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D7(BH) Weekly Discussion

Erin O'Connor

Feb 27 at 12:16am

1 31

REVIEW INFO ON UPCOMING TEST and INFO ON CLASS EXPECTATIONS AND GRADING

- **Info on upcoming tests (and all tests for semester)**
- **Info on Class Expectations & Grading**

Due this week

First, be sure to do the reading and watch the lectures:
Assigned reading and lectures

Then answer the following questions in this discussion forum (and yes, you may look to see what others write, but try to find what they might have missed and you should go back to the original reading and lectures to get answers for yourself). Then post your own question at the end, and then answer someone else's question. If no question is available, go ahead and check back later until the due date. If nothing comes available you can then pick any question you wish.

We hope to emulate a seminar classroom environment where students can share ideas. Always be respectful with all communications you have with your esteemed fellow colleagues (your fellow students) in this course.

- 1. DISCUSS in some detail something you found unusually interesting or intriguing in the reading or lecture material. Are there new insights that you have gained (something you had not thought of or considered before)? Focus on one of the concepts and explain as best you can in your own words. (4 pts)
- 2. Post a question that you have about something you read. Be sincere. What do you want to know? Write the word QUESTION all in caps, so that your fellow classmates know what your proposed question to the class is. (3 pts)
- 3. ANSWER the question of another student according to what we discussed in the lectures or what you read in the assigned readings (don't just make something up). Try to answer a question that no one else has responded to yet (but not a hard and fast rule). A good way to respond to another student's question would be to say something like, "Good question! The answer can be found on page..." and give the quote from the reading. You are free to reference other sources outside of class material, but always consider the credibility of the source, state what the source is, and give the link. (3 pts)

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Reply

(https:/ Sarah Savage (https://canvas.sbcc.edu/courses/46681/users/375381)

Mar 5, 2022

DISCUSSION:
This week's homework has given me a much better feel for the concept of light as both a particle and a wave. Learning about how the electromagnetic spectrum is built into the atomic structure, how electrons move in wave-like orbits, and how the electron's levels of orbit function really pulled this together for me. Also, the idea that an electron can only exist at a certain level because its wave needs to be able to connect back to itself makes complete sense to me.

QUESTIONS:
Does this mean that a photon is a part of an electron that "fills" with energy then shoots it out or does the photon not exist until the energy is absorbed?
Is an electron also both a particle and a wave?

Reply

(http Victor Jensen (https://canvas.sbcc.edu/courses/46681/users/416476)

Mar 6, 2022

Apparently the question of if wave-particle duality applies to particles like electrons, just like it did for waves of light, was first asked by Louis de Broglie. Four years later, the Davisson–Germer experiment confirmed that electrons do behave like waves when reflected off a nickel crystal. This property was later used in vacuum tubes, which served as the heart of the first electric computers.

This property has since been expanded to apply to all particles. The energy determines the frequency via the Plank relation, and the momentum determines the wavelength via the de Broglie relation.
Wikipedia article on the subject
(https://en.wikipedia.org/wiki/Davisson%E2%80%93Germer_experiment)

Reply

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

Very good question. I do not have an answer for you. I like to go to the source itself, to hear what Feynman and Hawking and Einstein stay, because in how they choose to explain things there are insights into deeper Concepts. So the idea of whether the photon is created and destroyed, rather than just combining with the electron, this is a very interesting question. My understanding is that it ceases to exist and the energy is stored in the system when the electron jumps to a higher energy level, but there is nothing visual for us to latch onto that makes any sense. That it somehow absorbs the photon and then somehow it creates the photon, but it's not really holding on to the photon in between. But, what do I know? We'll have to keep looking at what these great scientists themselves have to say about it.

Reply

Victor Jensen (https://canvas.sbcc.edu/courses/46681/users/416476)

Mar 6, 2022

The fact we can never observe all the physical properties of any object is interesting. Sometimes it's far too easy for humans to forget that we are a part of the system we are trying to observe, and that there are hard limits for what we can physically do.

I can also definitely recommend going to the Wikipedia page for the Uncertainty Principle and reading about Einstein and Bohr going back and forth, with Einstein desperately trying to think of a way to circumvent the uncertainty principle. Often with his arguments being defeated by his own works.

QUESTION: According to Wikipedia, the Uncertainty Principle is not unique to quantum mechanics, and has been observed in all wave systems. They state that it is, therefore, not an issue of measurement that can eventually be overcome but an inherent physical property of all wave systems. What exactly does this mean?
They also mention the Gibb's Paradox, which states that the Uncertainty Principle violates the thermodynamic rules of entropy by creating a non-zero probability that a system's entropy would decrease. The Gibb's Paradox suggests changing the definition of entropy to account for this. Has this paradox been solved? Wouldn't changing the rules of thermodynamics to allow spontaneous decreases in classical entropy cause issues for many theories of physics?

Reply

(http

Brian Wolden (https://canvas.sbcc.edu/courses/46681/users/274832)

Mar 6, 2022

In regards to the uncertainty principle, I believe this means that the problem in measuring both position and velocity is not a problem with our technology but is a function of physical principles. So even if we get better at measuring things, we still can't observe both directly at the same time. This is, in part, because as the instrument we use to measure things on the quantum level (photons) becomes more precise (smaller frequency), it also increases in energy and therefor has more of an effect on the thing we are measuring.

In regards to Gibb's Paradox, it looks like the paradox is resolved by defining the ability of the observer to distinguish the gasses. I don't fully understand this explanation but it seems like it has something to do with the ability of the observer to distinguish work (displacement through force) in the mixing of the gasses with an observer who can distinguish the two gasses being able to extract work where as the "ignorant" observer can't. I am assuming that the extraction of work necessitates an increase in entropy, thereby resolving the paradox but again, I'm by no means sure of that explanation.

I also found this article in Nature suggesting that at the quantum level, the ignorant observer can also extract work:

https://www.nature.com/articles/s41467-021-21620-7#:~:text=The%20classical%20Gibbs%20paradox%20concerns,extracting%20work%20by%20mixing%20them (https://www.nature.com/articles/s41467-021-21620-7#:~:text=The%20classical%20Gibbs%20paradox%20concerns,extracting%20work%20by%20mixing%20them).

Very interesting question and paradox! I'd love to understand more of what is going on both in the paradox and in the resolution, so I'll be looking into this further!

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

Very well-researched and thoughtful responses. We will talk more about thermodynamics and entropy in the weeks to follow, but you can have the entropy go down locally as long as the entropy increases in the larger system as a whole. So for example, us humans are an apparent violation of the laws of entropy, but our existence creates so much chaos and disorder around us, so that the overall amount of entropy for the universe always increases.

Reply

Luke Rutherford (https://canvas.sbcc.edu/courses/46681/users/373514)

Mar 6, 2022

DISCUSSION:

Something that I found incredibly interesting is that quantum mechanics doesn't predict one result from an observation but instead, predicts all the different outcomes and the likelihood of each one. This interests me because it includes randomness in experiments.

QUESTION:

If quantum theory is so successful and agreed with experiments why did Einstein object to the theory? Was it solely on the fact that chance was involved?

Reply

Franco Diaz Campo (https://canvas.sbcc.edu/courses/46681/users/403036)

Mar 6, 2022

Hi Luke!

I don't know the exact answer of it, what I can say is that Einstein had a fascinating mind, and how all the videos we have seen before of him, many of his theories were viewed for him as visual experiments, that might be a reason why he objected it, since he might haven't seen it possible.

Outstanding job!

Reply

Lucca Gambone (https://canvas.sbcc.edu/courses/46681/users/405319)

Mar 7, 2022

"God does not play dice"

Reply

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

Yes, he specifically objected to the statistical nature of quantum mechanics. His famous quote is "God does not play dice with the universe) or something like that. We will talk about Schrodinger's Cat later in the semester which explores these concepts further.

Reply

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

Despite the fact that quantum theory has been confirmed over and over again by ever increasingly accurate experiments, Einstein objected to it simply on fundamental conceptual principles. He just couldn't believe that the Universe was not deterministic, that with everything that happens, uncertainty exists with every physical interaction.

Reply

Franco Diaz Campo (https://canvas.sbcc.edu/courses/46681/users/403036)

Mar 6, 2022

DISCUSSION:

Hi everyone!

I think this was a perfect week in terms of fundamental physics concepts. We studied many concepts like light, waves, the temperature, among others. These concepts are essential to know more about physics, and I enjoyed it since they are topics that we have all seen before at any point in our lives, and I found it very cool that we had the opportunity of studying them again. I also liked the Zoom meeting we had this week; it had many exciting things and helped us love physics a bit more every day.

QUESTION:

How important do you think it is to review essential physics topics many times?

Reply

Abigail Jacobs (*She/Her*) (https://canvas.sbcc.edu/courses/46681/users/367167)

Mar 6, 2022

Hi Franco!

For me personally, I need a refresher everyone once and a while especially when learning new stuff all of the time. I would say at least 2 times before major text or quiz but adding old concepts and ideas into new material always helps me!

Reply

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

It's always good to review fundamental physics concepts again, since there are different ways to approach the questions and when it comes to Quantum Mechanics it's so difficult to grasp and understand. QM isn't intuitive, so you have to go over it several times so that you can train your mind to develop an appreciation or understanding of the more complex fundamental concepts.

Reply

Brian Wolden (https://canvas.sbcc.edu/courses/46681/users/274832)

Mar 6, 2022

DISCUSSION

Unsurprisingly, one of the things I found most interesting about this weeks material is the double slit experiment and the physical and metaphysical consequences thereof. The double slit experiment demonstrates that light can best be explained by thinking of it as both a wave and a particle. In the experiment, light is shone at a panel with two vertical slits a short distance apart cut into it, with a photoreceptive panel on the far side of the panel containing the slits. If light were made up of particles, the photoreceptive panel would show the light hitting it in a pattern like those we would see if any other larger matter (bee bees, marbles, etc.) were to pass through the slits. The result would be two vertical lines similar in size and shape to the slits. This is because any particles blocked by the slit panel wouldn't be able to pass through and leave a mark on the photoreceptive panel, just leaving those particles that happen to pass through the slits. This is similar to painting over a stencil onto a piece of paper; the paint outside the hole in the stencil can't make it onto the paper. However, what actually happens with light is that the photoreceptive panel shows a pattern we would expect from a wave passing through the two slits. When a wave passes through a double slit, the waves resume on the far side of the panel and cause destructive and constructive interference, creating areas of concentration and areas of no light reaching the pattern. Moreover, this pattern persists even when single electrons are fired at the panels one at a time, suggesting that the electron is passing through both slits and interfering with itself! Things get really weird

is when scientists attempt to determine which of the two slits the electron actually passes through. When this happens, the observation of the wave causes it to collapse resulting in it then behaving as a particle, not a wave! This demonstrates the uncertainty principle and the idea that the very act of observing (or measuring) something alters the thing being observed.

QUESTION

One thing that I am still unclear on is what constitutes measurement or observation that then results in the collapse of the wave function into a particle. Are these experiments performed in a vacuum without any input from the outside world, meaning that observation just means any sort of interaction, or is something more required? Can other light waves (or individual photons) interact with it causing both to collapse? If so, does that mean that interference from other light waves result in a collapse? My assumption is that light basically "moves" as a wave and becomes a particle the moment it interacts with anything else but that would mean that light is basically always a particle when on Earth and interacting with our atmosphere and I'm not sure if that is correct...

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

That's a very good question, the question about what constitutes an observation that would collapse the wave function. The short answer would be that yes, the experiments are done in evacuated tubes with no light, but I myself am a bit perplexed because I believe you would still get the double-slit interference pattern if you were doing the experiments even with light shining down on the electrons, but with lasers or whatnot, but I don't really know. That would be something to research.

Reply

(https:/

Abigail Jacobs (*She/Her*) (https://canvas.sbcc.edu/courses/46681/users/367167)

Mar 6, 2022

Discussion:

Through this week's reading and lectures, I found the two-slit experiment the most interesting in chapter 4. The idea is that light and matter can display characteristics of both classically defined waves and particles. The light source goes through the two slits and makes a pattern on the space behind, the middle being the boldest, and as there is more space, particles, and waves it spreads out with each outer line getting fainter. This is a crazy experiment to be

because when thinking logically about this concept there should only be 2 lines but quantum mechanics is able to prove us wrong!

Question:

If one was to travel at the speed of light, how long would it take to get to the nearest galaxy?

Edited by **Abigail Jacobs** (https://canvas.sbcc.edu/courses/46681/users/367167) on Mar 6 at 10:45pm

Reply

(http

Lexie Brent (https://canvas.sbcc.edu/courses/46681/users/122267)

Mar 12, 2022

Hi Abigail!

I was also super interested in the two-slit experiment! To answer your question, the nearest galaxy to Earth's spot in the Milky Way is thought to be the Canis Major Dwarf Galaxy. It's about 25,000 light-years away so it would take about 25,000 years to get there traveling at the speed of light.

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

People often wonder what would happen if one were to travel the speed of light, but it's the wrong way to approach that question. Since it can never be done, according to Einstein's laws of physics, it means nothing to say what if we were traveling the speed of light. It would be as if we said how did you feel before you existed, before you were born? It's not an answerable question. But what you can do is ask what would things be like as we approach the speed of light and got closer and closer to the speed, mathematically you would say that you asymptotically approach the speed of light. Then you can see what would happen and you would find that the length of the rocket ship would shrink, your mass would go to infinity, and time would slow down almost to stop, but wood never fully stop because you could never actually go to speed of light (which is when it mathematically would stop).

Reply

(https:/

Malcolm Tircuit (https://canvas.sbcc.edu/courses/46681/users/427388)

Mar 6, 2022

DISCUSS:

The idea of superposition completely stunned me. I think I still don't fully understand it yet. The fact that by looking at something on a quantum level changes its velocity must have made it really hard to measure observe particles. Also, learning about wave interference was very interesting. I had no idea that's how headphones create noise cancellation.

QUESTION:

The idea of a superposed state got me thinking. Like Schrodinger's cat, I was wondering if two realities themselves could be existing inside the same universe at once while not existing on a quantum scale. Could (for example) I seem to have two coffee cups instead of one because one is in a superposed state where I both have moved it and not moved it creating the illusion of two?

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

The idea that we are coexisting with all these different universes is very intriguing. I'm not sure the coffee cup example works because the states are supposed to be pretty well-defined as part of the same system, not necessarily just different locations you can move a coffee cup too. But these are the tricky questions that we must try to get answers from the great scientists themselves, Feynman, Einstein, Hawking. But you've made a good start. Keep up the good work and before I know it, I'll be quoting you in class for future discussions! :)

Reply

(https:/

Naomi Xu (https://canvas.sbcc.edu/courses/46681/users/27955)

Mar 7, 2022

DISCUSSION

I really strongly disagree with Occam's Razor, the idea that you cut out all work that isn't "necessary", with the example that we shouldn't try to prove the existence of parallel universes, just because we have no means of detect, find, or interact with them. I think that's an incredibly short sighted way to view science. Proving that we are actually heliocentric, that

the stars in our sky aren't fixed, finding the limit of the speed of light, the list goes on but all of these have the same "necessity" factor as us now trying to prove parallel universes. I used quotation marks around "necessity" because I think every step has been and will be necessary, even if we make wrong predictions, that's not time and energy wasted, ether was such a success of a failure. There is no necessary reason for us to find any meaning beyond our little mundane lives, but we choose to (if we even have free will, otherwise it be so cool to imagine if every astrophysics discovery was us one step closer to ending the simulation, or just breaking out of 3D).

QUESTION

This question isn't really related to our reading material but during the astronomy club meeting, the speaker mentioned different people or groups present their project every 10 years and explain the importance of furthering that field to get funding.

What's an astro related field/ project/ technology/ equipment/ anything really that you hope to see get funded more or that you're just interested and invested in?

Reply

(http

Lucca Gambone (https://canvas.sbcc.edu/courses/46681/users/405319)

Mar 7, 2022

Something I would like to see would be hover cars or cars that can easily become a spaceship and you could zip around space but also fly it back to earth and transform it back to car form and drive it to work.

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

I like what you say here. We have to always want to learn about the fundamental questions even if we don't think they apply to anything practical or even measurable. Einstein said we would never measure gravity ways, and here we are less than a hundred years later measuring gravity waves. I also like the proposal that parallel universes allow gravity to leak into our universe, and that can explain dark matter. So, you see, lots of examples of why we should continue to search for understanding of things even if they seem un-understandable.

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

About your funding question. Gosh, there are so many interesting things that would be great to see funded. I'm excited about a couple of spacecraft missions that are being planned. One of them is a multi phased trip to Europa, first to land and Survey, secondly to then melt a probe through the ice and have it swim around in the ocean underneath. I think that's pretty exciting and that is progressing as an actual project. Another project I would like to see is to send a spacecraft to Titan and have it float around in the atmosphere taking pictures, which would be easy to do because of the thick atmosphere. You wouldn't need to have a helicopter or something.

Reply

(http

Malcolm Tircuit (https://canvas.sbcc.edu/courses/46681/users/427388)

Thursday

I would really like to see the human race go to and live on other planets. That already has a lot of funding though.

Reply

(https:/

Lucca Gambone (https://canvas.sbcc.edu/courses/46681/users/405319)

Mar 7, 2022

Something I found interesting about the reading and lecture material, is when Richard Feynman described that a particle is not supposed to have a single history or path in space-time, as it would in a classical, nonquantum theory. Instead it is supposed to go from A to B by every possible path. This I found interesting because, it relates to the theory about a multi-verse, one of my personal favorites. Just like the Richard Feynmans approach to the movement of a particle, and how it goes from A to B by every possible path, the choices we make in our day to lifes could happen in every possible way, according to the multiverse, that there is an infinite amount of outcomes for each action, but it at the end of it all the deciding factor of which outcome happens is based on choice and chance. That is my idea at least, now my question is

If there is a multi-verse, where for each action is there is an infinite number of outcomes for it, would there be a way to travel to different multiverse's, is there a way to see all possible outcomes, or even choose the outcome you desire for a particular action?

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

The idea of a Multiverse is a far more reasonable idea than most people might imagine. I'm hoping to get a UC Professor friend of mine to join us for a zoom chat and he is able to lay out an argument that mathematically supports, if not proves, the idea that there must be an infinite number of parallel universes and we happen to live in just one of them. The sum over histories Feynman formulation plays into this in that the different decision branches could play out as different parallel universes.

Reply

(https:/

Lexie Brent (https://canvas.sbcc.edu/courses/46681/users/122267)

Mar 12, 2022

I love that everyone, including scientists, must admit that they don't fully know how quantum mechanics works. It's nice, in a way, to know that there are things in our universe that we can't understand and maybe we just aren't meant to. The double-slit experiment is really intriguing for that reason! It seems almost like a magic trick, where the electron is the magician and it "knows" things we don't and therefore behaves a certain way.

QUESTION: How is it possible that scientists can make only *one single* electron do the double-slit experiment? Do you think we'll ever be able to trick the electron into not knowing we're there by somehow detecting it without interacting with it? (I almost hope it stays a mystery hahaha)

Reply

(http

Erin O'Connor (https://canvas.sbcc.edu/courses/46681/users/24247)

Mar 27, 2022

Yes, the double slit experiment it is very mysterious and very intriguing. No, we will never be able to trick the electron so we know which slit it went through because that is what the laws of physics say, that if we ever know where it is, it has to behave like a particle. They say the wave function collapses. There always has to be some kind of interaction for us to

know where it is, either an electric field or a magnetic field or photons have to bounce off of it or something. But it seems impossible, and I share in your frustration.

Reply

Naomi Xu (https://canvas.sbcc.edu/courses/46681/users/27955)

Thursday

I like to think the same reason particles know they're being observed is the same way we feel "watched", often we can feel like someone is looking at us and they almost always are.

Reply