

PHYSICS

In thrall to uncertainty

A history of how quantum theory has permeated Western culture refreshes **Jim Baggett**.

Quantum theory is the most accurate and precise description of the molecular, atomic, sub-atomic and sub-nuclear realms ever devised. It is also utterly exasperating. To anyone tutored in the language and the logic of classical physics, it is mathematically challenging, maddeningly bizarre and breathtakingly beautiful. As charismatic US physicist Richard Feynman warned: “Nobody understands quantum mechanics.”

Given its recondite nature, quantum weirdness has entered popular culture in remarkable ways. What might otherwise have been the preserve of dry academic texts and stuffy scientific conferences has become common currency. Who hasn't heard of Heisenberg's uncertainty principle or Schrödinger's cat? Quantum ideas of space, time and matter inspired British artist Anthony Gormley's vast, enigmatic steel sculpture *Quantum Cloud* near London's



The Quantum Moment: How Planck, Bohr, Einstein, and Heisenberg Taught Us to Love Uncertainty

ROBERT P. CREASE
AND ALFRED SCHARFF
GOLDHABER
W. W. Norton: 2014.

O2 arena. And UK-based dramatist Tom Stoppard's 1988 play *Hapgood* blends the duality of the double agent with a quantum duality in which matter and light are both waves and particles. Both of these works are cited in *The Quantum Moment*, in which philosopher Robert Crease and physicist Alfred Goldhaber explore quantum theory's enduring cultural impact.

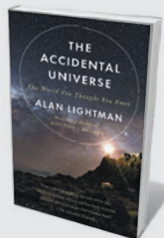
Based on a class that the authors have taught for six years at Stony Brook University, New York, the book asks why quantum theory carries such a metaphorical

punch — “wild and mysterious, packed with creative force” — and why it seems to be rediscovered in every generation. The authors' tale is structured along approximately linear historical lines, from Max Planck's discovery in 1900 that light can be described in terms of discrete ‘bundles’ of energy (quanta) to Bell's theorem, which opened the door from the 1960s onwards to some extraordinary experimental tests of the nature of our physical reality. Each chapter explores how some of the core ideas and principles that sprang from these historical moments have been absorbed into (inevitably mostly US) popular culture. This makes for an entertaining read, even for those already familiar with the story.

As Crease and Goldhaber explain, much of the impact on modern culture derives from what quantum theory has to say about the nature of reality. Arguably, centuries of observation, experimentation and strenuous intellectual endeavour were founded

NEW IN
PAPERBACK

Highlights of this
season's releases



The Accidental Universe: The World You Thought You Knew

Alan Lightman (*Vintage, 2014*)

Physicist and literary wizard Alan Lightman reflects on how our cosmos, potentially one among uncountable others, has fortuitously created the perfect conditions for life. He considers intricate symmetries in nature and the unfathomable vastness of space. This journey through seven overlapping ‘universes’ — frameworks for exploring recent research — culminates in a vision of humanity hooked on technology, gradually detaching itself from reality.

on scientists' expectation that the material world is composed of some kind of fundamental atoms of 'stuff'. Quantum theory, however, has rewarded these endeavours with phantom particles that, like waves, can be both here and there; a theoretical structure that tells us only what might happen (not what will); and quantum systems seemingly connected over great distances, giving rise to extended, non-local effects, or what Albert Einstein called "spooky action at a distance".

Einstein famously rejected the element of chance that lies at the heart of quantum theory, declaring that God does not play dice. He argued that quantum theory is not complete. Those scientists who, like Einstein, are less inclined to accept that we have reached an ultimate limit of what is knowable remain firmly in denial. So, in the past 40 years or so, the efforts of agents provocateurs such as John Bell and Tony Leggett have encouraged an orgy of sophisticated laser-based experiments to test the foundations of quantum physics — what I have

elsewhere called "experimental philosophy". It is this work that has prompted the current interest in quantum cryptography, quantum computing and the teleportation of photons.

I have only one quibble with *The Quantum Moment*. Crease and Goldhaber support their narrative with 'interludes' after each chapter, designed to provide technical details, including some equations. The exposition here is a little drier than in the main chapters, but does not need to be. The material also necessarily repeats much of what has already been covered, which can become a little tedious. The authors suggest that readers might prefer to skip these interludes; for linear readers like me, that does not really work.

Those versed in quantum theory's practical applications might be tempted to dismiss its many manifestations in popular culture as what the authors call "fruitloopery". And certainly, there is a lot of nonsense out there. But, as Crease and Goldhaber make abundantly clear at several points, many esteemed physicists

(who should probably know better) have been more than willing to indulge their inner metaphysician in research papers and popularizations on the mistaken principle that, as the Canadian philosopher Marshall McLuhan once put it, "mud sometimes gives the illusion of depth".

Thus we smile at the comical pronouncements on physics by US actress Shirley MacLaine, until the authors point out that she could be paraphrasing similar pronouncements made 55 years earlier by the British physicist James Jeans. I have elsewhere argued that contemporary theoretical physics has become rather self-indulgent and self-referential, a malaise that I have called fairy-tale physics. Deep questions about the nature of reality tend to provoke this kind of response, and it surely finds its origin in the quantum moment. ■

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LINGUISTICS

The write stuff

Steven Pinker's provocative treatise on language use and abuse would benefit from more data, finds **Paul Raeburn**.

No conversation about the science of language can get very far without a mention of Steven Pinker, the Harvard University cognitive scientist who has not yet made linguistics as popular as football — but is working on it. In *The Sense of Style*, he wants to give us the cognitive science, linguistics and psychology behind classic debates over proper English, from passive voice to split infinitives.

Plenty of others have given us stuffy decrees intended to end the interminable wrangling, but Pinker is different. He is unhappy with the classic style manuals — including revered texts such as *Strunk & White* (William Strunk and E. B. White's *The Elements of Style*) or

Fowler's Modern English Usage. We need a new guide "infused by the spirit of scientific skepticism", he writes, using grammar and research on "the mental dynamics of reading" to replace edicts with evidence. Pinker gave us the science in *The Language Instinct* (William Morrow, 1994); in *The Sense of Style* he sets out to offer its practical application.

He covers much of the same ground as the classic guides, including frequently misused words ("fulsome" and "noisome") and the serial comma. His problem with *Strunk & White*, however, is that the authors lack tools for analysing language, and so end up "vainly appealing to the writer's ear". That's on page two. By page three, he is challenging

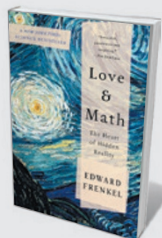


The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century
STEVEN PINKER
Allen Lane: 2014.

the manual's dismissal of the passive voice. Linguistic research, he later writes, has shown that the passive actually "allows the writer to direct the reader's gaze, like a cinematographer choosing the best camera angle". What research, exactly? Pinker does not tell us. His views are informed by psycholinguistics; that is his day job. But he

promises us science, so I expected to see data. However, in this instance, and in many others, the data are not there.

Similarly, Pinker's view on infinitives is to split them "if you need to", a conclusion backed by dictionaries and style manuals — not research. And when he quotes with admiration the opening line of Richard Dawkins' *Unweaving the Rainbow* (Houghton Mifflin, 1998) — "We are going to die, and that ▶



Love and Math: The Heart of Hidden Reality

Edward Frenkel (Basic Books, 2014)

With infinite passion, media-feted professor Edward Frenkel shares his rise to mathematical greatness against a tide of Russian anti-Semitism. Appeasing maths-haters, he uses a borscht recipe to explain quantum duality. (See Marcus du Sautoy's review: *Nature* **502**, 36; 2013.)



Life at the Speed of Light

J. Craig Venter (Abacus, 2014)

Biologist J. Craig Venter shares his life's work of catalysing progress in biological engineering, sequencing the human genome and ultimately creating the first "synthetic cell" (*Mycoplasma mycoides* JCVI-syn1.0). (See Nathaniel Comfort's review: *Nature* **502**, 436–437; 2013.)