Discussion questions for Becker's What Is Real? collected by Peter Bandurian.

Below are unedited questions/topic submitted to me from some of our membership. Please study them and attempt to prepare a response before the meeting. Thanks.

One complaint about the many-worlds interpretation is that the number of possible branches becomes infinite, making it impossible to recover the probabilities in the wave function. This is presented on pages 237 and 238 of the book. I can see that the number of possible branches gets extremely large, but I don't see how it becomes "infinite". So, maybe one of us can explain it better than the book.
Vlad

I didn't like (or perhaps I just didn't understand) our author's roulette wheel analogy. It always seems to be the case that when someone tries to analogize Bell's theorem, it is not understandable. But I sense that there IS a simple explanation out there to be found. As I understand it, Bell's idea is based on the difference between the functions cos(x) [entangled] and -x/2 [hidden variables]. Here is a table of values of the probabilities of a detector at angle x showing "up" for a particle prepared with spin up:

x	(1+cos(x))/2	1-x/π.
0	1	1
π/3	3/4	2/3
π/2	1/2	1/2
2π/3	1/4	1/3
π	0	0

The function values are the same for 0, π/2, and π, but differ for π/3, and that is the key. The question is, where do these functions come from, and if this really is the key, why did it take so long for this to be found? Seems like there must be a simple explanation under all of this somewhere, but it eludes me.
[Afer the discussion, Barry found the graph on p174 of Philip Ball, Beyond Weird.]
Barry

07/15/24 Meeting to discuss "What is Real" by Adam Becker

Questions and Issues for discussion submitted by Chela Kunasz

Our book (WisR) discusses the Copenhagen interpretation of Quantum Mechanics (QM) and various currently supported alternatives. WisR points out what most agree as well, that the Copenhagen interpretation itself has many variants. The words "real" or "reality" also have various descriptions.

1. What is a "measurement"? Measurement is crucial in the Copenhagen interpretation. Pg. 276 of WisR points out that a very common definition of this term in current textbooks is: "A measurement is defined as "any time a large object encounters a small one." It is assumed that classical objects are "large." Two separate worlds are assumed—the classical and the quantum. Is this the only current definition of "measurement" in quantum physics? What are other possibilities for this term in quantum physics, if any? See Sci Am "The Quantum Observer".
2. Our book (pgs. 276-7) points out that in practice, physicists believe quantum physics underpins classical physics, but although Bohr seemed to believe in a definite boundary, few subscribe to that now. When physicists conveniently forget this and treat some objects as exempt from the Shroedinger Equation and "shut up and calculate," what other options might they have? How do non-Copenhagen theories deal with the existence or non-existence or nature of "the boundary"?
3. Our book (pgs. 269-271) describes Zellinger's version of Copenhagen and

quote him as saying, “Measurement results live in a classical world. The quantum state is a “quantum world” which is only a mathematical representation” and are not (my CK words) objectively existing objects in our universe. But Zellinger also said that there was no fundamental boundary between these worlds. It seems Zellinger was attempting to distinguish classical objects as “really existing” in some sense that quantum objects do not. What do you think about that?

4. What do you think of Zellinger’s statement (pg. 271) that, “Distinction between reality and our knowledge of reality cannot be made.”

The next topic (pgs. 253-257) asks about “Many Worlds and Universes”

5. Gell-Mann and Hartle pointed out in their 1990 paper that opposed the Copenhagen interpretation, “Measurements and observers cannot be fundamental notions in a theory that seeks to discuss the early universe when neither existed.” they then presented a “one-world” version of Everett’s work and combined it with Zen, Joos, and Zurek’s work on decoherence to create a decoherence-histories interpretation of quantum physics. Does anyone in our group know more about this theory? It sounds very interesting.

6. On pgs. 254-256, the author writes about the effect of the emergence of much more precise data in cosmological science and much better computer simulations together producing great strides in the field. String theory arose and the concept of inflation arose, both seeming to point to a multiverse. Some postulated that Everett’s many worlds, string theories many possibilities, and inflation’s models were all different views of a

multiverse and many worlds. But issues concerning the central success of quantum mechanics' probability calculations presented a possible major problem. What is your understanding of the objection concerning probability that opponents of the theory presented?

7. On pg. 259 the author suggests that if probability is no longer about an observation in one world but rather the probability of being in a particular branch of many worlds it could solve the problem. But, he added, that answer is controversial. What do you think of that response? If you agree with the answer presented above, could it mean the many worlds only issue is that we humans simply cannot imagine the infinity of worlds (branches) that might exist? Note that in the many worlds interpretation, "when a quantum event with multiple possible outcomes occurs, the universe splits into different branches each representing one of the possible outcomes. The branches are separate and do not interact with each other."

8. Wikipedia's material on the "Many-worlds interpretation (MWI)" is very interesting. It says that this interpretation relates to physical reality. It asserts that the universal wavefunction is objectively real, and that there is no wave function collapse.[1] This implies that all possible outcomes of quantum measurements are physically realized in some "world" or universe.[2] In contrast to some other interpretations of quantum mechanics, the evolution of reality as a whole in MWI is deterministic and local.Many-worlds is also called the relative state formulation or the Everett interpretation.

It goes on to say that "In modern versions of many-worlds, the subjective appearance of wave function collapse is explained by the mechanism of quantum decoherence. Decoherence approaches to interpreting quantum theory have been widely explored and developed since the 1970s. MWI is considered a mainstream interpretation of quantum mechanics, along with the other decoherence interpretations, the Copenhagen interpretation, and hidden variable theories such as Bohmian mechanics. So it looks like since Quantum Decoherence is a theory that has been studied to understand how quantum systems convert to systems explainable by classical mechanics, this makes a lot of sense. It has to do with the loss of information from a system into the environment. (See more on the Wikipedia page on Quantum decoherence.) It looks like perhaps Gell-Mann and Hartle were on to something. What do you think? Are any of you knowledgeable on this subject?

9. It seems to me after reading this book and remembering others we have read and discussed, that we (as humans) have a ways to go to understand quantum physics. And, on pg. 285 in our book, the author says, "Nobody's had unequivocal success in building a theory of quantum gravity that doesn't break relativity" [See http://arxiv.org/abs/1407.4083]. We have more fundamental problems, perhaps interconnected. What is anyone's update on efforts in quantum gravity? Does anything in particular strike you as relevant to our understanding of quantum physics?

10. Pages 285-286 have a quick mention of "retro-causal" interpretations (Kastner? or?), t'Hooft's "superdeterministic" theory (a

local hidden-variable theory that has deep pre-arrangements between subatomic particles and experimental setups), and Penrose's modified Schrödinger Equation theory that has wave function collapse happen due to gravity "marrying general relativity and quantum physics in a novel fashion", and others (all, I think about which we have read in previous books). He also mentions that there are also problems with interpretations of quantum field theory (QFT) where the measurement problem and non locality are still there. The author added that the many worlds interpretation works with QFT, but there are problems for Bohm's pilot waves. Does anyone know more about the QFT issues?

Peter Below, page followed by paragraph number.

P40¶4: "Hitting an electron with a gamma can't alter the electron's momentum unless it has a momentum in the first place."! It appears to me that the Bohr/Heisenberg Copenhagen just fell flat on it's face!

P51ff: How was QED derived from Dirac's sea of negative energy particles? I just don't see (not "sea", hee-hee) the connection.

P110¶3ff: I had not realized Bohm's theory is non-local until I read it here. It is non-local because…?

P217: Why is the Bell experiment with the polarizers set only when the photons are in travel really an important one to do? Isn't this just a loophole-closing exercise? Does it really answer an important question?

P225¶1: Feynman speculates that one cannot really simulate physics without a quantum computer! Is this to suggest that we cannot simulate QM with a digital computer. In effect, do we need an analog computer?

This is http://www.sackett.net/BeckerRealQuestions.pdf.   Last updated 07/16/2024.