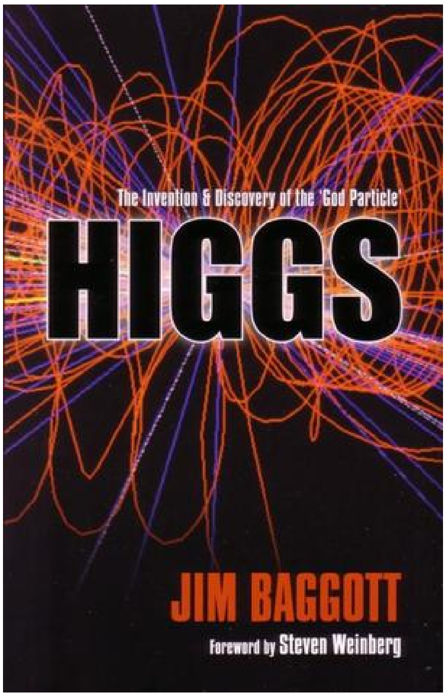

Higgs - The Invention and Discovery of the ‘God Particle’

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The hunt for the Higgs particle has involved the biggest, most expensive experiment ever. So what is this particle called the Higgs boson? Why does it matter so much? What does this "God particle" tells us about the Universe? And was finding it really worth all the effort?
The short answer is yes, and there was much at stake: our basic model for the building blocks of the Universe, the Standard Model, would have been in tatters if there was no Higgs particle. The Higgs field had been proposed as the way in which particles gain mass - a fundamental property of matter. Little wonder the hunt and discovery have produced such intense media interest.
Here, Jim Baggott explains the science behind the discovery, looking at how the concept of a Higgs field was invented, how it is part of the Standard Model, and its implications on our understanding of all mass in the Universe.

Higgs - The Invention and Discovery of the ‘God Particle’ Details

Date	:	Published September 6th 2012 by Oxford University Press (first published July 2012)
ISBN	:	9780199603497
Author	:	Jim Baggott
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Genre	:	Science, Physics, Nonfiction, History

From Reader Review Higgs - The Invention and Discovery of the ‘God Particle’ for online ebook

Dan Cohen says

Not a bad book, but I don't feel it will stand the test of time once the current excitement over the discovery of the Higgs boson is over.

It makes a good start with a discussion of Noether's Theorem about the connections between conservation laws and symmetries, but the discussion is not entirely convincing to a non-physicist - at least, it wasn't to this particular non-physicist. Subsequent references to the theorem hence feel like they have to be taken on trust, and this is not helped by the author resorting to references to "symmetry-breaking" without an explanation pitched at the right level intermediate between "pencil tipping over" and "lowest energy-state having less symmetry than higher-energy states". Symmetry breaking is such a core concept in the book that the author really ought to have looked for a way to explain this better.

The book also suffers from a sense of repetition as one particle (or set of particles) after another is discovered or predicted, when any lay reader will already be boggled by the particles previously mentioned. And then there's references to how certain theories give rise to new particles - why? The author needs to explain why such theories imply the existence of new particles. Especially because the Higgs boson is just such a particle.

On the positive side, the author writes well and there's plenty of good historical anecdotes. My review is a little negative because I found the book failed to help me advance my understanding - most of the explanatory content merely repeated simplistic stuff I already knew or repeated unfathomable stuff I had heard before but hadn't understood! I guess this isn't the book I'm looking for...

Krzy? Dz says

Fascynuj?ca ksi??ka na temat cz?stek, kwantów i ich odkry?. Opisuje równie? histori? i wyboje, które towarzyszy?y powstawaniu teorii, ??cznie z modelem standardowym i unifikacj? si?. Ksi??ka pisana przez fizyka, a nie dziennikarza wi?c posiada nietrywialne stwierdzenia poparte nieco technicznymi wywodami i definicjami. Bardzo dobrze i ciekawie opisany proces doswiadczalnego badania cz?stek za pomoc? akceleratorów w CERNie czy Fermilabie. Zdecydowanie polecam!

Aaron Thibeault says

*A full executive summary of this book is available here: http://newbooksinbrief.com/2012/09/02...

Up until very recently, news out of the European Organization for Nuclear Research (CERN) regarding the progress of the new Large Hadron Collider (LHC) had been slow in coming, and nary a major discovery had been announced. On July 4th, though, all of that changed. As on that day CERN announced the discovery of nothing less than the Higgs boson, the 'God particle'.

The potential discovery of the Higgs boson had been one of the principal reasons why physicists were so excited about the LHC; and therefore, within the scientific community the announcement was cause for a major celebration indeed. For most of the general public, however, while the announcement was certainly intriguing, there were many basic questions yet to be answered: Just what was the Higgs boson, and why had it been labeled the God particle? Why were physicists expecting to find it, and what did the discovery really mean? Adequately answering these questions was more than what journalists were able to do in their compressed news segments and newspaper articles--and, besides this, it was a task that many journalists were not up to regardless.

Jim Baggott's new book 'Higgs: The Invention and Discovery of the 'God Particle'' is meant to remedy this situation and provide the necessary context that the general public needs in order to understand the discovery of the Higgs boson and what it all means.

With impressive clarity, Baggott first takes us through the history of the development of the Standard Model of particle physics (which theory the Higgs boson is a part). He begins with the discovery that atoms are made up of the still more elementary particles of electrons, protons and neutrons. And then takes us through the discovery of the still more fundamental particles of quarks, leptons and bosons, and the 4 fundamental forces that govern these particles: gravity, the electromagnetic force, the weak nuclear force, and the strong nuclear force.

At every step of the way, Baggott is sure to explain what difficulties confronted the understanding of particle physics that was current at the time, what theoretical models were developed to overcome these difficulties, and the empirical evidence that was used to establish which theoretical model won the day. For instance, and of crucial importance here, is that--after learning of the 3 types of elementary particles, and the 4 basic forces--we learn that there was a problem with the then-current theory regarding the masses of the elementary particles--in that the 4 forces alone were simply unable to account for it. In order to overcome this difficulty, some physicists postulated that there must be a charged field pervading space, since such a field appeared to be the only appealing way to solve the mass mystery. This field was called the Higgs field.

The problem was that there was as yet no empirical evidence that the Higgs field actually exists. What physicists did think, though, was that if it did exist, it would imply the existence of a certain type of boson particle, dubbed the Higgs boson. What this meant is that if physicists could find the Higgs boson, they would have empirical evidence that the Higgs field does in fact exist, and the problem regarding the masses of elementary particles would be adequately solved. On July 4th, it was the discovery of this very particle that was announced, and Baggott takes us behind the scenes at the LHC to explain just what went into the discovery.

While the discovery of the Higgs boson solved one major problem with the Standard Model, there are a few others that have yet to be solved--including the hierarchy problem, and the problem of explaining gravity--and Baggott does touch on these issues as well.

Amazing science, wonderfully told. A full executive summary of the book is available here:
http://newbooksinbrief.com/2012/09/02...
A podcast discussion of the book will be available soon.

Linda Isakson says

Read this in preparation for an upcoming discussion on the Higgs Boson given by my local science club. This book gives a wonderful and engaging history of the physical, mathematical and intellectual hunt to complete the Standard Model of the atom, including the quest to discover if Peter Higgs was right all those years ago about the existence of a field which essentially gives matter its mass. While "Higgs" is a fairly easy read, in terms of writing style, I wouldn't recommend it for people who have not taken a basic physics or chemistry class. The author does not spend time explaining how atoms function, but assumes his readers already are familiar with such fundamentals. There are some mathematical explanations, but still intelligible for non-math majors. It will be interesting to see how our further understanding of atomic structure will translate into improved technological innovations. All-in-all, an excellent read for those interested in particle physics.

Jonathan Chuang says

Too brief for a history, and not good for learning any new physics. I'll stick to Abraham Pais' *Inward Bound* for now.

Manny says

I knew many individual pieces of the story of how the Higgs particle was discovered, but when I read this book I found that I didn't understand the overall picture nearly as well as I'd thought I did. Baggott does a very good job of tying it all together and showing you how a major scientific theory grows from a crazy idea you can't even get published into something that makes front-page news when it's empirically validated. He seems to know the science well - he's written a couple of other books on quantum mechanics - and he's clearly read a lot of background and talked to many of the people involved. There are some excellent anecdotes. The Manhattan project ran out of copper for the powerful electromagnets, and they had to borrow 15,000 tons of silver from the US Treasury; the standard metaphor for how the Higgs field works was the result of a challenge from then-Cabinet Minister William Waldegrave to describe it on one sheet of paper.

It's interesting to see that the plot becomes easier and easier to follow as it progresses; once they've got up to running the actual experiments and crunching the numbers, it all appears very clear, and he gives a convincing explanation of how it was possible to extract an unambiguous signal from such a huge amount of noise. (The raw data contained billions of interaction events; only a few dozen were relevant to demonstrating the existence of the Higgs). But going backwards towards the beginnings, it still seems mysterious to me. Three or four times, there is magic with representations of symmetry groups and renormalization, and somehow a new concept of the physical world emerges. I don't think it's Baggott's fault: I've seen several other people try to explain it in non-mathematical terms, and it doesn't seem to be possible.

The moral is painfully obvious. I need to read more *real* quantum mechanics.

Maša says

My brain hurts after thinking so much and so hard while reading this. Nevertheless I really enjoyed this book and almost cried at the end when they finally announced that it had been spotted.

Vy Tr?n says

Quá nhi?u ki?n th?c ?? có th? “nu?t” h?t trong m?t l?n . B?a nào ph?i ??c l?i m?i ???c :)))

Kantemir says

It's a fairly challenging book but definitely worth the time if you're interested in its topic. Baggotts writing makes complex concepts more accessible to a layman.

Jennifer says

Here's how much I loved this book. Within a week of finishing the copy I'd borrowed from the library (indeed, even before I'd returned said copy), I went out and bought a copy of my own. Because I need this on my shelves. Why? Well, as someone with an M.S. in physics, and whose research appointment as in relativistic heavy ion collions, I'm more frequently called upon than most to explain things like the Higgs boson. But before a month ago, any such request would be met with a deer in the headlights stare and a lot of handwaving. My research was more interested in the quark-gluon plasma. So, the strong force. And it has been a very long time since I read *The God Particle*, okay?

So it's no surprise at all that when I saw this book in the New Books section of the library on my way to the poetry aisle, it stopped me in my tracks. And while it took me a while to get into it, once I did I really geeked out on it, telling friends about cool things I'd learned, asking my professional physics friends questions and doing additional reading on concepts I wanted to understand better. I did work for this book. I'm invested in it. Of course I want to own it now.

Like most books about an emerging concept in science, this one is presented as a history of the idea. Baggott introduces a whole host of key players, many of whom I was previously unaware of. The major players get brief histories and character descriptions as well, and as a result even some of the names I knew I now feel I know much more about. (And now feel I have a better idea which of the books on quantum mechanics on my shelves will be more interesting.)

If all you're looking for is a brief description of what the Higgs boson and Higgs field are thought to be, let me recommend the minutephysics channel on youtube. But if you want a wider survey on how did we get to this moment, and why is it important, I heartily recommend this book.

BetseaK says

WARNING: My opinion of ‘Higgs: The Invention and Discovery of the ‘God Particle” by Jim Baggott is based on the Amazon sample of the book, which includes Prologue: 'Form and Substance', as well as on an executive summary I found @ newbooksinbrief.wordpress.com.

What I wanted from this book is a real explanation of what the Higgs field is and how the so-called 'massless particles' interact with it and acquire mass. In order to make up my mind whether to buy this book or not, I decided to 'taste' it first. I've just finished reading both the summary and Kindle book sample.

Both the sample and the summary of the book contain numerous physics concepts which I do not understand and it seems to me they are not well explained. Though I'm not a physicist, I've noticed lots of misleading things, logical fallacies and inconsistencies and my impression is that this book would fail to meet my expectations.

Among other things, the concepts of mass and energy are wrongly interpreted and misleadingly used throughout the book, which makes the explanation of the subject-matter highly confusing.

For instance, the first logical fallacy I came accross is Baggott's description of 'mass' in the very Prologue (loc. 227), which reads: "Mass, we now believe, is not an inherent property or 'primary' quality of the ultimate building blocks of nature. In fact, there is no such thing as mass. Mass is constructed entirely from the energy of interactions involving naturally massless elementary particles."

I can't help but wonder what the author wants to say with such description. A particle without mass does not exist. Besides, if there is no mass, there is no energy, i.e. capacity for performing any kind of interaction/work. If there's no such thing as mass, then I do not exist, and therefore I cannot buy and read the Baggott's book.

In Part I, Section 4 of the summary, entitled 'A New Understanding of Matter', I 'learn' that, as Baggott explains, 'the famous E=mc squared had it that mass is fully interchangeable with energy; and that therefore, mass is but another form of energy'.

This interpretation of Einsein's equation is totally wrong. The equation doesn't read E=m but E=mc squared, which makes a huge difference. In addition, if I have no mass (as Baggott's interpretation of the equation implies), how can I have energy, i.e. capacity to perform any work, including buying and reading this book?

And now comes the best. An explanation how the so-called 'massless particle' can acquire mass!
Quote from the summary:
'According to the theory, the Higgs field interacts with particles and slows them down in the process(loc. 1178). This makes it appear as though the particle has mass in itself, but truly it only acquires its mass through the nature of the interaction. The degree to which the Higgs field slows down any given particle (and therefore, the mass that that particle acquires) depends on the degree to which that particle interacts with the field.'

So, it appears that non-existant massless particles acquire mass because a charged field (the existence of which is to be confirmed by the Higgs bosone discovery) slows them down. What produces that charged field? Massless particles?! How can massless particles have energy to produce anything? These questions are giving me a headache and I don't like books which give me a headache.

Baggott further explains the process thus: "our instinct is to equate inertial mass with the amount of substance that the object possesses. The more 'stuff' it contains, the harder it is to accelerate. The Higgs mechanism turns this logic on its head. We now interpret the extent to which the particle's acceleration is resisted by the Higgs field as the particle's (inertial) mass. The concept of mass has vanished in a puff of logic. It has been replaced by interactions between otherwise massless particles and the Higgs field" (loc. 1189).

What logic does the Higgs mechanism turn on its head? What's 'a puff of logic' in which the concept of mass has vanished? Perhaps that 'puff of logic' is a sudden confession that the terms 'massless' and 'energy' are wrongly and misleadingly used throughout the book. My 'puff of logic' is telling me again not to buy this book.

On the other hand, it appears that this book contains a good historic review of attempts to discern a whole zoo of particles, some of which (bosons) are not considered as actual particles but carriers of force, and some of which (fermions) are considered as actual(matter)particles. For this reason I give this book 2 stars, which means: 'Ah, well, it's OK.'

To laypersons who want to read this book in spite of its faults, I highly, highly recommend first to read Felix Alba-Juez's book E=mc^2: The Most Famous Equation in History... and its Folklore (Relativity free of Folkore #1), at least.
Link: E=mc^2: The Most Famous Equation in History... and its Folklore

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Illiterate says

Baggott locates the CERN experiments in the history of particle physics.

Kain says

Bardzo dobrze si? czyta. Szczegó?owo opowiada o historii odkry? cz?stek fundamentalnych i praw nimi rz?dz?cych, prowadz?cych do odkrycia mechanizmu Higgsa i jego bozonu. O samym odkryciu ju? tak wiele jednak nie ma, wi?c tytu? troch? zwodzi.
Nadal nie wiem jak si? ma grawitacja i pole Higgsa, oraz jak odkrycie bozonu Higgsa ma si? na przyk?ad do teorii strun.

Brian Clegg says

Whenever someone famous dies or there’s a major royal event you will see a book arrive in the shops with undue haste. It’s hard to imagine it wasn’t thrown together with minimum effort – and with equally minimal quality. So when I saw that Jim Baggott had produced a book on the Higgs boson all of five weeks after the likely detection was announced following several years work by the Large Hadron Collider at CERN, it seemed likely that this too was a botched rush job. But the reality is very different.

In one sense it has to be a rushed job – the announcement was made on 4 July 2012 and the book was out by mid-August, featuring said announcement. So that bit of the book could hardly have had much time for careful editing, bearing in mind publishers usually take at least a couple of months from final versions of the text to having a physical book. (Much of the rest of the book was written well in advance.) But the remarkable trick that Baggott and OUP have pulled off is that the rush doesn’t show. This is an excellent book throughout.

The first, but probably not most important way it’s great is that it provides by far the best explanation of what the Higgs field is and how it is thought to work (and what the Higgs boson has to do with anything)

I’ve seen – and that by a long margin. However, for me it’s not so much that, as the way it provides a superb introduction to the development of the standard model of particle physics, our current best guess of what everything’s made of. Again, this is the best I’ve ever read and yet it’s here just as a setting for the Higgs business. It is really well done, and the book deserves a wide readership for that alone, not to mention the way it puts the Higgs into context.

Is it perfect? Well, no. Like every other book I’ve read on the subject it falls down on making the linkage between the mathematics of symmetry and the particle physics comprehensible. That is immensely difficult to do, but ought to be possible. However, as long as you take some of the symmetry stuff on trust, the rest works superbly well.

Congratulations, then, to author and publisher alike. Both in its timing and its content this is a tour de force. Recommended.

Review first published on www.popularscience.co.uk and reproduced with permission.

Erik says

Jim Baggott once wrote a lovely book about The Meaning of Quantum Theory (from Planck all the way to Bell) in which he said that you can't understand the physics without the philosophy. That was true of the early twentieth century and its physicist-philosophers (Bohr, Einstein, Heisenberg, Schrödinger) who laid the foundations of modern physics. In this blow by blow account of the standard model and the search for the Higgs, we see how the second half of the twentieth century saw the rise of a different kind of non-philosophical physicist, the brilliant "mechanics" who developed quantum theory into the most successful physical theory ever developed, crowned now by the discovery of the Higgs. I had questions that I suppose have not been answered yet, such as what happened to Einstein's famous principle of equivalence between gravitation and inertia. Inertia is due to the Higgs field and the force carrying boson, but gravitation awaits the discovery of a totally different hypothesized particle the graviton. So are they not the same after all? It sometimes seems that a search for all of these nuts and bolts in the erector set has replaced the elegant philosophical-scientific questionings of an Einstein or Heisenberg.
