



Totally Random: Why Nobody Understands Quantum Mechanics (A Serious Comic on Entanglement)

Tanya Bub , Jeffrey Bub

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Totally Random is a comic for the serious reader who wants to really understand the central mystery of quantum mechanics--entanglement: what it is, what it means, and what you can do with it.

Measure two entangled particles separately, and the outcomes are totally random. But compare the outcomes, and the particles seem as if they are instantaneously influencing each other at a distance—even if they are light-years apart. This, in a nutshell, is entanglement, and if it seems weird, then this book is for you. *Totally Random* is a graphic experiential narrative that unpacks the deep and insidious significance of the curious correlation between entangled particles to deliver a gut-feel glimpse of a world that is not what it seems. See for yourself how entanglement has led some of the greatest thinkers of our time to talk about crazy-sounding stuff like faster-than-light signaling, many worlds, and cats that are both dead and alive. Find out why it remains one of science's most paradigm-shaking discoveries. Join Niels Bohr's therapy session with the likes of Einstein, Schrödinger, and other luminaries and let go of your commonsense notion of how the world works. Use your new understanding of entanglement to do the seemingly impossible, like beat the odds in the quantum casino, or quantum encrypt a message to evade the Sphinx's all-seeing eye. But look out, or you might just get teleported back to the beginning of the book!

A fresh and subversive look at our quantum world with some seriously funny stuff, *Totally Random* delivers a real understanding of entanglement that will completely change the way you think about the nature of physical reality.

Totally Random: Why Nobody Understands Quantum Mechanics (A Serious Comic on Entanglement) Details

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From Reader Review *Totally Random: Why Nobody Understands Quantum Mechanics (A Serious Comic on Entanglement)* for online ebook

Christopher says

this is real life? this shit is crazy!

Nick says

In black and white, the graphics in *Totally Random* has a retro look, which I liked. I've read some popular books on quantum mechanics but they don't really explain, at least to me, why there's supposed to be spooky action at a distance, many universes, and so on. What I liked about *Totally Random* is that you get a feel for this by thinking about something concrete like coins. I liked the narration and the somewhat cheesy humor as for me it kept things light and broke up the story and was helpful but not too serious. Definitely worth reading if you are interested in quantum mechanics and aren't satisfied with the usual fare. I feel like I have a much better understanding than I did before I read it.

Ed Erwin says

Quantum entanglement described in comic-book medium, with no equations. Sounds difficult, but they pull it off pretty well.

Unlike many books on QM, they make little or no attempt to explain electron spin, the two-slit experiment, the uncertainty principle and the other stuff you might expect. The focus is kept squarely on entanglement and how that leads to non-locality, or instantaneous action at a distance. And really, that is enough! Entanglement is one of the weirdest things in QM, and non-locality is a really big deal. (The stupid cat does make an appearance, but it is done humorously.)

There are three sections. Section 1 describes a hypothetical device called a "Super-Quantum Entangler" which looks like a toaster but acts on coins to cause subsequent coin flips to obey certain rules. If coins (or anything else) did obey those rules you would be forced to conclude that they are sharing some connection even when separated: you'd be forced to accept that non-local interactions (of a certain sort) are happening. Section 2 describes various interpretations that have been proposed for QM over the years, but doesn't favor any particular one. Section 3 which talks about implications of the super-quantum entanglement. If you had some coins that behaved the way they do in section 1, you could instantly transmit an arbitrary amount of information by transmitting only one single bit of information across a classical channel.

I appreciate the fact that they skip the details of electron spin or photon polarization and replace it with a simpler system with simpler rules. But what is not made sufficiently clear, in my opinion, is that the super-quantum entanglement that their imaginary device produces is a simplified abstraction. That is why they call it super-quantum rather than quantum. As far as we know, no real physical system shows super-quantum entanglement. The fact that they simplified the probability calculations in no way invalidates the conclusion

that real QM systems show non-locality. It is simply easier to demonstrate with the simplified probability rules. But it is not clear to me whether the conclusions reached in section 3 follow from real quantum entanglement or only from super-entanglement. Someday, I'd like to dig into that question by going to the published articles, or maybe someone will write a clearer popular account of this newer area of "superquantum nonlocality" and "PR-boxes". (There is a website associated with the book which links to much of the relevant literature. Some discussion of this topic is also on wikipedia.)

I enjoyed this. That said, I'm not sure exactly who the target audience is. I already have a degree in physics and have studied QM quite a lot.

Final quibbles:

- 1) At one point they talk about making some concepts easy enough that even a comics reader can understand it. (When I find the exact quote, I'll edit this.) Why say that? If you are aiming a book at comics readers, why insult us? Comics is a medium that is capable of being as sophisticated as any other medium. Ninety percent of what is produced in any medium is garbage, probably, but comics are no different from any other in that regard and there are some very sophisticated comics.
 - 2) They use the head/tails state of a coin to represent one bit of information. Fine. But the coin they use is a US quarter, which is worth 2 bits of a dollar if you remember that one dollar equals 8 bits. (I may be the only person on Earth annoyed by this detail!)
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Peter Cipriano says

As a physics major that attends a private liberal art's college, Tanya and Jeffrey Bub's "Totally Random: Why Nobody Understands Quantum Mechanics" has given me a much stronger conceptual understanding of quantum entanglement. Through stories and pictures, they present key quantum concepts that are much clearer than what is often presented in college textbooks on quantum mechanics. Furthermore, Totally Random has given me the opportunity to fully internalize the concepts at a much easier pace than one of my past college courses.

I do wish, however, that Totally Random was a little more comprehensive in explaining quantum mechanics. In one of my past courses, much more attention was given to electron spin and Stern-Gerlach Devices. A considerable of my attention was also brought to the idea that particles can also propagate like waves.

Nevertheless, I suppose these ideas were pushed aside in writing this comic book because this book would have been made less accessible to people from non-physics backgrounds. It may also have taken away time to create their story.

Overall, I am glad to have read this book before I take my intro to Quantum Theory Course next semester.

Lauren says

The fact that I didn't understand most of what was happening in this book probably means that it was a success.

I did gain (a bit) more insight on quantum mechanics, as well as learned about the key physicists who

worked in this field over the last 100 years. The graphic novel format in such a complex theme is hard to pull off, but it worked pretty well. The humor and the strange illustrations helped it all along.

Ellen says

Totally Random was recommended to me by a professor who is planning to use it for a course on quantum entanglement. It covers some pretty challenging material but it does give you an idea of what entanglement actually is, what famous physicists like Einstein and Schrodinger thought about it and how it can be used in new technologies like quantum encryption, quantum computing and quantum teleportation. I enjoyed all the integrated quotes from the physics greats and even ended up downloading the famous Schrodinger cat paper as a result. Totally Random will give you a thorough overview of a difficult subject in an entertaining format.

Brian Clegg says

It's difficult to decide just where the problems start with Totally Random. It's an attempt to communicate the oddities of quantum entanglement using a comic book format. There has already been an attempt to do this for quantum theory in general - *Mysteries of the Quantum Universe*, which managed to both have a bit of a storyline and get in a fair amount of quantum physics. Unfortunately the format also got in the way - so much space was taken up by the pictures that the words simply didn't manage to get the message across. Doubly unfortunately, this is also true of *Totally Random*, with the added negatives that it has no discernible storyline and it's rarely even visually interesting.

The attempt to explain entanglement suffers hugely because Tanya and Jeffrey Bub decided to use a set of analogies for quantum entanglement ('quoins', a kind of magic toaster device that entangles them, various strange devices to undertake other quantum operations) that don't so much help understand what's going on, as totally obscure what's supposed to be put across. It's a bit like trying to explain the rules of football using a box of kittens. It's far clearer if you get rid of the kittens and just explain the rules.

Visually, the cartoon style varies considerably. There are quite a few pages that contain nothing more than a shaded background with a series of frames each having a line of text in it. It's just a dialogue where each character's words sit in a different frame - the comic format adds nothing to what is, often, a series of mutual insults, providing particularly 'you had to have been there' humour. My favourite parts of the visuals by a long way are the odd pages introducing a section where actual papers, such as the EPR paper are portrayed in realistic form. Those do look rather cool.

Most of the key characters of the quantum story turn up in cartoon format. We meet Schrödinger, Heisenberg, Bohr, Pauli, Bohm, Einstein - plus one or two more tangential individuals such as Everett. There are a lot of 'insider jokes' in these sections, where, for example, Einstein produces in conversation many of his better lines on quantum theory from his letters to Max Born. Unfortunately, unless you know the topic already, these in-jokes will mean very little and produce strangely stilted dialogue.

I think that summarises the real issue with *Totally Random*. It's very much an in-joke for insiders. It doesn't explain entanglement: to the general reader, it obscures it with a pile of baggage that you have to have been there to understand. And even then it can be hard work. I'm fairly confident in my understanding of

entanglement - I have a physics degree and I've read lots about it - but there were pages here I struggled to follow.

Sadly, the main feeling while reading *Totally Random* was tedium. With other graphic novel/comic presentations of non-fiction I've read, it has all been over far too quickly. Here I was thinking 'When will it end?' I was not inspired, but, rather, bored (or to sink to the level of the humour here, Bohred). It's a clever notion, but unfortunately the authors seem to be entirely the wrong people to make it work successfully.

Joel says

This book uses a novel approach to provide an excellent overview of quantum entanglement. YOU, the reader, get to figure out what's so weird about quantum mechanics by tossing a couple of entangled quarters (those hands on the cover are supposed to be yours as the reader is a central character in the book). If you're willing to go along for the ride, this book will twist your brain into knots, challenge your ideas about what constitutes a scientific explanation and give you real insights into why quantum entanglement remains one of the great mysteries of science to this day. There's no math in the book but it is a CHALLENGING read nonetheless as you have to follow the line of reasoning step by step in order to understand what's going on. If you are able and willing to do this you will be rewarded with insights into why Einstein thought quantum mechanics was incomplete, you will see how uncrackable codes can be created by exploiting quantum entanglement, learn what quantum teleportation ACTUALLY teleports and other such geeky delights that self identified science nerds live for.
