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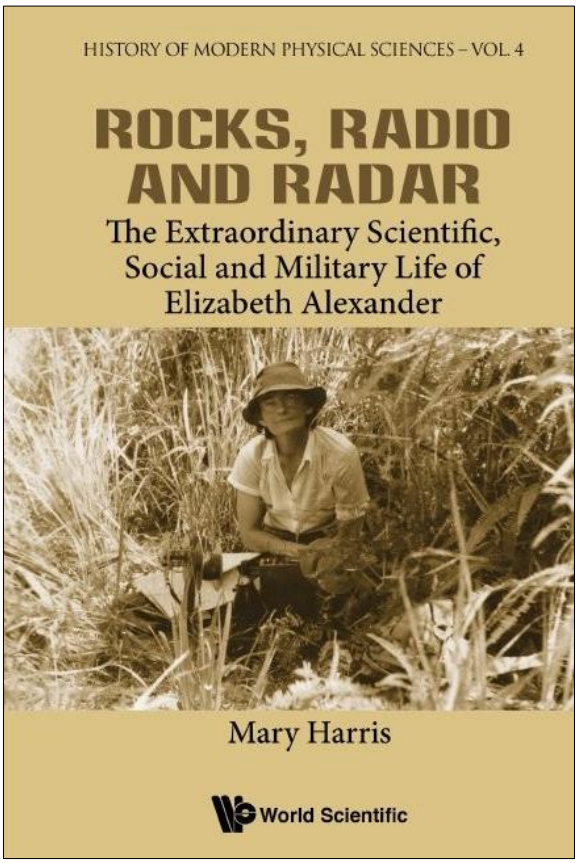
Rocks, Radio and Radar: The Extraordinary Scientific, Social and Military Life of Elizabeth Alexander, by Mary Harris. (New Jersey, World Scientific, 2019). Pp. xiv + 587, ISBN 978-1-78634-6640-3 (hardback), 155 × 230 mm, US$88:00.

To say that this is a remarkable book about a remarkable woman is a gross understatement. This is the story of Dr Elizabeth Alexander, a Cambridge-trained geologist who unwittingly became the world's first female radio astronomer. But it is much more than this. It is also about life in England, in Singapore, in New Zealand and in Nigeria. It is also a love story that began when Elizabeth was a young British Geology graduate student at Cambridge and he a New Zealander there to complet his PhD in Physics. It is about WWII, about academia in the British Empire, and about expatriate children —the so-called *colonial orphans*—who were sent 'home' to England to endure a lonely parentless existence while their parents enjoyed life in the colonies. All this, and more ...



Francis Ellizabeth Somerville Caldwell was born in England on 'Black Friday', or to be precise, Friday 13 December 1908 (Chapter 1). Her father, Dr Kenneth Caldwell, was in India working for the Colonial Education Service as Professor of Chemistry at Patna College, and

Elizabeth (as she liked to call herself) and her mother, Jane, joined him there in 1911. After WWI Elizabeth returned to England to complete her education, first at secondary school and then at Cambridge. She studied physics and geology and after completing her undergraduate degree began a PhD in geology, with a thesis on the Aymestry Limestone. She graduated in 1935, the same year she married Norman Alexander (Chapter 2), and after he completed his PhD they set off for Singapore where Norman was to be the founding Professor of Physics at Raffles College (Chapter 3).

WWII intervened and on 4 January 1942 Elizabeth escaped to New Zealand with their three young children (Chapter 6a). Norman stayed behind and was interned by the Japanese in the infamous Changi and later Sime Road prisoner-of-war camps (Chapter 7). In New Zealand, Elizabeth began a diary—a combined daily account of her life and an on-going love letter to her husband so if and when they eventually were reunited after the war he could share those missing months and years of her life.

The author of this book, Mary Harris (b. 1936), was one of those three young children evacuated to New Zealand in January 1942, and although she used a wide range of published and unpublished sources to thoroughly reseach this book, she also drew freely on her mother's diary.[1]

Elizabeth Alexander and her three children spent three happy years together in New Zealand (Chapters 6a and 6b), before reuniting with their father. After the war Singapore was not the same and it would take time, dedication and lots of money to re-build. After a while, including a period in England acquiring equip-ment, Professor Alexander had the Physics Department at Raffles College up and running, and Elizabeth was once more immersed in her study of Singapore geology. But she also had a new task to attend to when Raffles College remorphed itself into the University of Malaya, and she served as Temporary Registrar. The unfortunate losers in all this were the three Alexander children who were destined to remain in England with Elizabeth's relatives and become colonial orphans (Chapter 8). History was repeating itself!

The final phase in Elizabeth Alexander's life came in July 1952 when she and Norman left for Nigeria, where he would be Professor of Physics at University College Ibadan. Soon Elizabeth had a position there too, teaching elementary geology as a Temporary Lecturer in the Faculty of Agriculture (later this would convert to a permanent posiiton, a Junior Lectureship). She also began research on tropical weathering in Nigeria. But all this was to change on 15 October 1958 when she died after suffering a stroke. She was two months shy of her 60th birthday.

I purposely wanted to provide this resumé of Dr Elizabeth Alexander's life before discussing the reason for the appearance of this review in a journal about astronomical history. While she was primarily a geologist, she also did pioneering research in solar radio astronomy. This occurred when she was in New Zealand during WWII (see Chapter 6a). She understood that her husband had died (before later hearing to the contrary), and with herself and three young children to support she urgently needed to find work. When the authorities found she was living in New Zealand Dr Ernest Marsden, the Secretary of the Department of Scientific and Industrial Reserch, immediately offered her a post as Head of the Operational Research Secton within the Radio Development Laboratory (in Wellington).

It was a happy coincidence that led to this appointment. As Chapter 4 relates, back in 1940 Elizabeth and Norman spent six months in New Zealand (he was on sabbatical leave) and Marsden just happened to be a fellow-passenger on the ship from Sydney to New Zealand. He told Elizabeth and Norman Alexander about New Zealand's radar research program. They also had meetings with Fred White in Sydney and Percy Burbidge in Auckland, who provided further details, so when they returned to Singapore Elizabeth followed up on this, gaining an appointment as Intelligence Officer in the Royal Navy so that she could work on radar at the Singapore Naval Base. So when she arrived in New Zealand in 1942 needing a job the Director of the Radio Development Laboratory, Owen Pulley, quickly realised that "... the right person had turned up in the right place at the right time." (p. 311).

Elizabeth Alexander's new job (Chapter 6b) was primarily to monitor the performance of existing New Zealand radars at stations within New Zealand and in the Pacific, and design and evaluate new types of radar sets, but she also had to research the anomalous propagation of radio waves (including a major international radio-meteorology project, and phantom aircraft echoes), and differentiate radar signals from schools of whales, flocks of seagulls, submarines and other surface craft.

She also had to investigate the 'Norfolk Island Effect' when on 1 April 1945 the Officer-in-Charge of the Royal New Zaland Air Force Radar Station on Norfolk Island (in the Tasman Sea between Australia and New Zealand reported that

> ... since March 27th 1945, an increase in

> noise had been observed on the COL range tube every morning and evening. The set, turning gear, aerial connections, etc. had been checked and it was shown that this noise increase came from outside the set. The effect was observed only as the sun was rising or setting and lasted for about half an hour. (p. 385).

Follow-up observations were made at Norfolk Island and four radar stations in the northern part of New Zealand, and there were further detections. As a result of these observations and more made in October 1945 Elizabeth Alexander concluded that the Sun intermittently emitted strong radio burts at 200 MHz, and this emission was non-thermal in origin and was associated with the presence of sunspots.

As Mary Harris points out, this research was simply seen by her mother as a normal part of her work routine, and as such it is not even mentioned in her diary. Yet the fact that she interpretted these observations under the cloak of wartime secrecy makes her yet another independent discoverer of solar radio emission. Elizabeth Alexander's exploits as the first female in the world to conduct successful solar radio astronomical research were first detailed for the international radio astronomical community in Orchiston and Slee (2002) and Orchiston (2005), with revised and more accessible versions published later (Orchiston, 2016; 2017). Meanwhile, several much earlier attempts were made to bring these pioneering radio astronomical observations to the attention of the New Zealand public, and particularly amateur astronomers and science enthusiasts (Orchiston, 1994; 1995a; 1995b). Recently, Fraser (2017) and Harris (2017) has published papers about this work, targetting New Zealand amateur and professional astronomers.

Although radio astronomy and radio meteorology only occupy a minuscule percentage of this long book, I have to say that I found the entire book immensely entertaining, and educational. I also found it addictive: like a novel that once opened you cannot put down and must read through to the end. Yet this was no novel, and in places fact was stranger than fiction!

This book also filled me with nostalgia. I am only slightly younger than Mary Harris, and have vague memories of the last years of WWII, so her accounts of Singapore in 1940–1942 reminded me of Auckland (New Zealand) where I spent my earliest days and endured the hardships of the late-war and immediate post-war years. And the details of war-time Singapore touched another deep chord, bringing back a great many fond post-war memories for me of one of my favourite places (I have now visited 37 times).

But there were other crossed paths. One of Mary and Norman Alexander's friends while they were in Cambridge was the Welshman Dr E.G. (Taffy) Bowen (1911–1991). Taffy later moved to Australia, and was still Chief of the CSIRO's Division of Radiophysics (RP) in Sydney when I joined as an 18-year old, straight out of secondary school. At the time RP ranked as arguably the leading radio astronomical institute in the work, and I was privileged to work in the Solar Group. Taffy was rightly proud of our achievements, and I still have an autographed copy of his *Old Radar Days* that he gave me and my father many years later (Bowen, 1987). I can blame my experiences at RP for the abiding interest that I now have in the early history of radio astronomy.

Rocks, Radio and Radar ... is a wonder book, a true adventure story, and one that I am so thankful to Mary Harris for having written. In her final chapter, titled "Disappearance From History", Mary talks about how women scientists have been belittled or ignored for far too long. It is good to finally see this changing, and that the remarkable achievements of one more woman of international distinction, Dr Elizabeth Alexander, wife, mother, scientist, geologist and pioneering radio astronomer,[2] are no longer hidden and lost in the mists of time.

Notes

1. Mary Harris kindly sent me a copy of the diary when I was investigating her mother's war-time research in solar radio astronomy. While I certainly found it useful for my purposes, at times there were tender personal moments when I felt like an intuder who had no right to be reading her private thoughts.
2. Note that I use this term loosely, and with respect, for it was only coined in 1948, three years after Elizabeth Alexander carried out her initial study of 'solar noise'. Meanwhile, those with a non-solar interest at this time studied 'cosmic noise' (see Sullivan, 2009).

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Cosmos: The Art and Science of the Universe, by Roberta J.M. Olson and Jay M. Pasachoff. (London, Reaktion Books, 2019). Pp. 303, ISBN 978-1-78914-054-5 (hardback), 225 × 286 mm, £35.

This is a beautiful book, both physically and intellectually, and a fitting sequel to their earlier classic, *Fire in the Sky: Comets and Meteors, the Decisive Centuries in British Art and Science* (Olson and Pasachoff, 1998). Their new book, however, covers far more territory, its ten chapters extending from "Astronomy: The Personification and the Practice", to Star Maps, Constellations and Globes; the Sun; the Moon; Comets; Meteors and Bolides; Novae, Nebulae and Galaxies; the Planets; the Aurora Borealis; "New Horizons in the Cosmos: Photographs of Space" (some of them taken *from* space); and finally a 1-page Conclusion. Then there are references, Acknowledgements, Photo Acknowledgements and an Index.

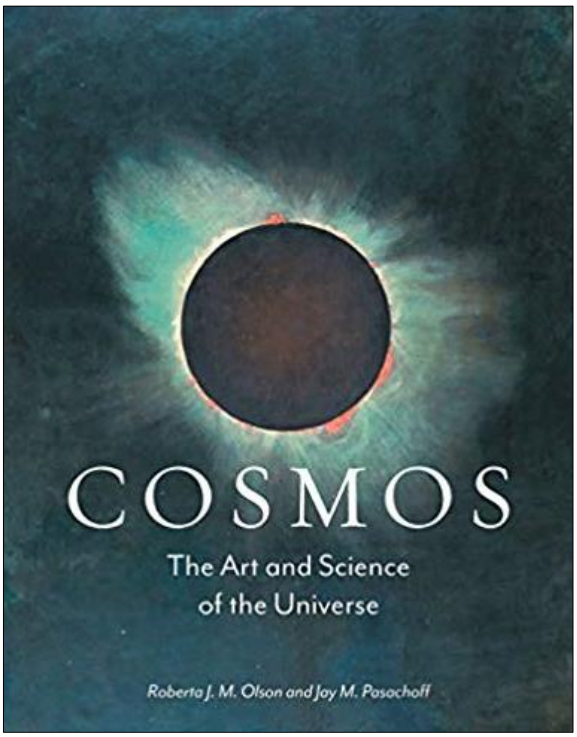
The authors explain the rationale for this book:

> This visually provocative volume charts the human love affair with the heavens in art and astronomy, We have written the book based on exciting science, art and cultural history, for a general but intellectually acute audience interested in the compelling story of the discovery of how the universe is arranged and how it functions. (p. 7).

Later on the same page Olson and Pasachoff explain that they began working together in 1985, and have "... pioneered the multidisciplinary study of astronomical phenomena in art." Furthermore,

> We are grateful that our work seems to have sparked much enthusiasm in many new areas of exploration, including a highly regarded international series of conferences entitled 'The Inspiration of Astronomical Phenomena'. (ibid.).

Olson and Pasachoff spent more than three decades accumulating material for this book, "... resulting in an archive of thousands of candidates for its illustrations." Three hundred and six made the cut, and this visual extravaganza is one of the highlights of the book, with each chapter presenting an exciting mix of text and art works. The latter include oil and watercolour paintings, an Aboriginal Australian bark painting, drawings, mixed media works, a fresco, wood cuts, engravings, etchings, chromolithographs, astronomical photographs, star maps, sculptures, astronomical instruments (including orreries), museum exhibitions, archaeological artifacts and even clothing, jewellery and a unique letter-opener.



One well-known artist/astronomer represented throughout the book is the French-born Étienne Léopold Trouvelot (1827–1895), and it is interesting to compare and contrast his different works. While some are beautiful and realistic, other renditions lack credibility (as with his drawing on page 182 of the 1868 Leonid meteors and his drawings of Jupiter and Mars on pages 234 and 241).

For those wanting to explore astronomical art further Olson and Pasachoff provide 10.5 pages of references, but two new references