paper, but by the same token there would be no need to cite the rebuttal. Also, in order to show that a paper is wrong, one has to know the material better than the person who wrote the original paper. (There is also the problem that if one shows that the original paper is correct, many journals won't publish such a confirmation, even though that is also an essential part of science, thus reducing the motivation for exploring a topic without knowing the outcome, which of course is the way it should be done.)

What can we expect in the future? I doubt that all of the suggestions (except perhaps the one, correct suggestion) will be shown to be wrong on their own terms (as opposed to being a good theory which is merely ruled out) on a case-by-case basis. Solutions for which some testable prediction is confirmed could be seen as more likely, and of course those with failed predictions could be ruled out. Many of the solutions are *ad hoc* in the sense that it was the Hubble tension itself which led to their proposal; that is not necessarily an indication that they must be wrong, and sometimes there is some additional justification. I'm happy to be corrected, but as far as I know there was no theory which *predicted* the current Hubble tension of about 6 km/s/Mpc (with statistical uncertainties claimed to be much smaller); while technically postdictions are just as good, predictions are more impressive.

Whether the solution turns out to involve interesting new physics or some banal explanation, perhaps the most interesting result will be that a consensus on the cause of the Hubble tension will rule out all of the other proposed explanations with one fell swoop.

Yours faithfully,
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REVIEWS

The Reinvention of Science. Slaying the Dragons of Dogma and Ignorance, by Bernard J. T. Jones, Vicent J. Martinez & Virginia L. Trimble (World Scientific), 2024. Pp. 493, 23 × 15·5 cm. Price £45 (paperback; ISBN 978 1 80061 360 7).

Most readers of *The Observatory* would be able to construct a historical timeline of our subject: perhaps by an ordered list of the kings and queens of our particular realm, and at least for the western story, the list goes something like: Babylonians, Greeks, Anaximander, Aristarchus, Ptolemy, Aristotle, Copernicus, Tycho, Kepler, Galileo, Newton, Einstein — then boom: the explosion of knowledge and us.

A few learned souls might add Giordano Bruno or the oddly named medieval Oxford scholar Robert Grossetestes — but even fewer know Copernicus's publisher and by what process he was selected. The authors tell us he was chosen *via* a centuries-long thread that starts with a text book on optics based on the writings of the Islamic scholar Alhazen in about the year 1000. This original work tumbled through the early centuries of the second millennium and along the way got translated into Latin and was subsequently published by Petreius in Germany in 1535. That published book was acquired by a friend of Copernicus and shown to him and thus he approved the publisher. It is that extra depth that makes this *Reinvention of Science* so different from many other history-of-science volumes and such a pleasure by which to be enveloped. You may also note that my list of kings and queens does not in fact include any queens and the authors would be very keen to correct that error. I should at least add Henrietta Leavitt, Cecilia Payne, Marie Curie, and Mary Anning. But wait! — Mary Anning was a fossil hunter not an astronomer. Indeed, the book is titled *The Reinvention of Science*, and although mostly told through the story of the unravelling of the evolution of the Universe, its much larger remit covers all of the relevant physics and thus geology and the ancient history of the Earth — including dinosaurs.

The opening chapter starts not with the Babylonians, as most traditional science histories do, but with Albert Michelson assembling his interferometer in the basement of a building borrowed from Edward Morley (his own laboratory, that he had been setting up for four years, had been destroyed by fire). Michelson and Morley were attempting to measure the Earth's movement through the luminiferous ether, and as we now know, no such movement was detected and also no such ether. The ether is the first of the Dragons, the slaying of which this book describes. Dragons are here defined as invisible, undetectable entities that are required to support the prevailing scientific consensus on the nature of the Universe at the time they were first postulated. The Crystalline Spheres holding up the stars is another, much earlier one. As the authors remind us such spheres were not such a crazy idea in a world in which unseen forces, like gravity, acting over long distances were unknown. If not crystalline spheres what else could fit the observations? The same rationale guides our thinking to this day.

As well as slaying Dragons the authors also challenge Dogma, one such being the requirement for the right sort of man to be engaged in and to write papers about science. This dogma excluded the acknowledgement of women's contributions for centuries and for just about as long, maybe longer, people of the wrong colour or social class. The authors are at some pains to ensure that the relevant women are mentioned, and celebrated, and also the common folk of whatever gender. For example, Milton Humason, Edwin Hubble's poorly educated mule driver, removal man, and telescope handler, who through determination and delicacy of touch, developed into the key scientist in recording the spectra of faint galaxies to enable the expansion of the Universe to be deduced.

In my reviewing notes for this book I find I often comment on the clarity of description. The overall tone is measured and scholarly and yet also light. For example, there is a beautifully concise description in Chapter 1 of Epicurean thought finding its way into the western world and giving us the concept of atoms and even the idea of heat as movement of atoms and almost the first inklings of Brownian motion. Another beautifully concise passage of just over two paragraphs, in Chapter 17, covers the description of the contents of the

Universe. As a further example of the extra detail provided, this passage notes that of the everyday baryonic matter which makes up just about 5% of stuff in the now-standard description of the Universe, just 0·5% is luminous objects: stars and galaxies, and 4·4% is non-luminous other stuff. The remaining dark matter is non-baryonic and about which we currently know very little. We are equally clueless about the almost 70% of stuff described as dark energy.

The authors' lightness of touch is seen in references to popular culture — The Simpsons and The Flintstones being offered as examples of how one side of a debate can become unquestioned dogma in a serious discussion on the causes of the extinction of the dinosaurs. As every school child knows, meteorite impact is the accepted cause, and yet the case for an extended demise through vulcanism is currently an equally strong candidate. This section also notes the advantage of having a good publicity machine when competing for limited publicly funded research money, but also the potential disadvantageous effect of bandwagons illustrated by a Walt Disney film that popularized the erroneous myth of lemming suicides.

Not just the past, but the present and future are also covered with the same measured tones. The final half of the book deals with the current state of physics, with detailed descriptions of the recent detections using the new techniques of gravitational-wave astronomy, and the search for polarization of such waves as signatures of primordial gravitational radiation. The final chapter deals, perhaps a little too uncritically, with the march of the machines and the possibilities of artificial intelligence as a potential tool for assisting in the analysis of forthcoming huge data sets.

In addition to the main text there are 73 pages of notes, and I had great fun checking and following links to the web pages; there is a ten-page index of names and 26 pages of subject index. So as well as clarity, detail, and scholarship one can also add thoroughness. At £45, however, this is quite expensive for a paperback, even one of 493 pages, and as a physical item the appearance may not reflect that price. Textually there are just a couple of obvious typos and the proof reading or editing goes awry for a few pages in the middle section. A huge omission for such a general title would seem to be that, other than a glancing mention of the Egyptians and China in the first chapter, the parallel history of science in non-western countries is barely mentioned. However, within the context of current science the content is very good — the layout and text are beautiful and there is so much wisdom and pleasure contained within these pages that I believe the price to be worthwhile.

All of us who paddle in the streams of scientific enquiry have our toes and our souls soaked in the search for fundamentals. Some in sleek clipper ships crash through the deepest oceans of abstruse mathematical scholarship while others paddle in the muddy, murky waters of experiment and instrumentation — all of us believing that we follow a flow, a direction to the one path of truth. But is finding truth the same as finding the good?

In conclusion I was tempted to quote the final philosophical sentence of the last chapter, but that would be as crass as giving away the ending to a detective novel. I will instead quote from the very beginning. In the preface Neil deGrasse Tyson, the director of the Rose Planetarium in New York, has said on Twitter and television "science is true whether or not you believe in it",

I can only add that in looking for the good as well as the truth this book offers both, a scientific truth and a book that is very good — almost excellent. — Barry Kent.