is not instantaneous but follows minutes after the earthquake. Liquefaction in Haiti's earthquake disaster of 2010 was responsible for few fatalities, with most of the damage occurring on bedrock.

The occasional jibes at the insensitivity and ignorance of myopic politicians will raise a cheer from many readers, as will Kieffer's championing of the precautionary principle. Simply stated, it is not up to the suffering world to prove that it is suffering. More precisely, if a government sanctions actions that may be harmful to our environment, it is up to the perpetrators to prove that their deeds are harmless. The principle applies well to profitable corporations. But how does it apply to unregulated deforestation by the world's poor, or to those who drive their cars to work?

At the end of each chapter, Kieffer explores the societal implications of the disasters, the threads of which she gathers in her concluding chapter. For instance, the double disaster in L'Aquila, Italy (the fatal earthquake of 2009 and its unexpected legal consequences), raises an important issue all scientists must face — how to describe uncertainty to a public that wants a black-and-white view of the future. In Italy, government representatives have chosen the moral high ground in condemning the absence of a clearly stated probabilistic assessment of potential future seismicity. Kieffer rightly views the L'Aquila process as a wake-up call for improving tools for characterizing future disasters. In a post-Fukushima world, we cannot afford to suppress an honest discussion of low-probability extreme events. But assessing what constitutes an acceptable risk to society is currently something that scientists and present societal structures are ill-equipped to handle.

Anyone interested in the processes that underlie catastrophic events within Earth will welcome this book, part riveting and all informative. We cannot prevent disasters, but with a little bit of foresight and a lot of common sense, we can reduce their impact on our growing population. Give a copy to your local politician! ■

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MARTIN O'NEILL; BASED ON A PHOTO BY NEILLD/BIGSTOCK

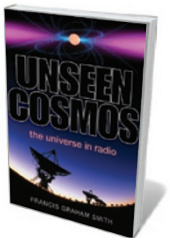
RADIO ASTRONOMY

Finger on the pulsar

Bernie Fanaroff probes a study on how radio telescopes have opened up our understanding of the Universe.

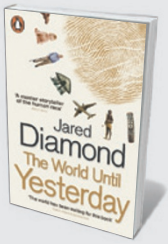
Francis Graham-Smith's *Unseen Cosmos* sets out the unique role of radio telescopes and observations at radio wavelengths in transforming our understanding of the Universe. The former UK Astronomer Royal describes the many important discoveries in radio astronomy and the techniques that made them possible. It is an extraordinary tour, from the rotating ultra-dense neutron stars known as pulsars and the cosmic microwave background left over from the Big Bang to powerful, distant radio-wave-emitting galaxies and the radio emission from molecules in galactic regions where stars are born.

Astronomy today is a multi-wavelength discipline. Observing astronomical objects and even the structure of the Universe at wavelengths from radio waves to gamma rays allows us to see different processes and often different parts of these objects.

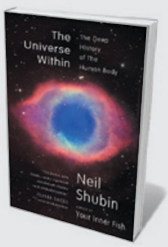


Unseen Cosmos: The Universe in Radio
FRANCIS GRAHAM-SMITH
Oxford University Press: 2013.

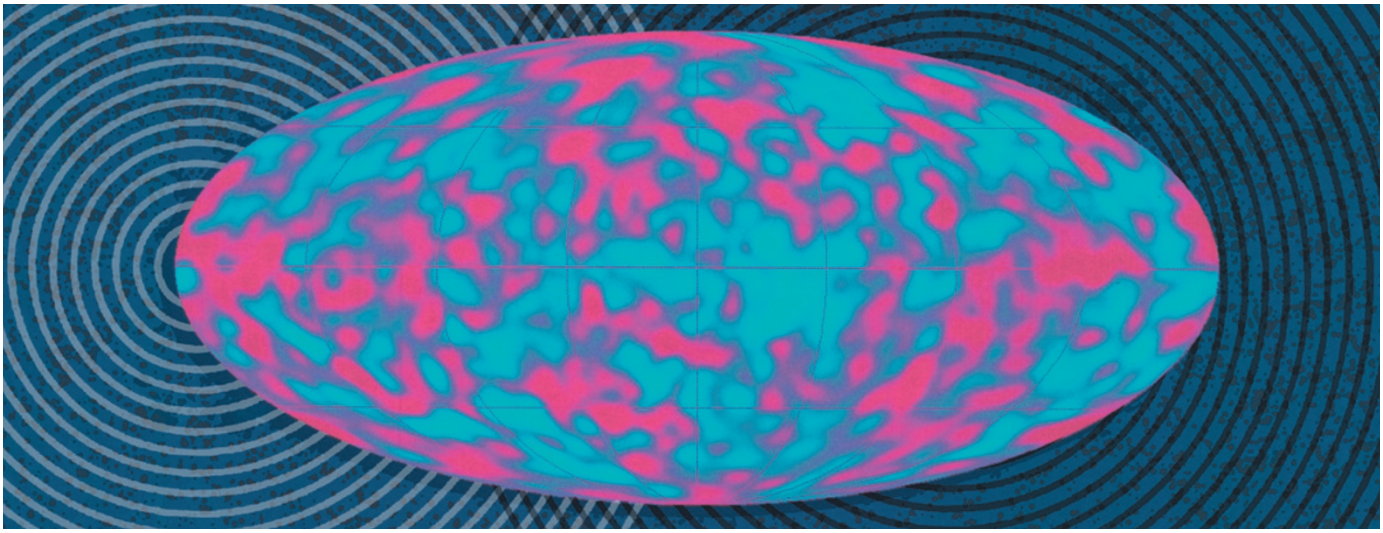
Observations in the infrared reveal cool galactic gas and dust; in the ultraviolet, hot young stars. At radio wavelengths, we spot neutral hydrogen gas and its motion, as well as synchrotron radiation (from electrons moving in a magnetic field at close to the speed of light) in galactic or intergalactic magnetic fields. X-ray telescopes detect very hot gas in and between galaxies, and optical wavelengths reveal the light from stars and ionized gas clouds. All of these data must be combined for a full understanding of objects. ▶



The World Until Yesterday
Jared Diamond (Penguin, 2013)
The cultural gap between traditional societies and the West is a rich seam for anthropologist Jared Diamond. Here, he explores what indigenous cultures can teach the West in areas from childcare to dispute resolution. (See Monique Borgerhoff Mulder's review: *Nature* **493,** 477–478; 2013.)



The Universe Within: The Deep History of the Human Body
Neil Shubin (Vintage, 2013)
Palaeontologist Neil Shubin unpicks the intertwined evolution of Earth and life, finding intriguing links, for example, between continental break-up and mammalian evolution. (See Birger Schmitz's review: *Nature* **493,** 25; 2013.)



MARTIN O'NEILL; NASA/COBE SCIENCE WORKING GROUP

Multi-wavelength observation is also needed because many astronomical phenomena are now known to be intimately linked. The evolution of galaxies and clusters of galaxies is a good example: there are complex, still little-understood relationships between phenomena such as radiation and jets from active galactic nuclei (AGNs, regions at galactic centres that emit vast amounts of energy, powered by supermassive black holes), accretion of gas, star formation and galaxy mergers. Observing galaxies at different epochs, stages of development and wavelengths is helping to clarify how energy is transferred between AGNs and the gas in and between galaxies, and how this affects the rate of star formation.

Against these new trends in astronomy, it is easy to forget radio astronomy's special role over the past 80 years. Graham-Smith reminds us that the existence of the Big Bang was confirmed initially by counting distant radio galaxies and radio quasars — remote, extremely luminous AGNs — and then by the discovery of the cosmic microwave background. He describes the beautiful experiments that measured the irregularities in this radiation and how they have transformed cosmology from a science based at least in part on aesthetics to one in which key parameters have been determined to an extraordinary level of precision. He details the discovery of pulsars by Jocelyn Bell and Tony Hewish and the extreme physics of these stars. The use of rapidly rotating pulsars as clocks has allowed astronomers to probe physics in very strong gravitational fields and has repeatedly confirmed the predictions of Einstein's General Theory of Relativity.

The new radio telescopes — such as the Square Kilometre Array (SKA) to be built in southern Africa and Australia, which will be the largest ever — also open up big possibilities. We could discover how the Universe was re-ionized by the first stars and/or quasars, detect the gravitational waves predicted by Einstein and possibly even detect extraterrestrial intelligence. The SKA will be sensitive enough to see ambient radio emission (the equivalent of airport radar) from habitable planets orbiting stars in our vicinity, and is by far the most likely way to find ET.

The first radio-astronomical observations were carried out by Karl Jansky and Grote Reber in the 1930s, but the key technological advances took place after the Second World War. Astronomers such as Martin Ryle, John Bolton, Bernard Lovell and Graham-Smith himself were amazingly innovative in designing and developing new instruments, such as radio interferometers. I was lucky to be a research student at the University of Cambridge, UK, from 1970 to 1974, with access to the One-Mile Telescope and 5-km Array. This was a unique opportunity — everything observed was new, exciting and publishable. *Unseen Cosmos* describes this history. And the tradition of innovation has persisted: the technology challenges in designing and building the SKA are immense. They range from wide-field and wide-bandwidth receivers to innovative algorithms for calibrating and making images from observations. The vast data output will stretch researchers' capacity.

Although much of the history has been told before, I found *Unseen Cosmos* interesting and informative. Combining history with explanations of particular topics and their contemporary development has its limitations, however. And like most books that try to describe very complex physics in a simple way, this book succeeds in some places and not in others. I found the description of pulsars lengthy but hard to understand. I would also have welcomed more on current developments and what capabilities will be provided by the new radio telescopes, such as the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile and the SKA.

Because radio astronomy is developing rapidly, it is perhaps safer to write a book that includes a large dollop of history than to write one that could quickly become dated. Nonetheless, this book is a useful reminder of why we want to build huge, technically challenging and expensive radio telescopes like the SKA. ■

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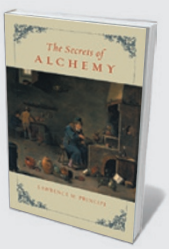

The Secrets of Alchemy
Lawrence Principe (University of Chicago Press, 2013)
The practice of alchemy overlapped with the birth of chemistry, reveals Lawrence Principe in this magisterial study. He traces its trajectory from ancient Egypt through its development in the Islamic world, Latin Europe and beyond. (See Jennifer Rampling's review: *Nature* **491,** 38; 2012.)

Round About the Earth: Circumnavigation from Magellan to Orbit
Joyce E. Chaplin (Simon & Schuster, 2013)
The ultimate round trip, circumnavigation has seduced scientists and explorers for five centuries. This riveting history covers sea, land, air, space, and transport from feet to Sputnik. (See Andrew Robinson's review: *Nature* **491,** 39; 2012.)