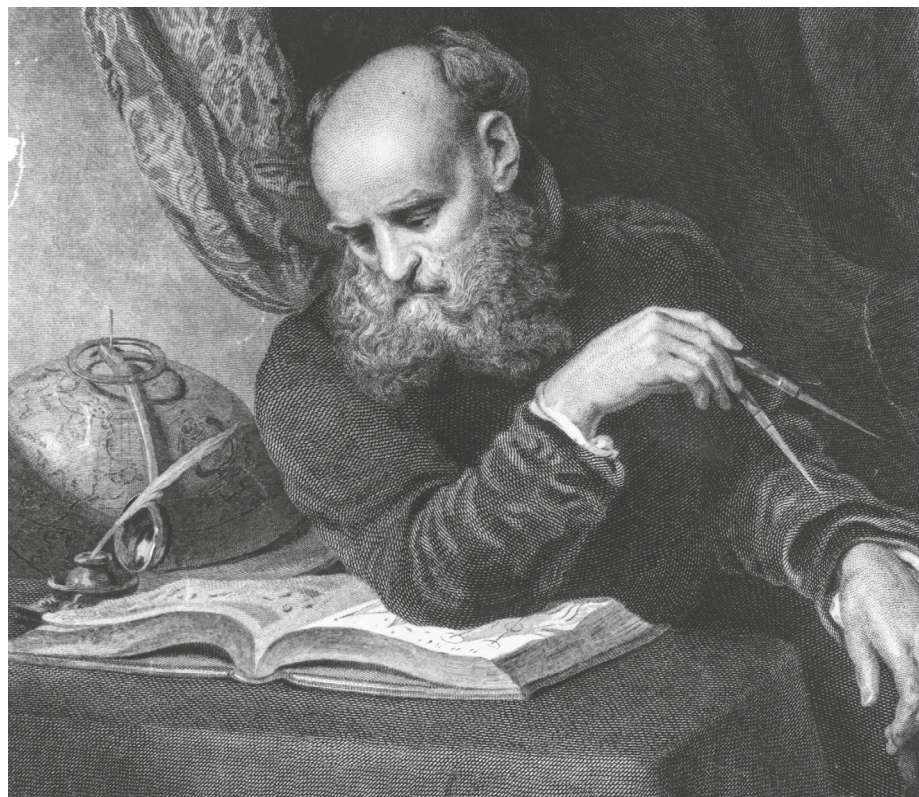


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In the seventeenth century, Galileo faced persecution for his heretical views on astronomy.

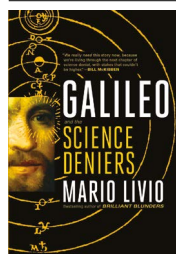
Galileo's story is always relevant

With science denialism stronger than ever, who better to revisit? **By Alison Abbott**

Is there room in the crowded canon for a new biography of Galileo Galilei? Astrophysicist Mario Livio is betting so. His *Galileo and the Science Deniers* aims to stand out by placing the original Renaissance man and his discoveries in modern scientific and social contexts. In particular, he argues, the charges of heresy that Galileo faced for his scientific claims in the seventeenth century have their counterparts in science deniers' condemnations today.

Born in 1564 in Pisa, Italy, into an intellectual family of declining fortune, Galileo pursued medicine at the University of Pisa. But he soon abandoned his course to study mathematics, his enduring passion. The

Universe, he famously wrote, "is written in the language of mathematics". It was an argot that allowed him to break reliance on the Aristotelian cosmology prized by the Catholic Church, and to forge a new, quantitative study of nature.



Galileo and the Science Deniers
Mario Livio
Simon & Schuster
(2020)

In Pisa, Galileo delved into mechanics, using his observations to question accepted ideas about motion (although Livio reminds us that Galileo probably never conducted the famous experiment in which he supposedly dropped spheres from the city's leaning tower and found that they fell at the same speed regardless of their mass).

In 1592, he moved to the University of Padua in Italy, an intellectually liberal environment happily beyond the jurisdiction of the Pope. Here, he began to discuss the revolutionary theory, proposed by Polish mathematician Nicolaus Copernicus in 1543, that rather than being the Universe's fixed centre as Aristotle had insisted, Earth was in fact orbiting the Sun.

Livio structures his account partly around specific works, including Galileo's 1610 *The Sidereal Messenger*, which described his major astronomical observations. While working in Padua, Galileo often visited the nearby port of Venice, where he was introduced to the 'spyglass', a new-fangled instrument from Holland that could be used to see ships approach. Galileo turned it to the heavens to make the discoveries that changed the course of astronomy, and launched his own fate.

In his first observations, Galileo saw that the Moon was not a smooth sphere, but was mountainous. This contradicted the church's view that the heavens were pristine and unchangeable, unlike the corrupt, mutable Earth. He also saw satellites orbiting Jupiter, shooting a hole in the geocentric argument that if Earth were to move, it would lose its Moon.

In 1610, against his friends' advice and in pursuit of more money, Galileo left the protective environment of Padua and moved to Florence to work for Cosimo II de' Medici, the Grand Duke of Tuscany. Despite now living within the Pope's sphere of influence, in 1632, Galileo published his book *Dialogue Concerning the Two Chief World Systems*, an imaginary debate between Salviati, an advocate of heliocentrism, and a witless geocentrist named Simplicio.

Putting the Pope's view – that God's universe is inherently unknowable – into the mouth of a fool was risky. Galileo's fame and fortune rose, but so did the power and determination of his enemies, and the Holy Inquisition finally claimed him. In a riveting account of the trial, Livio describes how the Inquisition dismissed Galileo's claim that the *Dialogue* was a balanced argument that ultimately rejected Copernicanism. On 22 June 1633, one of the world's most venerated scientists was on his knees before its members,

Books & arts

renouncing the errors and heresies inherent to Copernicanism.

Livio parses the considerable, and often ambiguous, evidence about Galileo's life and trial, and comments on the conclusions reached by various historians. The official summary of the trial proceedings, he writes, "revealed a clear intention to present Galileo in the worst possible light". Like others before him, Livio doubts claims that Galileo left the court defiantly muttering about Earth, "and yet it moves".

The non-chronological zigzagging of the book can be hard to follow, but allows Livio to focus on themes, such as Galileo's polymathy. He highlights Galileo's lifelong study of the great Italian poets Dante Alighieri, Torquato Tasso and Ludovico Ariosto. And he notes that the astronomer's drawing skills and knowledge of perspective allowed him to understand that the shadings on the Moon were shadows cast by mountains, and to depict them in lovely watercolours.

Livio is at his best when he discusses how Galileo's scientific understanding compares

"Critics from creationists to Donald Trump discredit arguments by exploiting gaps in knowledge."

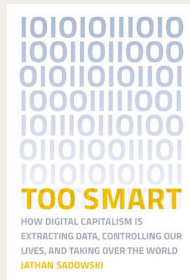
with that of researchers today. Galileo suggested, for example, that comets might be optical phenomena caused by the reflection of sunlight by vapours released from Earth. We now know they are 'dirty snowballs' made of ice, rock, dust and frozen gases. Some of these components vaporize when they get close to the Sun, giving comets two tails: one of dust that reflects sunlight, and one of gas that glows as it ionizes.

And what of today's science deniers? Livio briefly addresses how religion and business interests still conspire to attack evidence for evolution and anthropogenic climate change. In general, "processes that are not fully understood don't constitute flaws", he points out, but critics from creationists to Donald Trump discredit scientific arguments by exploiting gaps in knowledge. It's a chillingly relevant theme, yet the parallels he draws between Galileo's trial and contemporary science wars feel thin, and there's a frustrating lack of examples to demonstrate the continuity of denialism through the centuries.

Nonetheless, Livio has added to the canon an accessible and scientific narrative, in which a profound love for Galileo shines through.

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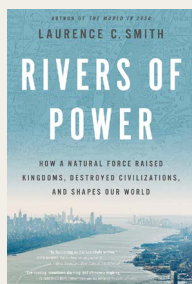
Books in brief



Too Smart

Jathan Sadowski MIT Press (2020)

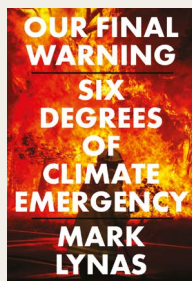
'Smart' technology in hands, homes and cities will "measure, monitor, manage and monetize all aspects of our lives", shows Jathan Sadowski. One toothbrush, for example, uses sensors to record when, how long and how well users brush their teeth, sending the information to cloud servers owned by the manufacturer or a third party. Users might choose to share such data with their dentists — but surely not with dental insurers without express permission. This hype- and jargon-free warning deserves a wide welcome.



Rivers of Power

Laurence C. Smith Little, Brown Spark (2020)

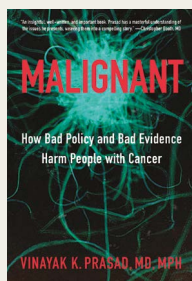
Many civilizations began beside great rivers: the Tigris and Euphrates in what's now Iraq, the Nile in Egypt, the Indus in India and Pakistan, and the Yellow in China. Rivers run through almost all our great cities, notes Earth scientist Laurence Smith in his highly readable history, extolling their fundamental benefits: "access, natural capital, territory, well-being and a means of projecting power". No wonder we still speak of 'crossing the Rubicon', a border river traversed by Julius Caesar's army in defiance of republican law, triggering the rise of the Roman empire.



Our Final Warning

Mark Lynas Fourth Estate (2020)

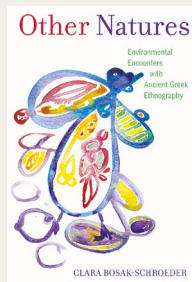
The average global temperature has risen 1°C above pre-industrial levels. This update to environmental activist Mark Lynas's 2007 book *Six Degrees* explores the likely effects of further rises. Its horrifying eloquence derives from its restraint, grounded in research, including a 2019 *Nature* assessment of future carbon dioxide emissions from existing infrastructure, which leads Lynas to forecast total emissions double those required to keep increases to the 1.5°C agreed in Paris in 2015. "This really is our final warning," he concludes.



Malignant

Vinayak K. Prasad Johns Hopkins Univ. Press (2020)

The cost of new cancer treatments in the United States is routinely US\$100,000 per year per person; some are more than \$400,000 per dose. Oncologist Vinayak Prasad's insider study analyses how US scientific, industrial and regulatory policies — as well as financial conflicts of interest for physicians — "incentivize the pursuit of marginal or unproven therapies at lofty and unsustainable prices". Aimed at general readers (including patients), oncology trainees and experts in health-care policy, it informs and disturbs throughout.



Other Natures

Clara Bosak-Schroeder Univ. California Press (2020)

US natural-history museums haunt classicist Clara Bosak-Schroeder's study of how ancient Greek historians Herodotus and Diodorus Siculus portrayed non-Greek peoples, such as Ethiopians and Persians. She begins with her childhood fascination with a diorama of a crouching African woman holding a pink grub to her mouth, and ends as she adopts a killer whale at Washington's Whale Museum. Ancient ethnographies, she says, can help people "confront environmental degradation and transform their own relationships to other species". **Andrew Robinson**