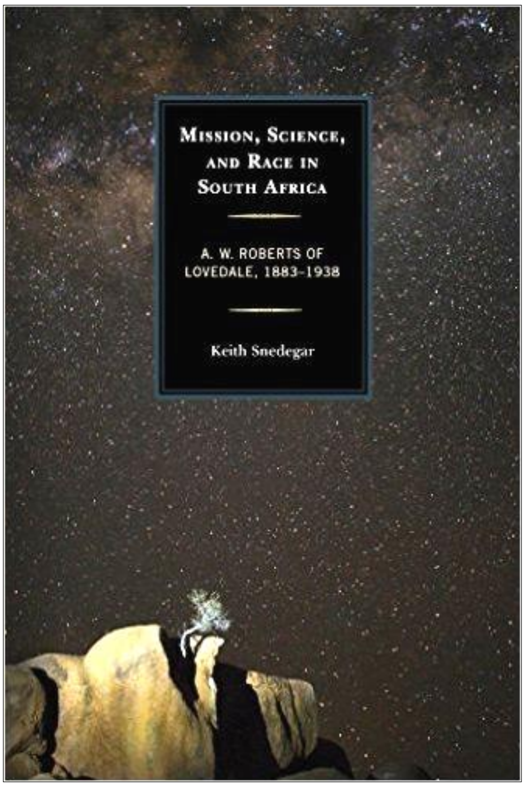
***Lost in the Stars: A.W. Roberts at the Crossroads of Mission, Science, and Race in South Africa 1883–1938*, by Keith Snedegar. (Lanham, Lexington Books, 2015), pp. xii + 189. ISBN 978-0-7391-9624-3 (hard cover) 978-0-7391-9625-0 (electronic), 160 × 234mm, US$80.00.**

This is the biography of a remarkable person who, though well-known to South African historians for his political work, deserves to be remembered worldwide for his astronomy. By day a lay teacher at the Lovedale missionary school in the rural Eastern Cape, by night he was a pioneering observer of variable stars. Late in life he came to play an important political role at the time when black Africans were beginning to claim their rights in the face of a complacent and generally-uninterested white minority government.

Alexander William Roberts came from a relatively poor Scottish family but was fortunately bright enough to receive a good education. He grew up a liberal Presbyterian and was to spend most of his life as an educator, Europeanizing and championing the rights of 'native' South Africans.

As a pioneer of serious amateur astronomy in South Africa he carved out an enviable reputation in the field of variable star studies, earning the respect of specialists in Europe and the United States of America. He eventually published nearly a hundred papers in scientific journals. This book conveys how difficult it was to do work of this kind from the isolated and austere institution of Lovedale. On top of it all, as a scientist, he was distrusted by his missionary colleagues. However, he soon began to receive encouragement from David Gill, W.H. Finlay and J.K.E. Halm, all professional astronomers at the Royal Observatory, Cape of Good Hope.

Arriving in South Africa in 1883, at first Roberts was limited to a pair of binoculars but later he could use a borrowed theodolite. Of particular interest to him were Algol-type variables such as R Arae that show eclipses. At that time, many pulsating stars were thought to be eclipsing also. Roberts appears to have been stimulated to undertake variable star observations by E.C. Pickering of Harvard. From the measured light curves he was able to derive



a number of parameters of the variable systems, such as period, relative sizes of binary components, departure from sphericity, etc. It is curious how excited the small astronomical community was in those days over the discovery of even one new variable star!

Inevitably, visual observations were subject to personal quirks. Roberts' method was to bracket the variable between two other stars that were respectively fainter and brighter. To obtain the best results it was necessary to worry about which part of the field of the telescope was being used. Roberts sought to eliminate systematic effects by multiple observations of the rotated field. Through Gill's influence, around 1900 he was presented with a small properly-mounted telescope and a prefabricated dome, as well as a chronometer. The telescope had a special prism in front that allowed rotation of the field.

Recognition for his work came slowly but surely. He was one of the founder members of the (amateur) British Astronomical Association in 1890. He was elected to the Royal Astronomical Society in 1894, proposed by Gill. In 1896, he became a Fellow of the Royal Society of Edinburgh. In 1897 he visited a number of well-known astronomers and delivered a paper at the Royal Astronomical Society. On that occasion he was invited for dinner at the Royal Astronomical Society Club, a kind of 'Inner Party' of British astronomy. He was recognized in South Africa by the award in 1899 of an honorary doctorate by the University of the Cape of Good Hope.

In a 1901 paper on "Southern Variable Stars" he could list 93 variables.

His scientific influence grew greatly in the early twentieth century and he was a founder member of S2A3—the South African Association for the Advancement of Science. The Cape Astronomical Association was formed in (1912) also with Roberts as one of the founder members. This later developed into the Astronomical Society of Southern Africa.

By 1920 or so, Roberts's observing became very sporadic and he ceased to work up his light curves for publication. Snedegar suggests that this was partly due to shyness on account of his lack of theoretical competence. The book lists the stars that Roberts observed in detail, comprising Miras, semi-regulars, Algol-type and classical cepheid variables, with a smattering of rarer types and stars found to be constant.

As a quasi-politician in the twenties and thirties of the last century, Roberts was openly in favor of the franchise for blacks on the same basis as for whites, a very radical position for the time. He had become well-known in political circles both through his membership of educational committees and his activity in the South African Association for the Advancement of Science.

In 1920 he was appointed a member of the Native Affairs Commission, intended as an official channel of communication between the then government and the 'native' population. He often found himself at odds with the other members, who tended to be much more conservative than he was. Unfortunately, as time went on and governments changed, communication tended to flow in only one direction and he found himself having to justify the government's unpalatable policies, particularly in landownership matters. He was appointed a senator by the statesman J.C. Smuts, an amateur scientist himself, to be one of four who were intended to represent the interests of the non-white races. He was regarded as having their interests at heart in a sober and level-headed (i.e. politically-acceptable) way. Not unexpectedly, he tended to become more conservative as he aged although even then he sometimes stood on the toes of those who had championed his appointment.

Snedegar's study is a *tour de force* of research into the political and scientific background of the South Africa in which Roberts lived and made his mark. Snedegar tells us that his interest in Roberts started in the late 1980s. He has made exhaustive use of material from archives and other sources scattered worldwide. His understanding of the convolutions of South African racial politics is by itself impressive. For my own part I found it hard to put the book down, opening as it did for me so many aspects of the scientific and political life that prevailed a century ago.

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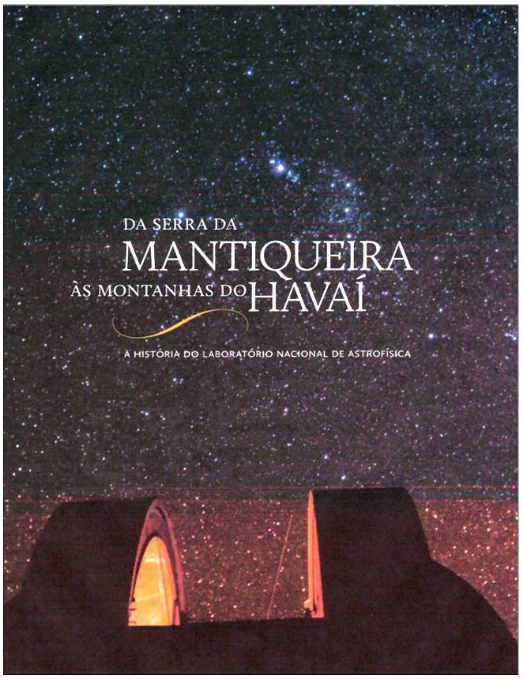
***Da Serra da Mantiqueira às Montanhas do Havaí – A História do Laboratório Nacional de* Astrofísica, by Christina Helena da Motta Barboza, Sérgio Tadeu de Niemeyer Lamarão, and Cristina de Amorim Machado. (Itajubá, LNA/MCTI, 2015), pp. 212. ISBN 978-85-98138-08-4 (paperback), 203 × 280mm. No set price.**

The plans to write this book about the history of the Laboratório Nacional de Astrofísica (National Astrophysics Laboratory, LNA) in Brazil began casually at a lunch in Brasilia during the 4th National Science and Technology Conference in 2010, when the then Director of the LNA, Albert Burth, asked me whether I knew anyone who could take on the task of researching and retelling the institution's history. The name of Cristina de Amorim Machado came to mind. Meanwhile, I myself would be a kind of project supervisor, since the budget did not stretch to paying more than one person. For bureaucratic reasons, an agreement had to be set up between the LNA and the Museu de Astronomia e Ciências Afins (Museum of Astronomy and Related Sciences, MAST) for Cristina to receive a research grant and have access to the MAST archives. Even before this was cemented, she started perusing the literature I had put her way. Still in 2010, we began having periodic meetings to discuss this pioneering project to recount the history of the LNA and the primary and secondary literature on astronomy in Brazil. I remained the official coordinator until the agreement was signed and the MAST took over the research and the writing of the book, designed to mark the 30th anniversary of the LNA.

The involvement of the MAST cast the project in a new light, changing substantially the nature of the resulting publication. After all, two institutions, both run by the Ministry of Science, Technology & Innovation, were now supposed to work together to produce a coherent version of the trajectory of the LNA from its beginnings until the present day. The end result, it must be said, is consistent with the new direction adopted when I stepped down as project supervisor. Cristina Machado carried on the work for some time, but she was not involved in writing the final draft of the book, since she had taken up a post as a Professor of Philosophy of Science and Research Methodology at the State University of Maringá.



As explained earlier, this book should be read as one version of the history of the LNA. As is common in the domain of history, other different versions could also be told. The story told here counted on the active participation of at least two of the institution's researchers: its former Director, Albert Bruch, and its current Director, Bruno Castilho. Both were involved in researching photographs, as credited on the title page. It is also important to stress that even before the MAST was involved, the project received wholehearted acceptance and support not only from the LNA's Directors, but especially from its employees, some of whom were interviewed and provided access to their personal archives. Without their involvement, this book could not have been written; indeed, nor could any other, since the LNA is still quite a young institution.

Something else that confirms the nature of this book is its Foreword by the former Minister of Science, Technology & Innovation, Aldo Rebelo. Similar projects have been pursued by other institutions from the same ministry. For instance, the Observatório Nacional (the National Observatory) and the Centro Brasileiro de Pesquisas Físicas (a Physics Research Institute) have both engaged in activities that resulted in the production of books, booklets and exhibitions. A major objective of many historical enterprises of this ilk is the opportunity to showcase past achievements in order to garner continued Government support for science in the future.

The book under discussion here is richly illustrated. There are five chapters, plus an Introduction and a Conclusion. The trajectory it describes is long, reaching as far back as the mid-1800s, when the Imperial Observatory of Rio de Janeiro began looking for a suitable site to install equipment for astrophysical research. The story then shifts to the 1930s, when a similar, also abortive, effort was made to equip the country with an astrophysical observatory. It was only in the 1960s, with the joint efforts of Luiz Muniz Barreto and Abrahão de Moraes, that things started to change. This phase, essentially the pre-history of the LNA, lasted some 20 years. Finally, in 1980, the first telescope for modern astrophysical research was installed on Brazilian soil. After these two initial chapters, the rest of the book presents a more strictly institutional perspective. The scientists themselves take supporting roles as the LNA is put center stage, and thus it continues to the end of the book.

In a bid to appeal to a wider audience, the book provides a glossary of technical and scientific terms, which helps readers understand many of the LNA's scientific projects and goals. The text itself makes pleasant reading, even if the tone becomes more official from the middle onwards, reflecting the work's institutional nature. The spotlight turns more to the LNA's achievements than those of its researchers, and the facts are more narrated than discussed. Some delicate periods from the institution's history are described, but some of the details are missing, even though many, if not most, of the people who lived through those times of tension—such as when the Brazilian Astrophysics Observatory (the original name of the LNA) split from the National Observatory—are still alive and active in their respective fields. In other words, this is not a book that will stir up any controversy. Rather, its aim is to show how much Brazilian astronomy has grown and matured through the work of the LNA.

Written by Barboza, Lamarão, and Machado, this book constitutes an important contribution to the history of astronomy in Brazil, but not just this. At least since the 1990s, the LNA has taken part in international projects like ESO and SOAR, in line with its institutional mission to coordinate the international work of Brazilian astronomers. The LNA effectively oversees Brazilian astronomy in other observatories in Chile, the United States and other sites where conditions for observing the sky are more favorable.

I do not know how this book can be acquired. I have only seen it in pdf format, even though it has already been printed. As it is institutional in nature, it will likely be distributed free of charge, but it can be accessed online on the LNA website (see http://lnapadrao.lna.br/acesso-a-informacao/institucional/livro_lna.pdf). The fact that it is written in Portuguese may prevent this important contribution to the history of Brazilian astronomy gaining wider attention. Until such a time as it is translated into English—which I hope will happen soon—readers may be interested in a research paper that was published in English in this very journal last year (Amorim Machado and Videira, 2015), which recounts some of the key events culminating in the creation of the LNA.

References

Amorim Machado, C. de, and Videira, A., 2015. A mountain observatory and the Brazilian Astrophysics Project. *Journal of Astronomical History and Heritage,* 18, 223–240.

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