

► specific role of the region targeted. He also skimps on neuroimaging techniques such as magnetoencephalography, which directly measures changes in magnetic fields produced by electrical signals in the brain. This is not an exhaustive account, and Poldrack focuses only on key developments and pioneers close to his own work. Yet his idiosyncratic approach is deeply engaging.

I was fascinated by Poldrack's description of why he decided to scan himself more than 100 times over 18 months to investigate how the brain changes over time — despite enduring a panic attack the first time he went into an MRI scanner. This intensive study uncovered much about the stability of brain function and the factors that affect it (including caffeine, food and mood). Yet Poldrack reveals that he learned “depressingly little” about himself during the experiment, highlighting the challenges of using fMRI for personalized medicine.

At times, Poldrack loses focus. His brief forays into topics such as the nature of mental illness are unsatisfying: they are too brief and lack the clarity of the rest of the book. Nevertheless, this is a compelling introduction that lucidly spells out the risks of taking media reports at face value, and urges readers to dig into the details. fMRI is evolving rapidly and researchers are just starting to map brain activity at sub-millimetre resolution, revealing activity — both in different regions and in different layers of cortex within a region.

Happily, despite the book's title, Poldrack makes it clear throughout that ‘mind reading’ as most people would imagine it remains in the realm of science fiction. What is much more exciting is the potential of fMRI for providing insight into brain function that will ultimately lead to clinical applications. ■

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The views expressed do not necessarily represent those of the US National Institutes of Health, the Department of Health and Human Services or the US Government.

## ATOMIC PHYSICS

# Secret histories of the bomb

**Sarah Robey** examines two books that together trace the birth and evolution of the nuclear age.

**T**he secretive twentieth-century history of nuclear weapons is an evergreen subject. Writers have mined it for stories of breakneck innovation, wrenching controversy, unimaginable violence, espionage and larger-than-life personalities. Two new books — *Fallout* from historian Peter Watson and *Burning the Sky* by science writer Mark Wolverton — continue this trend, recalling two instructive episodes in our collective nuclear past.

*Fallout* synthesizes the history of the race to create an atomic bomb in Germany, the United Kingdom and the United States from the 1930s to the end of the Second World War — a story of duplicitous players, sinister decisions and regrettable outcomes. In a twist of historical fate, Adolf Hitler's rise coincided with major breakthroughs in particle physics, including the theorization of nuclear fission by Lise Meitner and Otto Frisch in December 1938. By the time war broke out, many prominent scientists had fled the Reich, and the Allies assumed that any physicists remaining in Germany, including Werner Heisenberg, were working to harness fission to produce a bomb (see A. Finkbeiner *Nature* **503**, 466–467; 2013). This was the main reason that Britain and the United States sought to beat Hitler to the punch.

But, as Watson uncovers, British intelligence showed that Germany's atomic programme had stalled by 1942. Why, then, did the joint UK–US atomic programme move forward, despite incredible cost and danger? Watson painstakingly outlines a complex web of who knew what, and when, to show how a series of opportunities to stop what became the Manhattan Project arose, then passed. In 1942, without access to full

**Fallout: Conspiracy, Cover-Up, and the Deceitful Case for the Atom Bomb**

PETER WATSON  
*PublicAffairs* (2018)

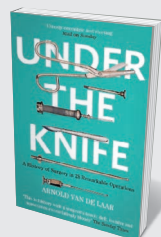
**Burning the Sky: Operation Argus and the Untold Story of the Cold War Nuclear Tests in Outer Space**

MARK WOLVERTON  
*Overlook* (2018)

British intelligence, the US government actually ramped up its project, assuming that Germany was advancing rapidly. As Watson puts it, “a series of momentous mistakes were made, and lies told” by French, German, British and US officials. Thus “the world stumbled, even blundered, unnecessarily into the nuclear age”. In his view, today's extraordinary nuclear challenges — deteriorating arsenals, ongoing proliferation and the rebirth of sabre-rattling nuclear diplomacy — were preventable.

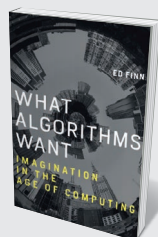
Watson's meticulous attention to this chronology is one of the book's strengths. He details wartime research on both sides of the Atlantic, from Copenhagen to New Mexico, and delves into the motivations and actions of the Allied leadership. Also interesting are his findings on the public availability of nuclear research in contemporary press reports and scientific journals, including *Nature*. Managing these threads is no small authorial feat — of research, especially. Watson also weaves together the insights of previous nuclear historians, such as Richard Rhodes, Martin Sherwin and David Holloway.

In what could have been a volume in its own right, the narrative is bookended by the overlapping wartime sagas of Niels Bohr and Klaus Fuchs. Fuchs, the infamous German



## Under the Knife

Arnold van de Laar JOHN MURRAY (2018)  
In this witty chronicle, surgeon Arnold van de Laar dissects thousands of years' worth of remarkably gruesome stories. From anaesthetic-free amputations and bloodletting to Albert Einstein's aneurysm, these are key insights into the cut and thrust of medicine.



## What Algorithms Want

Ed Finn MIT PRESS (2018)  
Algorithms saturate the digital universe, from Amazon book recommendations to Uber. Ed Finn will make you reassess how you think about these formulae: not as mere components of code and computations, but shaped by a philosophy, and shaping culture in their turn.

spy who passed secrets from the Manhattan Project to the Soviet Union, and the towering physicist Bohr serve as foils to the main plot. During the war, each had a longer-term vision of what nuclear weapons would mean to the post-war order. Bohr suspected that the Western Allies' relationship with the Soviets would be damaged; Fuchs, by delivering crucial technical information to the Soviets, helped to ensure that it was.

The aftermath of that era comes to life in Wolverton's gripping *Burning the Sky*, the first book-length treatment of a remarkable series of nuclear tests in outer space, code-named Operation Argus. After the Soviet Union launched its satellite Sputnik-1 in 1957, US agencies realized that they were lagging behind in missile technology. The cold war arms race took on new urgency. When, in early 1958, the US government finally succeeded in launching its Explorer 1 satellite — the first of more than 90 in the series — the achievement did more than calm US anxieties. Experiments on board Explorers 1 and 3 led to the discovery of the Van Allen belts, concentrated bands of radiation that circle the planet along the contours of its magnetic fields.

At a time of international tensions and ample defence dollars, however, scientific discovery was rarely separate from weapons considerations. At Livermore Radiation Laboratory in California, physicist Nicholas Christofilos believed that the belts could be harnessed as part of US defence. He theorized that high-altitude nuclear detonations would create a "shell of radiation" that could destroy missiles and warheads. Convinced, the US government under President Dwight Eisenhower embarked on Operation Argus, and later Operation Fishbowl, to test the theory.

The tests were logistical nightmares. Argus was conducted in the remote South Atlantic amid treacherous weather and technical problems. Only the last of its three 1.5-kiloton weapons detonated at the projected altitude, 794 kilometres above Earth's surface, in September 1958.

Half of the Fishbowl tests, in 1962, were aborted or cancelled. As Wolverton shows, it was incredible that there were no serious casualties. Although temporary belts were created, they were much weaker than Christofilos had theorized — capable of damaging satellites and releasing powerful electromagnetic pulses, but not of stopping a missile.

Together, these books highlight the tensions endemic to classified state-sponsored research in democratic society. Watson's subjects, including Manhattan Project heavyweights J. Robert Oppenheimer and Edward

ran counter to the IGY mission. Ultimately, national security lost out to scientific cosmopolitanism.

Whereas the Manhattan Project and its vast infrastructure of labs and production sites largely dodged press exposure, Argus officials struggled to contain leaks. By the late 1950s, the public was demanding nuclear transparency, and agencies involved in Argus, such as the Atomic Energy Commission, knew the tests would be controversial. The experiments were finally revealed in 1959 by *The New York Times*, inciting a media frenzy and public debate.

Nuclear-weapons science was born of an era that demanded secrecy. Recounting its history thus demands a sceptical lens.

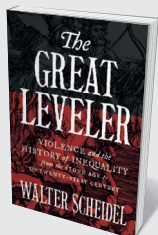
However, problems arise if it is assumed, beyond available evidence, that every source has a secret meaning, every actor an ulterior motive. Watson in particular has a penchant for the conspiratorial, and is eager to expose and blame. That makes for a page-turning read, but can discount the context of war — hot and cold. Both books are populated by egotists and opportunists, the quest for scientific priority, nationalism, ignorance, suspicion and doubts. Ultimately, their stories are all too human. Historians should not absolve their subjects entirely, but we owe it to past individuals, even the most belligerent, to try to understand all the forces at play.

Nevertheless, *Fallout* and *Burning the Sky* are informative and balanced in their attention to diplomacy, science and biography. They also provide much to ponder concerning the state of play now, from the nuclearization of North Korea to the unknown future of the Iran nuclear deal, and the part that the first members of the exclusive nuclear club might have to play in future. ■

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Teller, operated under — and were arguably victims of — extreme compartmentalization of information. Participants had a very limited view of the whole project. Fifteen years later, Wolverton's actors faced secrecy of a new kind. The Explorer missions took place under the auspices of the International Geophysical Year (IGY), the 1957–58 venture in which more than 60 countries shared data and took part in peaceful scientific collaboration. But as classified military studies, Argus



### The Great Leveler

Walter Scheidel PRINCETON UNIV. PRESS (2018)  
In this monumental, pessimistic study, historian Walter Scheidel examines anew an old social issue: economic inequality. As he reveals, disparities have burgeoned during times of peace, declining only during wars and revolutions. "Inequality never dies peacefully," he notes.



### How To Fix The Future

Andrew Keen ATLANTIC (2018)  
The Internet has advanced from a communication device to an unstoppable force moulding societies. Andrew Keen, pioneer of the cyber-tsunami, uses lessons from the Industrial Revolution to envision a future relationship with life online that honours human values. **Mary Craig**