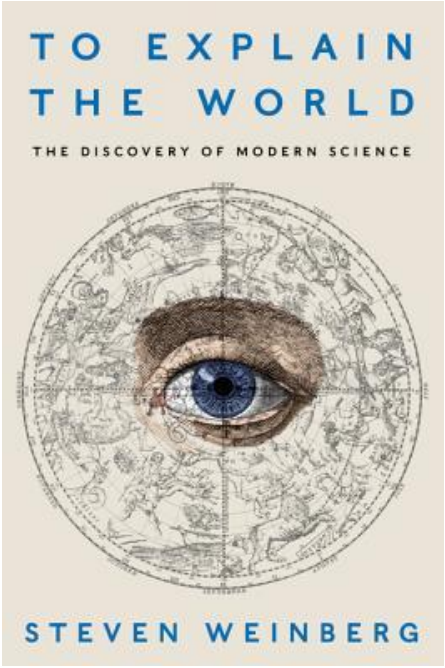

To Explain the World: The Discovery of Modern Science

Steven Weinberg

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A masterful commentary on the history of science from the Greeks to modern times, by Nobel Prize-winning physicist Steven Weinberg—a thought-provoking and important book by one of the most distinguished scientists and intellectuals of our time.

In this rich, irreverent, and compelling history, Nobel Prize-winning physicist Steven Weinberg takes us across centuries from ancient Miletus to medieval Baghdad and Oxford, from Plato's Academy and the Museum of Alexandria to the cathedral school of Chartres and the Royal Society of London. He shows that the scientists of ancient and medieval times not only did not understand what we understand about the world—they did not understand what there is to understand, or how to understand it. Yet over the centuries, through the struggle to solve such mysteries as the curious backward movement of the planets and the rise and fall of the tides, the modern discipline of science eventually emerged. Along the way, Weinberg examines historic clashes and collaborations between science and the competing spheres of religion, technology, poetry, mathematics, and philosophy.

An illuminating exploration of the way we consider and analyze the world around us, *To Explain the World* is a sweeping, ambitious account of how difficult it was to discover the goals and methods of modern science, and the impact of this discovery on human knowledge and development.

To Explain the World: The Discovery of Modern Science Details

Date	:	Published February 17th 2015 by Harper (first published February 10th 2015)
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From Reader Review To Explain the World: The Discovery of Modern Science for online ebook

Pouting Always says

I was pretty excited to read this one and apparently the author is a lecturer on the history of science and put the book together through the notes he uses to prepare for teaching his class. There was a lot of new stuff in this book that I didn't know, especially about the development of math which really helped make sense of why we use calculus and such. I learned a lot. That said I wish the author had focused on more than just math and physics, I understand that as a physicist that it's easiest to talk about those two subjects first and foremost but I felt like it left out a lot of other things and didn't give me as complete a picture of the history of science and how we got to where we are today. The writing was also a little dull and the book took effort to make it through. Really interesting and educating but I think the author could've generalized and simplified a little bit more if he wanted to write a book written for the average reader.

Alice Lippart says

Much more basic than I had imagined it would be and sadly didn't offer up much depth or reflection. It didn't offer up any new insight or really made me think. Interesting enough to finish, but generally just an OK book.

Rex Fuller says

Wanted to read at least one first-rate history of science. Did some research and settled on this one because it is renowned for its quality and ability to communicate the subject to the non-scientifically trained. On that score, it is just right. Immensely informative and sufficiently detailed to tell you what you need to know.

You get the full set of all significant contributions to science beginning with the Greeks of Miletus and Alexandria (yes, as its namesake implies, it was a Greek city at the time), through the Arabs of Baghdad, to the Italians, French, and Germans of the Middle Ages, and finally, the flowering of modern science through what were essentially the achievements of one man: Isaac Newton. It is an interesting and fulfilling story and superbly told. As a catalogue of what we have learned it is near perfect.

However, Weinberg says in his introduction that his focus is different from what is naturally the concern of any history of science: how and what we came to learn about the world. He says his focus is “how we came to learn how to learn about the world.” So, I watched every page like a faithful Doberman for how we came to learn how to learn. I didn’t see it. And I don’t think that resulted from failure to comprehend what was on the pages. My guess as to why: as Weinberg says, he drew the book from his notes of courses on the history of science he taught to non-science students at Texas, and when writing the introduction he remembered what he commented on in the classes, but then stayed true to the notes themselves when actually preparing the material in book form. So, by all means read this because you probably cannot find a better, more readable history of science. Just don’t fall for the tease.

Chris says

Stephen Weinberg, Nobel Prize-winning physicist for his work on the electroweak force, author of textbooks on cosmology, gravity, general relativity, and quantum field theory, writer of several popular books of popular science, here—at the age of 82—uncharacteristically offers his readers and fans not a work of greatness but a high school-level, superficial, simplistically argued, unoriginal overview of the history of science from the Greeks through Newton. Unexpectedly from an author of his calibre, this is not a prize winning work.

This nearly complete failure of a book, with its flat, uninteresting text, will not inspire non-scientists to embrace the field. For curious readers, it fails to explain even simple concepts in the main text, instead awkwardly referring readers to the "Technical Notes" at the end which are nevertheless insufficient. They give the reader only an illusion of understanding. To really grasp the science, you will have to look it up on Wikipedia or elsewhere. The main text is entirely devoid of illustrations, and are only barely adequate in the Notes.

For working scientists the book offers nothing. It's not a textbook; it's not a reference; and it's certainly not a model of good popular science writing.

Its frequent platitudes deliver a work of astounding commonplaceness. The problems begin with the two opening sections on Greek Physics and Astronomy. Weinberg unnecessarily goes out of his way to list the names and dates of countless Greeks of the Classical and Hellenistic periods, each with a few summary sentences describing their ideas: this cataloging is the worst kind of history.

We are treated to all the usual characters: Thales, Anaximander, Anaximenes, Anaxagoras, through Hipparchus and finally Eratosthenes when the world finally learned how big it is. Most readers will already realize the only reason they are presented is to get us to Aristotle, Ptolemy and that other one (I forgot his name) who first thought that the Earth revolved around the sun, which we know, while reading, will connect us to Copernicus a thousand years later. All the other characters serve as space-filler supporting these biggies.

At this point, readers will wonder "What's new here? I have already heard all this before in high school. When is Weinberg going to tell me something new?" Sadly, he never does.

Continuing forward then, he moves to the Romans, who, compared to the Greeks, didn't contribute all that much to science, so that era was glossed over to get to the Middle Ages. Weinberg again repeats his performance with the Greeks: a list of minor characters which support the linear push toward Copernicus—with the rising specter of the Church adding *potential* interest to the tale. There are a whole bunch of monks copying Greek and Latin texts, and a lot of Arabs translating Aristotle. Again, there is no new material, or even original analyses, presented here. Instead, we read: "Whatever the scientific revolution was or was not, it began with Copernicus." Really? Wow!

Then, on to the chapters about the discovery of science, where the reader hopes it will finally get interesting. Weinberg unoriginally claims this happened when time-honored explanations of the natural order developed solely from *observation* were for the first time augmented by *experimentation.* Thus, any high school graduate will wonder "Is this book written for adults? Maybe it's for educationally-challenged people from

Texas? I learned all this in eight grade when I had to do that horrible Observation-Hypothesis-Experiment-Revision-Experiment-Conclusions thing over and over again! Yeah, Galileo and his Leaning Tower and his telescope! I must be as smart as Mr. Weinberg!"

By this point the reader is either feeling pretty good that he already knows what a Nobel prize guy is lecturing him on—or, like me, he is wondering why he is wasting his time and money on this book.

The final (final?) chapter is about Newton and his synthesis of all that came before into the first non-trivial scientific theories, those of light and gravity, complete with explanatory and predictive power. Weinberg had a chance to rise to the topic, it now being much closer to his own life's work. To his credit he does, but not without the worst sophomoric statements in the entire book. What follows below is an outline of the Newton chapter, highlighted by quoting some of these simplistic utterances.

He breathlessly begins the last chapter with: "With Newton we come to the climax of the scientific revolution. But what an odd bird to be cast in such a historic role! ... Until middle-age he was never close to any woman, not even to his mother. " Oh, my god. One wonders how, and with whom, Newton's climax occurred, if it did at all.

Then, "It was Newton's theories of motion and gravitation that had the greatest historical impact." Really??? I never knew that, nor did *any* of his readers! We're sure happy he told us that; it led to the belated realization that this is actually a children's book—minus the sorely needed pretty pictures.

Showing evenhandedness to other scientists, he must not, and does not, acknowledge Newton as the "god" many thought he was: "Newton's theory did not meet universal acceptance." But why is that different from any new theory from any other scientist an any time in history?

Hitting him a little bit harder: "General relativity rejects Newton's notion of absolute space and time." Thank you for that, Mr. Weinberg. Since you ended your book with Newton, and didn't continue through to Einstein, we stupid readers wouldn't have known that—unless we had already learned it from other, less patronizing teachers.

Now, astonishingly, at the end of Newton's final chapter, Weinberg undermines the entire purpose of his book (on page 253) with the howler: "A question remains: why did the scientific revolution of the sixteenth and seventeenth centuries happen when and where it did?" What? Come again? Maybe Weinberg didn't expect that many would read his Preface to the book, but I did. There he states "My focus in this book...is how we came to learn how to learn about the world." This recursive sentence is nevertheless quite clear. I'll grant that he explains a limited form of "how" simply as the onset of experimentation. But "how" is answered sufficiently only if the "why" "when" and "where" are also addressed. As Weinberg admits, he leaves these unanswered. That's a major failure.

(Just like the criminally unfulfilled promises that Volkswagen would deliver "clean diesels" to its customers, I want my money back from Weinberg because he didn't deliver what he promised, either.)

He should have stopped at that point, but Weinberg appends an epilogue, I'm guessing because pre-publication reviewers complained about the abrupt end at Newton, leaving unaddressed the following centuries, even Weinberg's substantial, accomplished research. In this section, readers are told about the controversial topic of scientific reductionism, where the work of Newton and later physicists was increasingly invoked to explain everything from biology and cosmology, to god and morality. I'll leave it at that, except to mention that Weinberg writes more banalities in this section, such as: "Faced with a puzzling

world, people in every culture have sought explanations." Duh... does it take a Nobel prize winner to figure that out? Wouldn't nearly all of us known that already? We are then hit with a blazingly obvious declaration about Darwin: "It took a long time for natural selection to be accepted as a mechanism for evolution." ...wait...wait...clunk!

Could it get any worse? Yes. At the closing line in the book the reader suddenly realizes why Weinberg brought up Darwin in the first place. That earlier reference set the stage for this engineered line, one of some embarrassment, and one of the worst I can recall in any work of science: "It is toward a more fundamental physical theory that the wide-ranging scientific principles we discover have been, and are being, reduced."

Does that graceful sentence ring a bell? It should. Even done as as a joke (which I am not inclined to think it was since the rest of the book is *entirely* devoid of humor) ending this forgettable book by corrupting the eternally famous last line of Darwin's *On the Origin of Species* is in bad taste at best. And it's insulting if done to add some ill-defined kind of gravitas or authority to Weinberg's mediocre book.(*)

There's a good object lesson here for future science writers: don't take a series of poorly conceived lecture notes and expect it will make a great book. Few have done this successfully: for example, Richard Feynman's likely unsurpassable The Feynman Lectures on Physics, and (although not quite at the same level) Leonard Susskind's ongoing series which so far includes The Theoretical Minimum: What You Need to Know to Start Doing Physics and Quantum Mechanics: The Theoretical Minimum. Weinberg's lightweight, ephemeral, "To Explain the World" is nowhere near the status and significance of those.

Hey, you scientists out there! I'm speaking to you now. You *are* allowed to write deep, challenging books for intelligent readers. Show us what you got! Don't be afraid to go over our heads. Force us to think, to improve our minds! Write about what you know, about your expertise. Don't write to the lowest common denominator, which in the United States is a very low level indeed. At the same time, don't patronize those less educated. Whose book do you think will still be read 500, or 50—or dare I say 5?—years from now: Darwin's or Weinberg's? You can pick only one, good luck.

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*Charles Darwin's most famous quote of all, from his most famous book in of a full lifetime of scientific works, is the last line of *On the Origin of Species:* "There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

By the way, notice that I didn't bring up Darwin first, he did. After that, the associated criticism was fair game. I can't fathom the audacity of any author, Nobel Prize or not, using a corrupted version of that exquisite quote for any purpose, let alone to close his own inferior book. It is consoling to reflect on the near-certain probability that any such book, as is certainly the case here, will be forgotten in a few years, while Darwin's will live on to the end of human civilization in one form or another.

Brian Clegg says

There was a time when one approached a popular science book by a 'real' working scientist with trepidation. There was little doubt they would get the science right, but the chances are it would read more like a

textbook or dull lecture notes. Thankfully, there are now a number of scientists who make pretty good writers too, but one area they tend to fall down on in history of science. I've lost count of the number of popular science titles by working scientists (including, infamously also the reboot of the Cosmos TV show, hosted by Neil deGrasse Tyson) which roll out the tedious and incorrect suggestion that Giordano Bruno was burned for his advanced scientific ideas.

Luckily, though, Steven Weinberg, as well as being a Nobel Prize winning physicist for his work on the electroweak theory (and all round nice guy), has made something of a hobby of history of science and his accounts are largely well done. I might disagree with some of his emphasis, and there are a couple of arguable points when dealing with Newton, both in his introduction of centripetal force and in the claim that the Royal Society published Principia, but on the whole the history is sound.

Perhaps surprisingly for a modern physicist, whose working life has been focussed on the peculiarities of particle theory and the significance of symmetry, Weinberg chooses to write about the period when the scientific method was evolving. So he starts with the Ancient Greeks and runs through to Newton, with only a short summary chapter filling in everything else in physics.

I have given the book five stars because I think that Weinberg builds this structure beautifully, showing how very different the ancient ideas of natural philosophy were from natural science and explaining in far more detail than I've ever seen in a popular work how the different models of the universe (what we would now call the solar system) were developed through time, including really interesting points like the way that Ptolemy-style epicycles were maintained in the early Copernican era.

He is also very good on the period when Arab scientists did original work and brought the mostly forgotten Greek works to the attention of the world. Here he treads what feels a very sound line between the older tendency to play down the Arab contribution and the more recent tendency to allow this period more of a contribution than it really had. Weinberg is perhaps a little sparse in his appreciation of the medieval period, ignoring Grosseteste and only having a passing reference to one thing that Roger Bacon mentions, but again he then very much puts Descartes and Francis Bacon in their proper place, rather than giving too much weight to their work.

Reading this book you will find out a whole lot about Ancient Greek science plus the contributions of Galileo and Newton, and it will be a rewarding read. Don't expect a lot of context - there is only very sketchy biographical information - so the content can be a little dry in places, but Weinberg's impressive grasp of the gradual evolution of the scientific method more than makes up for this.

The only slight surprise was that the book is significantly shorter than it looks. The main text ends on page 268 of 416. The rest (apart from the index) is a series of 'technical notes' which are effectively textbook explanations of various developments in physics from some Greek basics through to Newtonian matters like planetary masses and conservation of momentum. I'll be surprised if 1 in 100 readers makes it through these.

So, highly recommended if you want a history of the development of physics from ancient Greece through to Newton with a lot of detail on the way that both the model of the solar system and the basics of mechanics were developed in that period. Weinberg's writing may be a little dry with its lack of biographical context, but it is rarely dull as he keeps the ideas flying.

Gary says

The book listens like a series of lectures given to undergraduates (or maybe even graduates) in the liberal arts who want to understand how science developed and how we finally got to Newton. Newton changes everything, and the author will explain why the greatest book ever about the physical world is Newton's Principia ("Principles of Natural Philosophy"). The author outlines the steps that it took for the world to create a Newton. But just like in a college course you have to learn a lot of difficult things (which you'll quickly forget after the class) in order to understand the big picture.

In the process of getting there the author will describe in detail the theories of the early thinkers. To get to that understanding the author steps the listener through the Early Greeks, the Hellenic Period, the great Islamic thinkers (and they were great!), and through Thomas Aquinas, and to the start of Modern Science.

I now know in excruciatingly detail the wrong theories from the history of bad science such as the Ptolemaic system, the Aristotelian theory of motion, and Galileo's erroneous theory of tides. That's sort of a problem with this book. It's hard enough to keep today's less false theories about the world straight than it is to try to learn the fine points about the previously more false theories from the past.

The biggest crack in the armor of superstitious thinking and absolute knowledge comes with Thomas Aquinas. He takes the theology of his time and uses the logical principles of Aristotle to support his faith. At first the Pope forbids that approach but then the next Pope commends the approach. Allowing the logic and the reason that Aristotle represents (but not quite allowing for empiricism), allows the West to create a Newton.

The real theme of the book is along these lines: Plato is silly with his complete reliance on absolute knowledge; Aristotle puts science on the right path by categorizing the real world, but mars it with his final causes; Bacon's empiricism is still not relevant since he is striving for absolute knowledge by divorcing the individual from the world; Descartes's methods of thought leads no where, but his science (and math) are quite impressive; Galileo makes incredible strides but still doesn't realize the universe is not made up of mathematics, math is just a tool for understanding. Newton takes Kepler's empirically derived laws, idealizes them and derives them from first principles and shows how they can explain as well as describe.

Science needs to be understood as studying the particular, contingent and probable, and it never proves anything it just makes statements less false and this book helps one understand how we finally got to this point and out of Plato's Cave.

Bettie? says

[Bettie's Books

The rating, any status updates, and those bookshelves, indicate my feelings for this book. (hide spoiler)]

Ian Divertie says

A friend recommended this to me. I admit its given me reason for deep thought, something I so seldom do.

Its interesting that ancient revered personages come across as ignorant savages in this book. I don't think my feelings regarding Plato could sink much lower after reading this. I feel the main purpose of this book is more to point out man's prejudice toward false certainty, superstition, and instinct over a searching curiosity. And if you think this might make me an Atheist, far from it, a grounding in a system of ethics is a good thing. The desire to control and structure is not, ---in fact its antithetical to science as well as good moral human behavior. I also tend to agree with the authors view that science is a search, a type of fumbling about, its certainly been my experience conducting "science" over the years. Science as I've been involved with it, is creative, spontaneous, and unpredictable, those who try to make it otherwise don't really understand science. Discovery is wonderful, the journey often confused. Excellent book!

I don't know why, but this book reminded me of an issue I've been rolling around in my head. Following WW II American elites all wanted to become their new heroes. Capitalist, bankers, and managers all wanted to emulate Generals. Generals all wanted to be become bankers and managers. In the 1950's engineers, scientists, and intellectuals were stunned by this development, becoming merely cogs in the machinery or employees. Since this time, engineers have desired to become managers, and intellectuals have morphed into experts. Scientists and those of a yen to be scientists have felt somewhat adrift, although most can find steady employment as the dreaded expert.

Mohamed al-Jamri says

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Ints says

Nedaudz izv?rsts lekciju konspekts, kur tikai vietumis var nojaust, ka autors sp?j uzrakst?t lab?k.

Siv30 says

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Luke says

I gave this book 2 stars based on my opinion that the most valuable elements in a condensed book on the history of science (made for the general public) are:
1. The author's selective inclusion of subjects/scientists
2. The author's detailed analysis of the key scientists' achievements relative to the overall progress of his field or science in general.
3. The author's analysis and commentary on factors contributing to the beginning of science and it's continued progress, the abolition of science during the dark ages, and the revival starting during the Renaissance which led to modern day science.

For point #1:
I think the author did an OK job, but the subject matter is only astronomy and other classical physics. There is no mention of biology, chemistry, or electricity/magnetism until the short epilogue. Further, it is only up through Newton. I think these points would have been fine if it was written in the book's description.

For point #2:
The author does a poor job of providing the reader any real sense of how difficult the discoveries discussed must have been. That is, the reader cannot get a good sense of how a problem looked to the scientist given

his time period. There are some comments on observation difficulties that were overcome by brilliance, but there are only brief comments, no details. There is no clear explanation in the building up of scientific concepts, or a clear explanation of what a specific scientist was working with upon starting his work. The history reads as a list, jumping from great scientist to great scientist, rambling off their discoveries. To me, it is very puzzling why the author wastes space on the details of mathematics after stating a discovery instead of providing any of the aforementioned details.

Because of the above, there is not any feeling of the significance of any particular discovery to the progression of science. The author may state that "'such and such" a discovery was the first of its kind, but beyond these statements, there is really nothing to go on. The author seems to stay as neutral as possible, and just rambles off discoveries. Aristotle is the one major exception to this rule. The author is highly critical of Aristotle, which to me is a complete failure in this category. After the first few chapters, I was ready to try and ignore this, as the author claimed to be more neutral with respect to Aristotle than other modern physicists. But throughout the rest of the book, Aristotle's errors in science were mentioned whenever they could be squeezed in, and confused statements showing the author's true interpretation that Aristotle had a negative impact on science were repeatedly made (more about this in point #3).

Other significant (non-neutral) commentary is very short and includes opinions on:
- Plato = negative (understandably)
- Short on Bacon, Descartes = negative
- Very short on Aquinas = positive? Which makes the author's viewpoint on Aristotle even more confusing.

For point #3:
On this point, the author had me very confused throughout the entire book, and failed on all three major time periods.

Beginning of Science:
He starts by giving accounts of the pseudoscience (my term not his) practiced by the major pre-Socratic players and poets up through Plato. He properly gives credit to Aristotle as bridging the gap between this pseudoscience and the base for the foundation that would become science. The author seems to understand that Plato's Forms and fundamental belief that reality cannot be perceived by the senses is anti-science in which no foundation could be established, but cannot grasp how Aristotle's validation of the senses and the reality we live in does not do the opposite for science. He seems to conclude that since the Hellenistic period post Aristotle had more scientific theories that proved to be in better accordance with reality than those of Aristotle's, the Hellenistic period was far more influential than Aristotle. This ignores the fact that it was already stated that Aristotle made the Hellenistic period possible. It's hard to imagine science building up from the principles of Plato. The rest of the book is a good Aristotle thrashing...

Times up to and during the Dark Ages:
In terms of detailing specific scientists' achievements, the author properly focuses on the Arab world while it was still thriving, since science was non-existent in the West. "while al-Rashid and al-Ma'mun were delving into Greek and Persian philosophy, their contemporaries in the West, Charlemagne and his lords, were reportedly dabbling in the art of writing their name". As far as commentating on why science was dead in the West, the author says little of significance. For example, he stays mostly neutral on the role religion played. To me, this is another failure. When science goes from studying space to illiteracy, I expect some significant insight on why it happened, for the sake of science. There is some attempt at the end of Newton's chapter, but there are only a few sentences and no firm stances taken.

Renaissance:

Given that the author does not know why science died, it logically follows (thanks Aristotle) that he cannot give any reasons how it recovered from the dead. For every mention of Aristotle's influence in the great scientists' lives of the Renaissance and post Renaissance, there was a statement on how they disagreed with Aristotle as if the author was trying to diminish the influence as much as possible.

Summary:
The fact is that the essentials for a history of science book (from my perspective) were lacking, and the take on Aristotle just poured salt on the wound. But I have to acknowledge that the author is qualified to write on the subject, the movement of the material logically flows, and if you are OK with everything I mentioned above, it may be right for you.

Terry says

To Explain the World is an uninteresting walk through the development of our understanding of the solar system. The book purports to do other things but really the majority of its bulk centers around this point. Normally, I love history of science, but this book is both slow and lacks insight. Avoid this book.

The book grows out of the lecture notes for a course the author instructed and the text very much has that feel. The text feels like an outgrowth from a not particularly good outline and this has left holes. Usually, a book offers insights that a course would not. Some sense of the grand overview and the book only pokes at these. The author is a Nobel prize winning physicist which would suggest he'd be better able to talk about why something is important. The book also stops shortly after the beginning of the scientific revolution with no fanfare. Discussions on how the nature of science has changed don't appear substantively.

On the plus side, the book isn't bad. The writing is clear and the coverage of Arab science is better than most treatments. There's good coverage of the fight between Socratic and Aristotelian astronomy which is almost interesting.

Again, there are few people I could recommend this book to.

Tlaura says

Some history of science books suffer from the problem that the authors don't actually know much science (or can't explain it). That's not a problem here. Weinberg gives superb accounts of technical astronomy up to Kepler (with one small exception having to do with the center of motion in Copernicus' system which I won't get into) and an incredibly lucid account of Newtonian mechanics. I confess I had never really understood why the earth should bulge at the equator before reading Weinberg's explanation and now it is clear. Ditto for Weinberg's explanation of Descartes' theory of the rainbow.

Beyond the science itself, Weinberg's problems as a historian are twofold. First, as a self-professed amateur he doesn't know much history. And, second, he doesn't much care about history. This book is uber-Whig history: the pre-history of the Standard Model. Weinberg is mainly interested in how we got to a world in which he could win his Nobel prize. This approach would be fine -- even refreshing -- if Weinberg were a more consistent positivist. By that, I mean if he would focus on the methods and results of scientific investigation instead of constantly digressing into what what metaphysical commitments make a scientist

most productive and appealing, which of course are his own. Weinberg seems amazingly blind to his own philosophical commitments, and often ends up falling into the same sort of philosophical determinism he dislikes among historians of science who prize fuzzy grand metaphors over the actual, difficult, insights into nature that make up scientific knowledge.

To get an example of Weinberg's strengths and biases, take his account of the role of observational data in early modern astronomy. Weinberg correctly (in my view) explains that the improvements in predictive accuracy around the turn of the 17th century couldn't disprove Ptolemaic astronomy in the modern sense of proof. The reason is simply that a Ptolemaic model with a solar equant *could* have done nearly as good a job as the Kepler model at explaining the observed motions of the planets in the night sky. This is an excellent point. But then, a few pages later, Weinberg argues that the phases of Venus *did* disprove Ptolemy because only a Ptolemaic model in which Venus and Mercury's deferrents are the orbit of the sun (i.e. a Capellan model) could account for the phases while "this arrangement had never been adopted by Ptolemy or any of his followers". Fine, but the solar equant also had never been adopted by Ptolemy or any of his followers! With good reason: the solar equant remained very controversial in the 17th century precisely because of its obvious Copernican implications until it was definitively established empirically by Cassini and his associates in the early 1660s. Even Huygens had trouble accepting that the earth could be *that much* a planet. Heilbron's *The Sun in the Church* provides an excellent discussion of this episode.

So why does Weinberg apply these different standards to the Rudolphine Tables and the phases of Venus? My strong suspicion is that it's because Galileo discovered the phases of Venus (at least in the reduced-form account of the period presented here) and Weinberg wants Galileo to get the credit for disproving Ptolemy because Galileo fits his idea of a proper scientist who doesn't "sound like Plato". (Weinberg doesn't like Plato at all. Or Aristotle. Various historical figures are judged on how much they sound like Plato or Aristotle. Galileo gets high points here.)

Related, although it's admittedly a smaller point, Weinberg claims that Kepler accepted solid spheres for the planetary orbs in the *Mysterium Cosmographicum* and only rejected them because of the ellipses. This is false. Weinberg would likely say it doesn't matter because *MC* was a bunch of woo and so it might as well have been based on solid spheres. Then don't write about it! At least one reviewer bungled this point too, meaning Weinberg is spreading misinformation. Interpretation is one thing, but historical facts matter in the same way and for the same reasons that scientific facts matter.

Weinberg also doesn't much like Descartes, who got a lot of things "wrong", which Weinberg blames on the lack of empiricism he brought to his physical theory. He quotes a Descartes biographer saying "The seventeenth-century rise of Modern Science, the eighteenth-century Enlightenment, the nineteenth-century Industrial Revolution, your twentieth-century personal computer, and the twentieth-century deciphering of the brain —all Cartesian". Weinberg rightly calls this absurd (though judging from a review, Watson's biography is intentionally absurdist) but it doesn't really reflect a mainstream view in the history of science. Descartes gets a few props for his analytical geometry and his theory of the rainbow, but later Weinberg credits Newton's first law to Gassendi and Huygens, conveniently leaving out the fact that Newton almost certainly took his concept of inertia directly from Descartes, another example of Descartes being "right", and moreover in an extremely influential and fundamental way that reflected the fruits of his rationalist approach.

At the other end of the rationalism/empiricism spectrum, Weinberg brings up Francis Bacon to dismiss his importance, which is fair enough at least as far as physics is concerned. Does Weinberg realize that Koyre got there 70 years before him? Also, when Weinberg later approves of Newton not "feigning hypotheses" (an example of his not "sounding like Plato") he should probably be thankful for Bacon's very large influence on scientific aesthetics in England circa 1690 which likely explained Newton's happily modern-seeming attitude

toward hypothesizing more than anything else.

Newton provides the biggest problem for Weinberg's theory of how science must be done. Weinberg doesn't deny Newton's basically teleological and religiously motivated worldview, or his "cavalier" attitude toward reporting the results of experiments accurately. Somehow, though, his problematic metaphysics didn't stop Newton from being a very great scientist (and Weinberg's description of Newtonian mechanics really drives this home). That makes Weinberg's endless (and often horribly arrogant -- the word "stupid" is thrown around a lot) lecturing of previous thinkers for being hidebound by their unscientific commitments ring a little hollow. In a post- Newtonian or even a post-Keplerian world, teleology may make less sense as a philosophical commitment. Put another way, maybe changes in knowledge drive changes in philosophy and not the other way around. Maybe the philosophical commitments of thinkers are actually not very good predictors of their achievements or reflections of their genius. Good modern positivist history of science -- of which there is plenty -- tries to explain what historical processes and institutions made these changes in knowledge possible without getting hung up on who "sounds like Plato" and who doesn't.

In the end, Weinberg tells us that since there are no final causes, and no guarantee that the most successful theories will even be elegant, all we can hope for is to generate better and better theories. These theories provide us with fleeting "joy" because they are pretty and save the phenomena. He justifies this with reference to what Ptolemy, Copernicus and Kepler "must have" felt when they made their discoveries (specifically the ones Weinberg approves of. Is Ptolemy supposed to have felt joy when he reformed astrology in the Tetrabiblos?). Presumably Newton must have felt the most joy of all, which is a bit hard to reconcile with his nervous breakdown in the early 1690s. Fortunately, though, you don't need to dwell on these problematic details but can skip ahead to the excellent and quite long mathematical appendix. There, Weinberg the scientist and excellent popular science writer gets back to what he does best.

Nikki says

This book is ostensibly about the development of science, and particularly the scientific method: the development, in short, of the understanding that we need both theory and experiment to derive natural laws. It goes into a lot of the history of the development of astronomy and physics, and thus necessarily chemistry to some degree as well (since the makeup of an atom affects chemistry)… but neglects biology almost entirely. Since biology is my interest, I'd hoped for a bit more of it, but instead it was more or less included as an afterthought.

Weinberg's tone is entertaining enough, and he certainly isn't constrained by anyone else's ideas of who truly contributed to science — he dismisses most of the ideas of Plato and Aristotle, even within the context of their time, because they didn't conceive of the scientific method or how to come up with testable theories and follow through. You may or may not find that justified; I was glad, personally, that we didn't spend too much time on Plato, as I'm not an enormous fan.

There's a lot of science in here as well, in that Weinberg explains how discoveries were made and proven, or why they weren't actually consistent with the world and what you can observe. Most of this is very clear, but anything that involves maths is sadly lost on me, and I confess to skipping the back section. There's a reason my BSc in Natural Sciences is almost all biology — I have neither the head for, nor the interest in, mathematical rules and proofs.

It's entertaining enough, but it's narrower than the blurb might lead you to think — the vast majority of it

actually deals with astronomy and maths.

Originally posted here.
