Quests of a theoretical astronomer

Practical Mystic: Religion, Science, and A. S. Eddington
by Matthew Stanley
University of Chicago Press: 2007.
320 pp. $37.50

Owen Gingerich

In this extraordinary book about the life of the distinguished English astrophysicist Sir Arthur Eddington, Matthew Stanley examines the entangled roles of science and religion in his work. *Practical Mystic* is not a biography in the ordinary sense — readers will look hard to find dates for Eddington's birth and death (1882–1944), and much else has been omitted. But included in rich detail are Eddington's Quaker milieu and the tensions he faced at the tribunal as a conscientious objector during the First World War, his astrophysical research, his pioneering fascination with Einstein's relativity, and his role as a major popular writer on astronomy and the philosophy of science.

I can recall only one other book that attempts to build a convincing biographical interconnection between a religious ethos and scientific achievements — Job Kozhamthadam's *The Discovery of Kepler's Laws: The Interaction of Science, Philosophy, and Religion* (1994). Trained as a theologian, Kepler saw God's design throughout the cosmos. Whether that drove him to search for the physical (rather than the traditional geometrical) understanding that led him to his three laws seems inconclusive. In Stanley's analysis of Eddington, there is no doubt of the compatibility and mutual influence of science and religion.

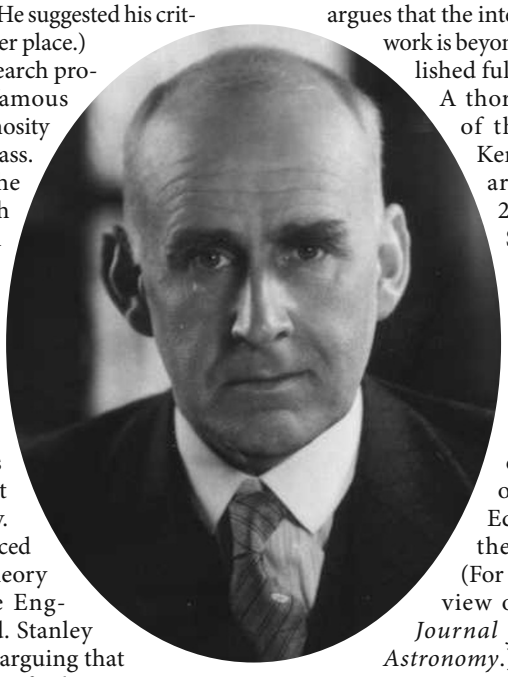
To analyse the relationship between science and society (including religion), Stanley examines the bridging function of what he calls "valence values". Like the bonding ring of electrons, these values facilitate the interaction between science and culture. Through the lens of these values, Stanley uses Eddington as a test case for exploring the interaction of science and religion in Britain in the first half of the twentieth century.

Unlike the natural theologians of the previous century, Eddington did not seek a harmonization between science and religion. He saw both as processes of seeking. As he reminded his audience at the British Association for the Advancement of Science, "A knowledge of nature is the great end of our work; but, if we cannot attain that, there is at least the struggle after knowledge, which is perhaps no less a thing." Eddington could have said the same of his religion.

When he approached fundamental questions of astrophysics, Eddington did not try first to establish basic laws from which conclusions could be deduced (as Newton had done and as his rival James Jeans insisted on doing), rather he built a web of approximations whose results could be compared with nature. Instead of first asking specifically what could power the Sun, he worked through possible structures to establish the likelihood of an extremely hot, temperature-dependent core as the seat of the Sun's energy source. (He suggested his critics should find a hotter place.)

Out of the same search procedures came his famous law linking the luminosity of stars with their mass. Stanley describes the astrophysics with considerable skill and using essentially no mathematics. It must be a little perplexing to the non-specialist though when the expression "$\kappa\varepsilon$" appears with no definition, nor does Stanley explain that "κ" stands for opacity.

Eddington introduced Einstein's general theory of relativity to the English-speaking world. Stanley tells this story well, arguing that Eddington's Quaker faith and his pacifism motivated his desire to test the work of a German scientist at a time when, after the First World War, Germany and its scientists were loathed by the Anglophone community.



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Eddington saw science and religion as processes of seeking.

The results of the 1919 eclipse expedition, which showed stars near the Sun slightly displaced by the curvature of space associated with its mass, made Einstein famous overnight and thrust Eddington into the limelight too.

A story — now almost an urban legend — has gained currency that Eddington was so convinced of the accuracy of Einstein's prediction of the bending of starlight by the Sun, that he fudged the treatment of marginal eclipse plates to obtain the desired results. Here Stanley argues that the integrity of Eddington's work is beyond doubt (he has published full details elsewhere). A thorough examination of the case by Daniel Kennefick (preprint at arXiv:0709.0685 v2; 2007) substantiates Stanley's claim.

Among the omissions in Stanley's biographical study is the put-down of S. Chandrasekhar's calculations of the ultimate collapse of highly massive objects, something Eddington found aesthetically distasteful. (For a perceptive, neutral view of this episode see *Journal for the History of Astronomy*.) Perhaps this also connects with Eddington's aversion to the idea of the Universe starting at a finite time past, something that may have smacked too much of the ultimate miracle for his religious outlook and a dead end for his philosophy of seeking. Stanley's *Practical Mystic* is not a biography but a biographical study — a fascinating one. ■

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Time deconstructed

The New Time Travelers: A Journey to the Frontiers of Physics
by David Toomey
W. W. Norton: 2007. 320 pp.
£15.99,$25.95

Lawrence M. Krauss

There are innumerable books on time travel, including the masterful *Black Holes and Time Warps* by Kip Thorne, one of the key players in a serious scientific investigation of the possibility of time travel. The subject has a chequered history, peppered with false claims and hyperbole. The title *The New Time Travelers* had me worried that the book belonged to '*People* magazine popular science' — the genre that propagates the false notion that somehow researchers are more interesting than research. Happily, David Toomey, professor at the University of Massachusetts, Amherst, has produced an honest, intelligent and largely accessible work of impressive scholarship on a difficult subject. Most important, he provides a rare glimpse into the day-to-day practice of science, in which the right direction is never clear and false starts abound.

After some historical, scientific and philosophical scene-setting, the book focuses on the surge of attention, which began almost two decades ago, on the question of whether

general relativity allows for the possible and practical realization of time travel. This heightened interest followed the 1988 paper published in *Physical Review Letters* by Thorne and his colleagues on the physics of wormholes, shortcuts through space and perhaps time. The paper was inspired by a question Carl Sagan posed to Thorne when writing his science-fiction novel *Contact*.

The discussion of time travel in a mainstream science publication attracted media attention and piqued interest in the scientific community. It also encouraged a lot of fanciful speculation by scientists about ideas on the very edges of respectability. And it motivated the writing of numerous popular books.

Since the mid-1990s, most concrete results regarding the possibility of time travel have been negative. The few outstanding issues ended up mired in quantum gravity, which remains ill-defined and elusive. As a result, interest in this issue in the physics community has subsided somewhat.

M. KULYK/SCIENCE PHOTO LIBRARY

The physics of wormholes: are there shortcuts through time?

Toomey remains enamoured with the philosophical and literary possibilities of time travel, so is less critical of some dubious proposals than he might be. He nevertheless provides a largely accurate rendering of time-travel science with all its twists and turns, errors and dead ends. This is sometimes frustrating: it is tough to labour through detailed discussions of complex ideas that Toomey eventually correctly reveals to have proved fruitless. But it is also refreshing: popular books too often present research as a logical narrative that bears little relation.

Errors, as might be expected from someone writing outside his field, have crept in. Early discussions of physics, including special and general relativity, are quite clear. Later explanations of modern topics, such as inflation, are more uneven. A grating mistake is Toomey's statement that the Planck length is a million times smaller than the size of a proton. It is actually closer to a million million million times smaller. We regularly investigate regions a million times smaller than a proton with large-particle accelerators: it is the vast chasm between even these minute sizes and the Planck length that makes probing quantum gravity so difficult.

Aside from such gaffs, *The New Time Travelers* is sound and informed. If readers leave this book feeling unsatisfied, Toomey may have done them a service. He captures the nature of the scientific process — that one never knows where fundamental research will lead, that most of it doesn't result in ground-breaking developments, and that even negative results can prove enlightening. It is sometimes difficult for us to be honest about these facets when popularizing our work. That an 'outsider' has captured this is impressive, and useful. ■

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Scientists on film

Hollywood Science: Movies, Science, and the End of the World
by Sidney Perkowitz
Columbia University Press: 2007. 256 pp. $24.95

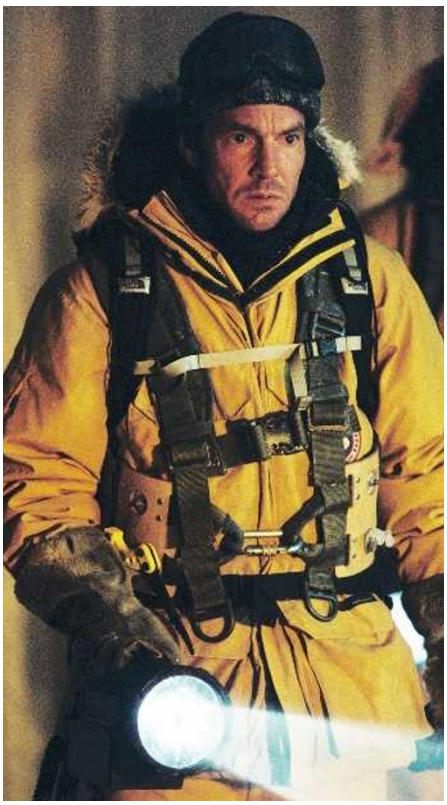
Emma Marris

Science-fiction films are often called to account by scientists — for their inaccuracies and for skipping over the years of gruelling effort behind discoveries. But film is not particularly interested in reality. It is obsessed with unreality, which, after all, is why we go to the movies. We get reality at home. *Hollywood Science* reveals, perhaps inadvertently, what scientists owe to film: a kindling of interest in scientific concepts that shadows the audience as they leave the cinema.

In film, science and scientists act as a magic key to the unknown. They take us into realms where people and animals mingle in the same individual, where heads live apart from bodies, where aliens and robots and clones wear shiny jumpsuits and talk to their watches and make love. In the cheesy 1994 film *Stargate*, a hammy James Spader plays an egyptologist who saunters into a military industrial complex and does his science thing, which enables guys with guns to walk through a door into another world. In films involving an atomic bomb, scientists turn a key that leads to a bleak but fascinating future. Science provides new modes of transportation and new destinations: time machines to the future and rockets to the stars.

Yes, researchers may cringe at some of cinema's favourite lab-coated characters — the effeminate egghead who wants to negotiate with murderous aliens, or those government jerks in hazmat suits who wanted to carve up ET. But the important thing, perhaps, is that science and scientists continue to be used to expand the world of film in imaginative ways. These themes reveal that, despite its anti-science spasms, the culture at large believes that science is a means to go places, see things and know more, for good or ill.

Over the years, scientists have complained that they are not in fact megalomaniac geniuses with delusions of godhead that prompt their hair to stand on end, like Victor Frankenstein, or Dr Rotwang in *Metropolis*. This earnest refutation does not do much to dispel another scientific stereotype: that of the humourless pedants immune to the communal pleasures



20TH CENTURY FOX/THE KOBAL COLLECTION

Dennis Quaid, with stern expression, as a scientist in *The Day after Tomorrow* in 2004.