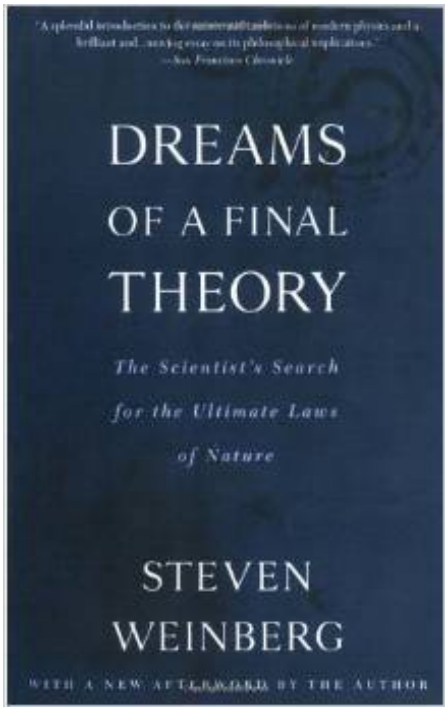

Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature

Steven Weinberg

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“Unusually well written and informative…Weinberg is one of the world's most creative theoretical phsyicist.”
—Martin Gardner, *Washington Post Book World*

In *Dreams of a Final Theory*, Stephen Weinberg, the Nobel Prize-winning physicist and bestselling author of *The First Three Minutes* describes the grand quest for a unifying theory of nature—one that can explain forces as different as the cohesion inside the atom and the gravitational tug between the sun and the earth. Writing with dazzling elegance and clarity, he retraces the steps that have led modern scientists from relativity and quantum mechanics to the notion of superstrings and the idea that our universe may coexist with others.

But Weinberg asks as many questions as he answers, among them: Why does each explanation of the way nature works point to the other, deeper explanations? Why are the best theories not only logical but beautiful? And what implications will a final theory have for our philosophy and religious faith?

Intellectually daring, rich in anecdote and aphorism, *Dreams of a Final Theory* launches us into a new cosmos and helps us make sense of what we find there.

“This splendid book is as good reading about physics and physicists as this reviewer can name…clear, honest, and brilliantly instructive.”
—Philip Morrison, *Scientific American*

Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature Details

Date	:	Published January 1994 by Vintage (first published February 1st 1992)
ISBN	:	9780679744085
Author	:	Steven Weinberg
Format	:	Paperback 340 pages
Genre	:	Science, Physics, Nonfiction, Philosophy, Popular Science

From Reader Review Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature for online ebook

Charlene says

Absolutely a must read. I cannot believe it took me this long to read it. Weinberg presented his and other physicists' theories that try to explain the universe. As difficult and possibly impossible as this goal may be, Weinberg makes it fairly simple for the curious reader. He really does have a gift for relaying complex knowledge to the non physicist.

Since this book was written in 1992, I think readers can and should forgive it for its focus on beauty as criterion for a viable theory. It is only recently that physicist, to my understanding, have begun to parse out aspects of symmetry from aspects of beauty. If you were to replace every mention of "beauty" with "symmetry", it might work better-- but it might fail to convey what Weinberg was trying to convey.

In any case, this book was simply incredible. How we can understand the forces, branes, possible other universes, symmetry, and more? Just follow Weinberg through the beginning of our universe to now and even if you fail to truly understand our universe, as most physicists do, at least your brain will be brimming with wonderful questions for a long time to come.

Essential physics reading. Period.

Trevor says

I'm again about half way through this one, but I've spent the last couple of days thinking about a quote in this by Bohr. Now, you need to know that the Uncertainty Principle states that one can not know both the position and the momentum (sometimes people say velocity – but it is actually momentum, as they wrongly assume that a particle’s mass won’t change) of a particle at the same time and that the more accuracy you have in measuring the one, the less you have of the other. These types of properties have a name in Physics – and that name is complementarity. Bohr was once asked at a dinner party what is the complementarity for Truth – and after a moment’s thought said – wait for it – Clarity. That is brilliant. I’ve been thinking about it every which way and it is a stunning insight. Why don’t I get invited to dinner parties like that?

The clearer something is explained the less truth it contains, the truer the explanation, the less clear it appears. Not an absolute law, but interesting nonetheless.

Xander says

Steven Weinberg is a remarkable man. A particle physicist and cosmologist, and Noble prize winner (due to his work on the electroweak theory), he is also passionately interested in the history of science and a popularizer of the work he's involved in.

In The First Three Minutes (1977) Weinberg tried to explain to the popular audience the current scientific insights about the origin of our universe. This was (to my knowledge) the first accessibe and complete

account of this topic.

Ever since the 70's particle physics and cosmology have developed and seen the rise (and fall) of new theories and experiments. In Dreams of a Final Theory (1992), Weinberg explains the progress in physics from the ancient pre-Socratics throuh Newton and Einstein to modern conceptions.

Weinberg's main motive for writing this book is explicitly stated, and spans the final chapter and a postscript. He wants to explain the current status in particle physics as an argument to build the Super Conducting Supercollider (SCS). This device will let physicists experiment with bigger and better tools to cross the frontiers in particle physics (for example, the detection of certain predicted particles which require high energies to be detected).

The building of this SCS was cancelled a year after Weinberg published his book; CERN in Europe built the Large Hadron Collider and detected (among other things) the long-predicted Higgs particle.

So, Weinberg's plea went unheard. I still think his book is successful, though. The current status of pure science requires the expenditure of billions of dollars - money that could have been used in many other ways. In a democratic society (such as the US or European countries) there has to be a mechanism that allocates money in a democratic way. This means that if scientists want to spend public money, they have to explain why this money is so crucial. And besides, the allocation of these sums of money (but really any amount of money, in general) creates an obligation for the scientists involved in spending the money in explaining their results to the public.

(In this sense, we need more people like Steven Weinberg. Scientists are generally reluctant to publish books, while continuously publishing abstract articles in obscure and barely read journals. Most publish the general progress of their carreers in book-form when they retire, but this is just too little, too late. I would claim that the public has a right to know what the current status in important scientific domains looks like.)

But back to Weinberg's book. He has a gift for explaining difficult theories like general relativity and quantum mechanics in accessible terms. Of course this means a lot of generalizing and simplifying, but Weinberg manages to get his main theses across (whereas other popular writers like Krauss are more problematic in that respect).

In a sense, Dreams of a Final Theory explains how physicists have been homing in on ever simpler, singular and more beautiful theories. This means (in layman's terms) mathematical theories that cannot be changed without leading to absurdities. This leads Weinberg to the conclusion that the ultimate theory, a theory of everything, is near (at least in distance, it still can take a lot of time for us to get there).

A theory of everything would mean a mathematical theory that incorporates the standard model of particle physics and general relativity. The standard model is itself a major breakthrough of twentieth century physics: it incorporates the electroweak theory (the theory that incorporates the electromagneticity and the weak nuclear force that is responsible for nuclear reactions) and the strong nuclear force (which is responsible for keeping the quarks inside protons and neutrons).

The standard model incorporates three forces of nature - electromagneticity, the weak force and the strong force - and will have be combined, one way or another, with general relativity, which describes the fourth force of nature: gravity.

Thus far, attempts to combine Einstein's relativity and the Copenhagen interpretation of quantum mechanics

into one single consistent equation have failed. Weinberg argues that structures like the earlier mentioned SCS as well as the European Large Hadron Collider could help with our search for the final theory. In other words: physics is at a relative standstill and we need better equipment to progress beyond the current frontier.

Since this book was published in 1992, it naturally is outdated. Since then, a lot has changed. As mentioned, CERN has build the LHC in Geneva and one its major discoveries is the Higgs particle. The experiment confirmation of the existence of Higgs particles shows the correctness of the Higgs field theory. This is a theory that explains the symmetry break in the theories of the standard model of particle physics. Basically, all the elementary particles (photons, electron, quarks, etc.) are bundles of energy, quanta, in various fields.

For a layperson, this last statement might seem arcane and/or trivial, but it really is a radical break with the past. Gone is the mechanism of Newton and Laplace: everything in the universe is the result of fluctuations in various fields. The radicality of the new science (relativity, quantum mechanics) is legitimate, since they yield the exact same theories as the old ones (like Newton's gravity being incoroporated, as a special condition, in Einstein's general relativity), as well yielding very narrow predictions, which have been validated by the most accurate and precise experiments ever conducted.

There is a whole collection of elementary particles - Weinberg even admits (with a smile) that physicists, at all times, have to carry a list in their pocket which sums up all the different particles - and the quest is to unite them all into one consistent theory.

Weinberg's approach to science is reductionist, albeit in a reasonable sense. Reductionism claims that a science has to be explained, ultimately, in terms of the science which describes its building blocks. So for example, sociology - the study of human social groups and human interaction - has to be explained in terms of the behaviour of individual human beings. Hence, since the building blocks of sociology are human minds, psychology and neuroscience is the foundation at which sociology rests. Likewise, chemistry is the interaction of molecules and atoms; hence, chemists have to explain, ultimately the building blocks in their theories (i.e. atoms) in terms of physics.

According to people like Weinberg, physics is the ultimate resting ground for all the sciences. But this has to be interpreted in a very precise way: the chemist studies chemical processes and the sociologists studies human group interactions; they both don't need physics to study the emergent processes in their domains. Reductionism just means that any scientific field has to have its foundation in a more basic science. Reductionism has been a very fruitful way to approach science, while anti-reductionists have never been able to mount a serious alternative.

What does this mean for physics? Physics has to rests on some foundation as well, right? Well, according to Weinberg - and he uses two chapters in getting this point across - physicists are looking for a mathematical equation that is simple and beautiful, in the sense that (1) it contains all the current theories in physics (quantum mechanics, general relativity), (2) it is consistent and coherent, and (3) it cannot be changed in any way without leading to obvious absurd results. This means that physics, ultimately, rests in a mathematical equation that could legitimatelly called a theory of everything. In practice, we are still far from this, though we can never be sure when - and if - this equation will ever be found.

I found this book to be a revelation. Weinberg is able to explain the most important theories and discoveries in physics in a very easy-to-grasp style and he is able to paint the general picture. He also manages to emphasize the dualistic and mudy approach of science: observation and theory development are in continuous interaction, without the one being dominant over the other. Lastly, Weinberg clearly makes

explicit when he gives his own opinion and when he tells the generally accepted view - something that not many authors manage to do.

I much liked Weinberg's description of the Super Conducting Supercollider as being just the last piece of equipment in a long line of inventions. Those inventions are the crutches that we use to overcome the fallibity of our own senses. Galileo's telescope started it all; the particle accelerators are the latest crutch.

As a last remark, I'd like to mention Weinberg's view on religion and science. Weinberg explains that scientific developments have pushed God out of the world of science and that conservatists as well as scientists realize the importance of this, as opposed to the liberal masses. Hence, the continuous struggle of movements like Creationism and Intelligent Design. For Weinberg, there is no place for God in this universe; the scientific laws discovered explain anything from the big bang onwards.

What I find remarkable in Weinberg is his honest reluctance to admit the success of science in explaining the world. Weinberg longs for the mystery of the past and even admits that the scientific outlook is barren; it lacks emotion and spiritual fulfilment. Yet, he is a seeker of truth and hence has to apply his own methods to his own outlook, leaving him an atheist.

I sympathize with this view, it is something I fully subscribe to as an atheist and reductionist. But in the end, we have to strive to rationally approach all the important matters of life. As Weinberg himself explains, the irrationality of the past (i.e. religion or other forms of superstition) has led to immense human suffering. Science has given us better weapons, true, but it has also given us the tools to lead better (and safer) lifes. There has never been a war about a scientific idea (those are fought in journals) or a war between scientists. Irrationality is dangerous; rationality is, though no sinecure, the best we've got.

Cara says

I won't judge this book on its out-of-dateness or it's terrible audiobook narrator (not the author's fault), and I will try not to give too much weight to the ending of the book, where Steven Weinberg leaves the realm of science and instead moves into religion (this is never a good thing for a scientist to do - too often they conflate "science being unable to prove the existence of God" with "science proves God doesn't exist"). The rest of the book is pretty good, though not exceptional, and not as good as The First Three Minutes: A Modern View Of The Origin Of The Universe. It explains the search for the theory that will unite unite quantum mechanics and gravity and everything into one. It's not the author's fault that this book is out of date, but it does make a big difference (so much has happened in the past 20 years), and I wouldn't recommend this book except as an introduction to physics and an exploration of the view of the universe from the early 90s.

Ahmed Omer says

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Vismay says

At last, respite! Finally there comes a writer who does not evoke God when writing a book on physics for general public, finally I get to read someone who brings out his point with little or no historical bullshit or brings in no orientalism or mysticism when dealing with the interference pattern!!

Maybe if I were a reputed critic working for Times in 1993, I might have started my critique in the above manner for Steven Weinberg's 'dreams of a final theory'.

Well, I my short, stupid life I have read my share of books, but this is the first guy who openly, unashamedly and unabashedly favors reductionism and firmly believes that 'NO GUT (GRAND UNIFIED THEORY), NO GLORY'.

Right from a bee's sting to black hole, from the recoil of a gun to oxygen's spectral lines, from a piece of a chalk to dinosaurs- everything, can necessarily come under the ambit of the Unified Theory. Maybe the laws derived regarding the objects fore mentioned might not be calculated if we spend all the resources existing on earth, but Quantum Mechanics permeates every branch of anything concerning matter or energy for a simple reason everything is matter or energy (or anti matter or dark matter!).

This book had come at a crucial time when American Congressmen were mulling to scrap the project of Super Conducting Super Collider (in fact it did…), but Mr. Weinberg has put forward his points in a much passionate manner why that should not be done.

The laws so far determined by the Quantum Mechanics have passed the acid test of stringent experimental facts, the fact that it isn't applied to large world phenomenon, is not that it is impossible or that it cannot, it's just that its improbable.

Mr. Steven Weinberg envisions (and has also contributed much in that vision!), a theory that is so logically isolated that if we were to make the slightest change in the theory, the can of worms of infinities would open up without any hope of canceling each other out- thus giving logically absurd solutions. He along with Abdus Salam has been able to produce just such a theory combining Electromagnetism and the Weak Force- The Electroweak Theory. The Final theory should be beautiful, logically isolated, with symmetries.

As he paces forward in his arguments, it is brought to our notice that the Final Theory may be the one given by String Theory, but that too is not without its usual set of problems. The basic problem is that there are large number of string theories which are logically isolated!! There is a thing called Cosmological Constant which first arose in Einstein's General Relativity- which changes the belief systems of scientists in a way that wasn't imagined. There could be different universes with different set of constants, with different wave functions and the only reason we exist in this particular universe is due to the favorable circumstances provided by such constants.

But Mr. Weinberg is not ready to give up to this Anthropic viewpoint, he hopes to find (or for the theory to

be found in his lifetime!) the Unified Theory that can explain the presence of such constants. Maybe he would.

Lastly- he has blatantly and incontrovertibly proved the existence of interested God unnecessary.

Neither are we at the cosmic centre stage nor are we in any manner being helped by an interested God who answers our prayer, after reading this book, he had managed to convince me that we are just pawns in this larger game of life, Big Bang and GUT as such (even big bang is a pawn of Mega Universe). Maybe lurking behind historical fluctuations and utter complexity, we may find a fundamental theory that needs no other theory to explain it, in the bubble dance of sizzling hot particles which have been accelerated 99.99% the speed of Light at the Large Hadron Collider!!

H L says

Fascinating mashup of sciences and arts usually thought to be exclusive of the others, but this book demonstrates, probably more clearly than any other I've read, that physics, mathematics, philosophy and religion are inextricably intertwined. There's something here to stimulate the fundamentalist physicist, the atheist mathematician, and any and all combinations in between.

Manuel Antão says

If you're into stuff like this, you can read the full review.

Infinity is -1/12: "Dreams of a Final Theory" by Steven Weinberg

(Original Review, 1992)

I wear a giant panda suit outside a Panda Burger giving out promotional leaflets. As this job is a bit easy and I can do it without too much conscious effort .....the only thing I have to watch out for is farting as it is unpleasant trapped in that panda suit .....anyhow I digress .....this gives me a LOT of time to think about serious issues such as time and the merits of having a TOE. As infinity is -1/12 it is a rather odd notion; I have come to the conclusion that it is not space and time that is curved but numbers and mathematics. Space and time is actually straight when you take this into account (as my wife would say: "I'd say that's a pretty major step up from what you're intellectually qualified for. Well done. There is an opening going for a flipper inside the joint if you are interested.")

Pavan Dharanipragada says

This book documents the argument made by Steven Weinberg for continuing to fund the Super-conducting Super Collider in 1993; an argument that was doomed to failure. The collider was going to achieve energies

much larger (approx. 3 times) than LHC, which would have enabled it to discover new particles that were expected to explain the spontaneous symmetry breaking between electric and weak forces. (The equations governing electric and weak forces are symmetric with respect to these fields, but the solutions allow for asymmetry between them. This was supposed to happen through a new force-carrying particle that would be too massive to have been observed in earlier experiments.) Of course, the Higgs particle was discovered two decades later in the LHC, but the higher energies achievable at SSC were expected to bring to light new phenomena that can never be observed in LHC.

Not very long after this book was published the project was canceled by the American Congress, knowing which gives a very ayyo paapam feel while reading Weinberg's earnest, desperate arguments. Weinberg also gives the reason for this desperation. High Energy Physics was on the brink of a veritable stagnation then, having far surpassed the realm of experiments. We needed more ambitious experiments that were far grander in scale to give the necessary impetus to theoretical research; to give direction to problems unresolvable without experimental guidance. Well that all is over now. HEP has been stagnant for a long time. People are losing all faith and interest in string theory, that was expected by 90s optimists to reach high school textbooks.

The book is not about SSC though. Along the way, Weinberg describes the search for by and attitudes of prominent scientists, including himself, and philosophers about a final theory of everything since the pre-Socratic period, when one particular school of Greek philosophers posited that everything is made up of air. Later on people did not take the idea seriously, until the beginning of the 20th century when the atom was discovered. What is meant by a final theory? If it explains everything, does that mean we do not need any other field of science, like chemistry, biology, psychology, economics? If it doesn’t, what is the use of such a theory? Is a final theory even possible- what if the search for a final theory is just a series of ‘why’s and the universe is all like fuck you? How do you go about constructing a final theory- do you only constitute it with observables, (like the positivist structure incorporated by Heisenberg in Quantum Mechanics, and Einstein in the Special theory of Relativity?) How would a final theory look like? (Answer: “beauty”ful. Google Emmy Noether and symmetries in physics.) Isn’t such a final theory incompatible with the philosophical paradigm shifts of the twentieth century? Is there a place for God in the Final theory?

If you’re interested in any of the questions listed above, you should read the book, cos Weinberg is remarkably comfortable with all these topics, and gives satisfactory and illuminating answers to almost all of them. (Well, one of them is not like the others. The discussion on God feels out of place. Unnecessary. The Higgs boson has nothing to do with God. Weinberg shouldn’t have had to explain it.) The chapter on philosophy reserves some generous thrashings to various philosophies that stood against science at various times. Weinberg feels they mostly did more harm than they did good. He also warns about brilliant young men who were seduced by philosophy in the past and wasted their potential. He himself had great fascination for philosophy as an undergrad, but had abandoned it in favour of science, seeing how much more satisfying and successful science is. Now, I am more into philosophy than the average person/ physics student, but Weinberg makes a persuasive argument. I will reserve my judgement.

Safae says

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Jimmy Ele says

Good book, but dated.

Tuomas says

Weinberg manages to include a lot in this book, although it's of a very manageable length. It's primarily about particle physics of course, but there is also plenty of history of science, cosmology, and a few funny anecdotes. The discussion about reduction is perhaps the most interesting though, and also the reason why I picked up the book in the first place. Weinberg is skilful in explaining difficult material understandably -- the discussion of symmetry principles comes to mind.

It must be said that at this point in time, some material is obsolete: the book seems to have been inspired by the financial plight of the SSC project, which has now long been abandoned. The book was written well before the successes of the LHC though, so we now know much more about many of the things that Weinberg speculates about. I'm not a huge fan of his writing style either, but that's more of a personal taste issue. Finally, there is the chapter 'Against Philosophy'. It was quite disappointing to see that Weinberg's case was primarily based on complaining about logical positivism, a view that has been discredited long ago and that (almost) no contemporary philosopher would subscribe to. So, as usual with physicists, Weinberg is rather uninformed about contemporary philosophy, although he does cite several philosophers. Anyway, I did enjoy the book for the most part, despite these shortcomings.

Manny says

Probably just a lucky hit? It's getting harder and harder to tell with these new deep learning architectures. Though if a human being had done that, I'd have said it was quite insightful.

[After reading]

- Professor Weinberg, thank you for agreeing to testify in front of the committee.

- The pleasure is all mine, Senator.

- Very good. Now, let's get down to business. Why should the US pay 8 billion dollars to build this - ah -

- Superconducting Super Collider.

- Thank you. You know, you could have chosen a shorter name. So, we're hoping you'll tell us what it's good for.

- Senator, that's not a straightforward question to answer. In fact, as I think you know, I've almost finished writing a book about it. I mailed you a manuscript -

- Professor, that was very kind of you, but I'm afraid we haven't all had time to read three hundred and fifty pages. Interesting as they are. I'm going to have to ask you to summarise.

- Well -

- First of all, what do you expect to achieve here? Is this going to help the US consumer electronics industry?

- It's very unlikely, Senator. At least in the short-term.

- Defense?

- Even more unlikely.

- So what it is it good for?

- Senator, we are trying to discover the fundamental laws of the universe. It's impossible at this stage to say what they might be useful for.

- Fundamental in what sense?

- They are at the basis of everything, Senator. That's how science works these days. Since people discovered DNA, we know that biology is in principle just chemistry. And we've known for a while that chemistry is in principle just physics. And all other physics rests on the basic laws which we will be investigating.

- So if you succeed, then chemists and biologists will be out of a job?

- Absolutely not, Senator. When I say "in principle", I mean just that. We will have the theoretical possibility of explaining everything. But in practise, we won't be able to do it except in very simple cases. The equations are far too hard to solve.

- In other words, it won't actually be useful?

- I didn't say that either, Senator. We just don't know yet.

- Now what gives you the idea that you'll even be able to do this?

- Senator, we theoretical physicists are definitely getting closer. We have all these scientific theories, and, as I said, one theory explains another. We draw arrows to show that *this* explains *that*, and we see that the arrows are all coming from one place. It looks like they'll meet up somewhere just off the edge of the picture.

- And what will you find there? God?

- Personally, Senator, I don't think so. The arrows seem to be coming from a different direction.

- That's a pity.

- I'm sorry, Senator.

- Well, Professor Weinberg, if not God, then what? Some deep philosophical idea?

- I don't think that's the answer either, Senator. In fact, we've been quite surprised to see how little help we've got from the philosophers. None at all, to be honest.

- Professor, if you're looking for ultimate answers, and you aren't guided by God or by philosophy, then what are you guided by?

- Ah... by our sense of beauty, if you want to know. Mostly.

- Your sense of beauty? Physics is beautiful?

- Yes Senator. If you're that way inclined.

- And what kind of beauty is it? Like a picture? Like a play by Shakespeare?

- More like a Shakespearian sonnet, actually. The plays are messy, like everyday life. But the sonnets are pure, with nothing wasted. You couldn't add or remove a word. That's how a physical theory is. Or if you want to think of plays, the laws we're searching for are like Greek tragedies. They can only come out one way, they're inevitable.

- You say all this in your book?

- Yes Senator, I explain it at greater length there.

- Well Professor, let me summarise. You think the US government should spend eight billion dollars to find something which you say is like a Greek tragedy.

- Like a Greek tragedy in a certain rather specific sense, Senator.

- Thank you Professor. You've been very helpful.

Ivan Vukovi? says

Incredibly lucid, honest and concise. Possibly the best popular science book I've read so far. But I do have to warn you that I'm a theoretical physicist with worldviews closely resembling those of Weinberg, so don't expect an unbiased review.

Although he doesn't go too far to explain the actual laws of nature, as one might expect to see in a popular science book, Weinberg touches on some of the most important questions.

Can we have a final theory? Are we close? How can we know if we are close? If we are, what then and what after that? What about philosophy and God? How should we allocate resources for fundamental research?

Some things in the book are clearly outdated, which comes as no surprise, but it's an important record of historical events which shaped and still continue to shape the world of fundamental physics and its continuous effort to uncover the final theory.

From the point of view of a physicist in 2016, it's nothing less than depressing to read about the early history

of the Superconducting Super Collider (SSC), which was ultimately cancelled. The mere thought of how much could we have known by today if it had been constructed fills me with sadness and contempt for modern politics and economics.

Thanks to CERN and the LHC we are now in possession of answers to many important questions that we wanted to have answered, but I sometimes wonder how much more could we have known by today if the SSC hadn't lost its battle with the shortsightedness of lackwits in power...

Bob Nichols says

This is sort of an intellectual biography of Weinberg's career in (quantum) physics, and a pitch for the Superconducting Super Collider that was under consideration in the early 1990s. As with many other books for "general readership" in physics, a good part of this book is difficult to understand. Even so, there are several things that stood out.

Weinberg states outright that quantum mechanics, in contrast to classical mechanics, describes nature in terms of waves and probabilities, not particles and matter. Does this mean that ultimate reality is not matter and energy, but only energy? And are massless particles (e.g., photons) pure energy? Weinberg also states that electrons and electron forces inside of atoms leave no freedom for atoms to behave any other way. Does this mean that there is a directive, "inner character" built into the heart of matter and energy?

Weinberg provides a clear description of reductionism: "If you go around asking why things are the way they are, and if, when you are given an explanation in terms of some scientific principle, you ask why that principle is true, and if like an ill-mannered child you persist in asking why? why? why? then sooner or later someone is going to call you a reductionist." In reference to the reductionism of the early Greeks, Weinberg writes that "Atomism has roots in Indian metaphysics that go back even earlier than Democritus and Leucippus." This is the first time I've seen a reference to Indian metaphysics being connected to early Greek thinkers and could explain why the central (and non-atomistic) elements in Plato's metaphysics seem strikingly aligned with the Vedas.

In his own philosophical perspective, Weinberg states that we find no standards of value or morality in the laws of nature. Is this true? Is not the desire to live a value? Might our desire to live, and the other's desire to live, to seek and to defend, be the origin of our visceral belief in and attachment to freedom? Where does, after all, freedom come from? In the pursuit of freedom by all, might that necessitate, logically, a "golden rule" type of principle where it's in everyone's mutual interest to respect the freedom of others and to oppose inequality that lends advantage to some at the expense of others?

Weinberg states that science is "the discovery of explanations built into the logical structure of nature." How that "logical structure" got there goes to the heart of philosophical and religious questions. Weinberg doesn't see God involved as an explanatory factor in the laws of nature, and he objects to intellectual descriptions that strip God of its everyday meaning for most people. An interested God, a creator and lawgiver "is the God that has mattered to men and women throughout history," he writes. "Scientists and others sometimes use the word 'God' to mean something so abstract and unengaged that He is hardly distinguished from the laws of nature."

Weinberg's description of the various facets of quantum theory was particularly difficult to understand. It was a relief, therefore, to find this quote from him: "…I admit to some discomfort in working all my life in a

theoretical framework that no one fully understands.”
