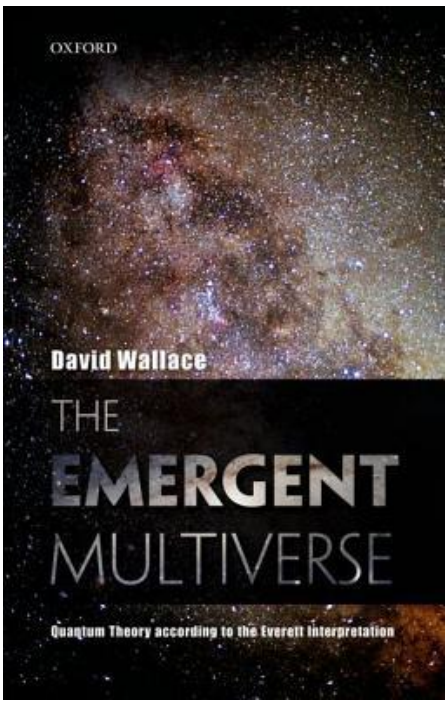

Emergent Multiverse: Quantum Theory According to the Everett Interpretation

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The Emergent Multiverse presents a striking new account of the "many worlds" approach to quantum theory. The point of science, it is generally accepted, is to tell us how the world works and what it is like. But quantum theory seems to fail to do this: taken literally as a theory of the world, it seems to make crazy claims: particles are in two places at once; cats are alive and dead at the same time. So physicists and philosophers have often been led either to give up on the idea that quantum theory describes reality, or to modify or augment the theory.
The Everett interpretation of quantum mechanics takes the apparent craziness seriously, and asks, "what would it be like if particles really were in two places at once, if cats really were alive and dead at the same time?" The answer, it turns out, is that if the world were like that--if it were as quantum theory claims--it would be a world that, at the macroscopic level, was constantly branching into copies--hence the more sensationalist name for the Everett interpretation, the "many worlds theory." But really, the interpretation is not sensationalist at all: it simply takes quantum theory seriously, literally, as a description of the world. Once dismissed as absurd, it is now accepted by many physicists as the best way to make coherent sense of quantum theory.
David Wallace offers a clear and up-to-date survey of work on the Everett interpretation in physics and in philosophy of science, and at the same time provides a self-contained and thoroughly modern account of it--an account which is accessible to readers who have previously studied quantum theory at undergraduate level, and which will shape the future direction of research by leading experts in the field.

Emergent Multiverse: Quantum Theory According to the Everett Interpretation Details

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From Reader Review Emergent Multiverse: Quantum Theory According to the Everett Interpretation for online ebook

Manny says

If you've been paying any attention, you must already have at least a vague idea of what the Many-Worlds Interpretation of Quantum Mechanics is about. For example, *Source Code* is a romantic movie treatment; *Transition* is an SF thriller treatment; and *The Grand Design* is a For Dummies treatment. There is not just a single universe, there are a huge number of them, and new ones are constantly splitting off.

But can something that's been this enthusiatically embraced by the SF community really be respectable? In his impressive book, David Wallace argues persuasively that it is. It's not merely a good alternative to conventional interpretations of quantum mechanics; he claims it's the only one that gives us a view of what's going on which makes intuitive sense, and doesn't involve the addition of unprovable or downright mystical ideas like "the collapse of the wavefunction" or "the essential role of consciousness". One's first reaction may well be to label this as paradoxical or willfully contrarian, but Wallace, who has PhDs in both physics and philosophy, lays out his reasoning with skill. Since it's easy to get lost in the many details, I will focus here on two clever analogies which he uses throughout. The first is the heliocentric revolution (Copernicus and Galileo); the second is dinosaurs.

Let's look first at the heliocentric hypothesis. The book opens with a thought-provoking quote from Wittgenstein: what would it have looked like if it had looked like the Earth went round the Sun? Stop and consider that for a moment. The answer, of course, is that it would have looked exactly the same. Every piece of factual evidence people had, which convinced them that the Sun went round the Earth, could equally well have been interpreted in the opposite direction. At the end of the day, the main reason why people were so slow to agree with Copernicus was a simple one. His idea was so goddamn weird that it couldn't possibly be correct.

Similarly with the Many-Worlds Interpretation. Wallace's argument is that this is just the most straightforward way to make sense of the underlying mathematics of quantum theory, which everyone agrees on. You look at what the equations tell you is going to happen when a superposed state (Schrödinger's cat, for example) is allowed to interact with other parts of the world. The result is that the cat's state becomes quantum-entangled with everything else, including any observer who may be present. The math represents this as the sum of two algebraic terms: one stands for the live cat, plus everything else in the world; the other stands for the dead cat, plus everything else in the world. The two terms rapidly "decohere", in other words cease to influence each other. The basic claim of the Many-Worlds Interpretation is that this is best conceptualized as saying that the universe splits into two copies. That's what the math seems to be telling us: why not believe it? Yet, somehow, most people seem reluctant to take this final step. It's too goddamn weird. What do they do instead? The most common alternative is "shut up and calculate": use the equations, since they certainly appear to work, but don't worry about what they mean. Indeed, throw out the question as irrelevant and positively distracting.

So over to the dinosaurs. As Wallace says, suppose people applied the same kind of reasoning to paleontology. There are fossils; everyone agrees on that. Fossils are bits of rock which you can touch. There are consistent patterns in many of these bits of rock, and the only sensible way of explaining these patterns is to say that their appearance is as it would have been if there once had been dinosaurs. Just about everyone agrees on that too. But suppose now that you're talking to a creationist petroleum geologist (I presume such people may exist), who stops at this point and says that there were in fact no dinosaurs; they are just a

theoretical device that helps us categorise fossils. You would have a hard time refuting this argument. Our hypothetical geologist would agree with everything you said about the links between fossils and dinosaurs, and in fact she would probably know rather more about it than you did, since it was part of her job. She just wouldn't agree that the dinosaurs *actually existed*. Needless to say, you would find this person intensely irritating; you would be sure they were wrong, even if you couldn't prove it. Well: the argument here is that we've been doing exactly the same thing in rejecting the Many-Worlds Interpretation.

Quite apart from the content, the style of the book is also interesting, and is constructed as an ingenious piece of homage to Wallace's great predecessors. Stylistically, Copernicus and Galileo were polar opposites: Copernicus was a dry, technical writer, and Galileo was an entertaining polemicist. Copernicus was extremely conservative, and worked entirely within the Ptolemaic system. (As Rovelli remarks in his recent book on Anaximander, no one could have loved Ptolemy more than Copernicus did). His intention was simply to show that Ptolemy's deferents and epicycles worked *even better* if you moved the Sun to the center of the universe. Galileo, in contrast, wanted to shake things up and introduce genuinely new ideas.

Wallace has daringly attempted to mix these two very different styles. Rather more than two-thirds of the book is Copernican, and consists of lengthy technical proofs; the most important ones have to do with the concept of rational behavior in the quantum multiverse, where it is easy to become confused and think that, since everything is going to happen in some branch, it makes no difference what you do. Wallace shows that this is absolutely not true. In fact, the concept of "branch weight" plays a role exactly analogous to that of probability in a classical theory, and rational agents end up doing what they would have done in a classical universe. Establishing this apparently trivial conclusion unfortunately requires over fifty pages of difficult mathematics. If all the book were like this, it would have been unreadable; despite its honored place in the history of science, it is notorious that hardly anyone has ever read *De revolutionibus orbium coelestium*. Wallace has addressed this problem by adding a parallel thread written in an engagingly Galilean style, where he explains the intuitive consequences of the ideas in everyday language. The layman will no doubt want more Galileo; on the other hand, the Copernicus is necessary to convince the many sceptical experts, none of whom appear yet to have detected obvious holes. It's a difficult balancing act, but he pulls it off well.

Should you buy *The Emergent Multiverse*? On the minus side, it's long, it's heavy, it's expensive, and there are large chunks you will most likely not understand. (There were, at any rate, large chunks *I* didn't understand). On the plus side, it's well-written, it's often funny, it will expand your mental horizons, and it's not impossible that it will turn out to be one of the pivotal books of the twenty-first century. I don't know how to weigh up these competing factors. You will just have to decide for yourself.

Simon Evnine pointed me to the excellent review here. If you're interested in learning more about the technical details, this is where to go.

It's hard to stop thinking about this book. The author makes a strong case for the reality of the quantum multiverse; if his reasoning becomes generally accepted, it is impossible to imagine how fundamentally it will change the way we view the world. At the moment, the evidence is of an indirect nature, as it was when the pioneers of the heliocentric revolution first proposed their idea. The math works out more sensibly when you posit that the Earth goes round the Sun; also, as Aristarchus had pointed out seventeen hundred years earlier, the Sun is evidently much bigger than the Earth, and it seems odd to have the big thing circle the small thing. Direct, smoking-gun proof didn't turn up until Bessel first measured stellar parallax in 1838, but by then the scientific world was already sure that Copernicus had been right. The accumulation of indirect evidence was overwhelming.

In the case of the multiverse, Wallace suggests that the next tranche of indirect evidence will probably come from quantum computing. If things progress a little further along the directions that are currently being explored, it will soon be possible in practice to solve problems with quantum algorithms that cannot be solved at all on conventional computers. People will routinely be writing quantum software and thinking about debugging and improving it. As Wallace says, the natural way to conceptualize some of these algorithms is that the computation is parallelized by sending subtasks into enormous numbers of parallel worlds, then retrieving the answer from the branch which succeeded. When tens of thousands of geeks are spending their working day manipulating the geometry of the multiverse, it will be difficult to maintain the polite pretense that it doesn't actually exist.

Wallace appears reluctant to delve too deeply into the moral and ethical aspects. He demonstrates that rational short-term betting behavior is the same in the multiverse and the classical world; given a choice between a 75% chance and a 25% chance, you should pick the 75% chance, irrespective of whether you believe that all the outcomes will happen in different branches, or that there is only a single world governed by the laws of probability. But in cases like the notorious quantum suicide thought experiment, it is not as clear that things are still the same. Wallace notes that death is "philosophically difficult", and explicitly advises philosophers not to discuss these matters in popular works. There is a striking resonance with the last chapter of *Time Reborn* , where Smolin expresses concern that belief in multiple universes may lead people to value less the one universe which we can directly perceive around us.

So maybe I shouldn't even be talking about this. But, as Eve said to Adam, those apples just looked so tasty...

Brendan McAuliffe says

(I understood the introduction , and that was about it)

Alexis Hall says

Convincingly and engagingly lays out the case for and consequences of the Everettian interpretation of quantum mechanics.

Probably kind of a niche interest ;)

Ron says

This book discusses the "natural" interpretation of quantum mechanics. Wallace does a fabulous job of addressing all the issues with the Everett Interpretation, including showing how the Born rule can be arrived at through a decision theoretic approach. Some parts of the book can be very technical and these can be skipped if you are not interested. The last chapter was one of my favorites, discussing various implications of the multiverse interpretation.

Carmelo Valone says

This is also a great book on Everett's Many Worlds theory and whenever you are done reading those primers by Kaku. The author has been working on the MWT for more than 20 years.

G.R. Reader says

David makes some slightly dubious assumptions in a couple of the proofs, and they could be more elegant, but all in all a remarkably impressive piece of work. I can't understand why there isn't more buzz. He needs to get himself a better agent.

Peter Mcloughlin says

This book is about the Many worlds interpretation of Quantum Mechanics. The author defends this interpretation showing that many of the problems with this interpretion like defining probablities in experiments suffer the same problems other interpretations of QM face. The author defends the Everettian (many worlds) interpretation as the one way of looking at QM that makes the fewest assumptions. The extravagant number of branching universes is defended via the analogy that assuming the points of light in the sky we see at night are other suns is outside our solar system is just as extravagant assumption with less evidence (we have stronger evidence of the existence of our solar system compared to other solar systems having probes that have reached those objects). We accept the evidence of other suns because it makes sense with the evidence we have collect on the light from stars and current theories. The many worlds of the Everettian interpretation are of the same status and we should not be concerned with multiplying universes any more than multiplying suns outside our solar system. The book itself defends the many world interpretation very well. It is really two books. One part of the book is a dense physical and mathematical academic treatment of The Everettian interpretation of QM which I have to admit I had a hard time following. The other half of the book interlaced in the same chapters is a down to earth clear philosophical agument that is easy to follow that defends the many worlds (Everettian) interpretation of Quantum Mechanics. I think the author could easily write a popular book on the same subject to reach a wider audience. I think he should.

Manuel Antão says

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

Falsifiable Multiverse: “The Emergent Multiverse: Quantum Theory According to the Everett Interpretation” by David Wallace

"Readers familiar with typical discussions of the measurement problem may be surprised that I have mentioned neither the 'eigenstate-eigenvalue link' nor the 'collapse of the hidden variables' theories.”

In “The Emergent Universe: Quantum Theory According to the Everett Interpretation” by David Wallace

Surprising statement to say the least. If one accepts the truthiness of the eigenstate-eigenvalue link it follows that if states are relative, then so are the values of observables. Not accepting this. What have we got here? If an observable has got a value at a certain moment, is that observable-relative or not?

Uhm…

A long time ago I remember Fred Hoyle asking "Are there any constants for all the universes?” I thought the universe was a put up job. There always being "something" is what shivers my timbers. I know they say energy is eternal but what is energy?

If you're into weird stuff, read on.

Christopher Elliott says

I get lost in much of the mathematics so it's not really a fair review. The arguments in prose are compelling but this just isn't a book for the layperson and it'll be a while before I can consider myself otherwise.
