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D14(BH) Weekly Discussion

[Erin O'Connor](#)

Apr 23 at 2:19pm

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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)



[← Reply](#)**Alak Fryt (He/Him)** (<https://canvas.sbcc.edu/courses/46681/users/354278>)

Apr 29, 2022

DISCUSS: I found it interesting to read about string theory, I've known about the concept for a while now but I've never understood it and so it was nice to kind of get a glimpse as to what string theory is about. While I still don't really understand the complexities of string theory or the newer heterotic string theory, I think it's still interesting to think about and try to comprehend. It's hard for me to comprehend what exactly these pieces of string are but it is intriguing to think of the particles as waves that travel along this infinitely long string.

QUESTION: Do the strings or the world sheet wrap around the entire universe?

[← Reply](#)**Luke Rutherford** (<https://canvas.sbcc.edu/courses/46681/users/373514>)

May 1, 2022

Hi Alak,

I'm not completely sure what is being asked but I believe that world-sheets are open/closed strings that exist within 2 dimensions, space and time.

[← Reply](#)**Erin O'Connor** (<https://canvas.sbcc.edu/courses/46681/users/24247>)

Wednesday

Very thoughtful responses. I think many people have heard of string theory but very few have any idea what it's all about. It's about these tiny strings vibrating in harmonic or resonance modes. But remember, it's tiny strings, not infinitely long strings. There are superstrings, which are giant structures on the scale of the cosmos, but that's a different thing.

[← Reply](#)

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

Apr 30, 2022

**DISCUSS:**

While I love the idea that there could be a Grand Unification Theory for the laws of physics, the universe is so complex that having just 1 theory that applies to everything feels far-fetched despite the fact that 1 theory would be the simplest foundation. After going through all of this week's material, I find myself gravitating toward the 2nd possibility that Hawking proposed — that there is no ultimate theory, but rather just a sequence of theories that can be compiled like a collection of maps to view the whole picture. In pursuit of a GUT, it feels like scientists have overcomplicated their ideas in order to reach a simple string. Then they've complicated the string by turning it into a membrane. I keep thinking, "what about Occam's Razor?" A single theory is simple but should the process of reaching it be so complicated? Mathematics that humans can't approach and would take 4 years for a computer to solve? Maybe the universe is too complex to boil down into just one thing.

Additionally, the concept of a membrane also feels derivative of the concept of the fabric of space-time. Could the fabric be made of these strings? I'm a visual learner and not being able to see an example is difficult for me. I'd like to get a better understanding of how the string membranes arrange themselves to make a quark.

String Theory feels like it's making things more complicated.

QUESTIONS:

Do you think that scientists may have guided us down the wrong physics path by including man-made constants in their equations?

So now we have strings... what is making them vibrate? What makes them stick together as a membrane? If they're stuck together, wouldn't the vibration of one be felt all down the membrane?

← [Reply](#)

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

Wednesday



Excellent questions. Very in-depth and building on the foundation of the physics that we have learned this semester. I also struggle with the idea that these strings are simplifying things, especially when they are so complex we can't even understand them. I'm looking forward to hearing what physicists and string theorists will come up with next.

← [Reply](#)



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

May 1, 2022

DISCUSS:

The concept that some infinities can be greater than other infinities was really intriguing to me. It's weird to think about that. I also found the thought that extra dimensions are rolled up inside our universe really interesting. The analogy of rolling up a piece of paper made me understand it better. Also, the thought that the only objects that exist inside these higher dimensions are on a quantum level. The material this week made me excited for what's going to happen in the future because seeing how far we have come with only a few hundred years of science makes me think what's gonna come next must be really exciting.

QUESTION:

Could there be other forms of life that we are not yet aware of that could potentially exist in higher or lower dimensions?

[← Reply](#)



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

May 1, 2022

ANSWER

Hi Malcom,

I think it could be possible, I think we don't know as much of the universe, and I could predict that this will change through the years, and we will have more knowledge about all things surrounding us.

[← Reply](#)



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

Wednesday

That's great to hear that you are excited about the possibilities that all of this crazy higher-dimensional advanced physics has to offer. And yes, wouldn't it be intriguing if there are

some type of life-forms that can only exist in these higher dimensions and we are not even aware of them. Wow!

← [Reply](#)



Naomi Xu (<https://canvas.sbccc.edu/courses/46681/users/27955>)

Thursday

Often in our history (and some present tbh) religion and science clash heads but take Christianity for example, their God knows them their whole lives no matter what age they are, it knows everything you've done and will do, which sounds exactly like the perspective of a high dimension. Remember in Flatland, the way a high dimensional being as able to see a whole extra axis, and apply that to us, which would make a high dimensional being to us see all of our time at once.

← [Reply](#)



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

Thursday

That's a great perspective, that God is a higher dimensional being.

← [Reply](#)



Franco Diaz Campo (<https://canvas.sbccc.edu/courses/46681/users/403036>)

May 1, 2022

DISCUSSION

Hi everyone,

I hope you enjoyed this week's assignment like I did! It was an exciting week; we had a great meeting with a UCSB professor, we saw the solutions to the most missed questions, which helped a lot because I didn't know many of those answers, we saw the String theory, which was quite interesting, and many things that made this an exciting week. I find very different this week's meeting, and it was more natural than the others; I think the format of doing a presentation and showing it to us didn't happen; it was very different from what we've been accustomed to.

QUESTION

What do you think about the String Theory?

← Reply



Abigail Jacobs (She/Her) (<https://canvas.sbccc.edu/courses/46681/users/367167>)

May 1, 2022

Hi Franco!

First of all, I think this is actually a really interesting question! I don't know why but thinking about things on a smaller than atoms basis freaks me out and scares me a little. Thinking that everything is made up of incredibly small vibrating strings is something that I can't wrap my brain around. If this is a theory proven to be true with future technology, I think a lot of other ideas or discoveries that we have made will be questioned.

← Reply



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

Wednesday

Glad to hear that you enjoyed this week's activities. Where near the end of the class and so String Theory sort of ties things up (haha.. no pun intended), in that it is a grand unification theory that is very promising and is our best bet for unifying general relativity with quantum mechanics. But, we aren't quite there yet and have a long ways to go still.

← Reply



Luke Rutherford (<https://canvas.sbccc.edu/courses/46681/users/373514>)

May 1, 2022

DISCUSS:

I find it interesting that even if humans find out all there is to know about physics and the laws that govern our universe we still would not be able to predict the future. It is also interesting that we would have no way to prove that we do understand all there is about the universe because there would be a limited amount of observations to test it.

QUESTION:

Hawking states that he believes that there's a good chance a complete unified theory can be developed soon, so my question is what is the last step/discovery that shows we know all that we can?

← [Reply](#)



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

Wednesday

Although Hawking says he thinks we can develop a Grand Unification Theory soon, that's something where I disagree with him. I think the more we learned of the universe, the vaster and more complex it seems to get, and the more elusive a Grand Unification Theory seems to become. It's like a paradox, the closer we get to an answer, the more the answer recedes away from us.

← [Reply](#)



Abigail Jacobs (She/Her) (<https://canvas.sbccc.edu/courses/46681/users/367167>)

May 1, 2022

Discussion:

As time goes on the universe will change color, it will get red and dim because of the dying and or dead stars. The long-lived red dwarfs will be the last to survive. The degenerate era is the cooling and dying of stars, the stars will cool or they will come together and make an extremely bright reaction. As the universe expands our view gets smaller, that is crazy to me! I find this era to be the most interesting because a huge change will be happening to the universe and we probably won't be here to see what happens. Black holes can leak mass... what!?

Question:

Will earth even exist when the degenerate era comes around?

← [Reply](#)



Brian Wolden (<https://canvas.sbccc.edu/courses/46681/users/274832>)

May 1, 2022

Hi Abigail,

As far as I understand it, the Earth will probably lose all its water in the next 1.5 billion years due to the increasing energy output of the Sun. Apparently this is actually an improvement over the previously though 700 million years! You can read about that in the article below:

[https://www.science.org/content/article/earth-wont-die-soon-thought#:~:text=The%20upshot%3A%20Earth%20has%20at,the%20polar%20regions%2C%20Wolf%20suggests_\(https://www.science.org/content/article/earth-wont-die-soon-thought#:~:text=The%20upshot%3A%20Earth%20has%20at,the%20polar%20regions%2C%20Wolf%20suggests\)_.](https://www.science.org/content/article/earth-wont-die-soon-thought#:~:text=The%20upshot%3A%20Earth%20has%20at,the%20polar%20regions%2C%20Wolf%20suggests_(https://www.science.org/content/article/earth-wont-die-soon-thought#:~:text=The%20upshot%3A%20Earth%20has%20at,the%20polar%20regions%2C%20Wolf%20suggests)_.)

I would say that, if humans are still around, we may have technological solutions to deal with that specific problem at that point. When talking about technology millions of years in the future, I think it's impossible to predict what will be possible.

According to the below article from Universe Today, in about 5.4 billion years the Sun will leave its main sequence phase and become a red giant (I thought I had heard later estimates than this during this or my EARTH 101 class, but it is close enough for this discussion). At this point, the Earth could be engulfed by the Sun and be burnt to a crisp.

<https://www.universetoday.com/12648/will-earth-survive-when-the-sun-becomes-a-red-giant/> [\(https://www.universetoday.com/12648/will-earth-survive-when-the-sun-becomes-a-red-giant/\)](https://www.universetoday.com/12648/will-earth-survive-when-the-sun-becomes-a-red-giant/)

It may even be possible for us to move the Earth at this point, but it seems like there are easier ways to avoid burning up with the Earth if we have that sort of technology. So, if we are still around, our best bet is to get off Earth all together.

The degenerate phase will start about 1 quintillion years after the big bang. Given the size of that number, that's basically 1 quintillion years from now! I think this means the Earth will be long gone by then under just about any circumstances we can even fathom at this point.

← [Reply](#)



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

Wednesday

Yes, there are philosophical implications here. As the universe expands and as it begins to rip apart due to dark energy, the farthest areas of the universe will exceed the speed of light and therefore we will no longer be able to see them or even know of these galaxies existence. Our knowable universe will shrink until eventually it will just be our own Galaxy.

If the universe is open and we end up in a degenerate state, the Earth will no longer exist. All of matter as we know it will have either been crunched into black holes or will have decayed into this degenerate highly entropic thermal energy soup. Good times ahead.

← [Reply](#)



Lukas Gott (<https://canvas.sbccc.edu/courses/46681/users/417976>)

May 1, 2022

I found it interesting how in the Hawking chapter this week it focused on no matter how many theories scientists come up with, we still have no confirmed theory to how the time and the universe works. Every time the chapter produced a new theory I bought into it, attempting to rationalize the theory with little to no conclusion. Yet even when they finally introduced string theory, I still have a hard time understanding the idea of a particle connecting as a string to all of space time. It all amazes me and no matter how long I stare at it I'm guessing I won't completely understand it. But I guess that's the amazing part of every theory, as with every theory there is no confirmed answer without years of perfect research and calculations.

QUESTION: Do you think anyone will ever confirm a theory such as string theory or supergravity in our lifetime? Or do you think it will be an entirely different theory?

← [Reply](#)



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

Wednesday

Great responses and an excellent question. The hope is that we will build larger and more powerful particle accelerators that will help us get to the high energies needed to discover the subatomic particles that string theory predicts. We have not been able to do this yet and as Hawking explained in his book, we would need a particle accelerator to the size of the entire solar system in order to produce the energy needed to create the special type of Higgs boson that is needed to confirm String Theory. However, I'm sure there will be other ideas and developments that will be testable and will allow us to test for string theory in other ways. That I believe can happen in our lifetimes. Now whether String Theory will prevail, as is, or if it will transform into a new better more advanced Theory, I do not know. But perhaps it will have the string concept at its foundational base. In that event, I think string theory will prevail. Only time will tell (no pun intended).

← [Reply](#)



Brian Wolden (<https://canvas.sbccc.edu/courses/46681/users/274832>)

May 1, 2022

DISCUSSION

One thing that I found particularly interesting this week was Hawking's breakdown of the possibilities in regards to a grand unification theory (GUT). He says there are three options:

1. There is a GUT that we will figure out given enough time and intelligence.
2. There is no GUT just more and more precise theories but none that ever explain everything.
3. At a certain level, things are inherently unpredictable and unknowable. (I am assuming that he means actually random instead of simply probabilistic, as is represented by quantum mechanics).

It seems he is talking about the actual nature of reality here, rather than an epistemological question about what we can actually know or theorize, since he already notes that we can't really ever know if we are correct about our GUT, because science doesn't prove things.

However, I'm not entirely sure if that is what he is getting at here or not. If he is talking about the nature of reality and not what we can know, I would add one more option, which is that there are rules to the universe that explain everything but they are inherently unknowable since we are in that system (or for some other reason). In effect (epistemologically speaking), this would equate to option two, but may have different metaphysical meaning than what Hawking intended.

What I really appreciated was his explanation for why we may have a way out of option two. He explains that with a "particle with an energy about the Planck energy" the mass of the particle would be such that it would collapse and form a singularity, cutting it off from the rest of the universe. This would mean that it obviously couldn't combine with other particles to make larger things and thus, is not a fundamental particle. This sets a necessary limit the energy of fundamental particles and therefore a limit to continuing refinement of theory as we "look" closer and closer at the fundamental nature of reality. Of course, that is assuming that our current understanding of singularities and microscopic black holes are correct, so who knows...

QUESTION

I have a couple sets of related questions this week all about string theory:

What space do strings vibrate in? Is it some of the "higher" dimensional spaces we don't observe? Are our observable dimensions included in the space they vibrate in? Does the dimension they vibrate in dictate the properties of that string? If so, is that why 11 dimensions are required? If not, what about string theory requires 10/11 dimensions? I had read at one

point that the 11th dimension added by M theory is the dimension to view all the other string theory variants from to make them make sense but what about the other 6 “extra” dimensions?

If the properties of fundamental particles is based on the frequency of strings, wouldn't there be an infinite number properties since there can always be more precise, and therefore infinite, measurements of frequency? Or is it more like steps or energy levels like electron energy levels? Are there octaves (a doubling or halving of frequency) in string theory where frequency ratios have similar properties? Or is vibration and frequency more metaphorical when talking about strings? How many different vibrations/properties does string theory propose? Is it just enough to explain the fundamental particles we already know about or are there more that are only theorized by string theory?

← [Reply](#)



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

Wednesday

Wow, your discussion about Hawking's three possibilities is very analytical, metaphysical and philosophical. I know you are a double major with philosophy, and your advanced understanding of philosophical critical thinking and analysis is appearance here. You really can approach these topics much more analytically than the rest of us. I think in this case, you the student has advanced beyond what me the teacher can offer. I can learn much from your perspective on these things.

← [Reply](#)



Naomi Xu (<https://canvas.sbccc.edu/courses/46681/users/27955>)

Tuesday

DISCUSS

I feel like this is kind of unrelated but I am really enjoying the big bang theory scenes as part of our materials. What I thought was so interesting though, about this week's clip, is the way penny breaks these theories down in much simpler terms and concepts. She is underestimated often and thought of as the "dumb one", especially being the only person in their group not in STEM. I feel like it's inspiring also kind of a reminder that maybe sometimes even the smartest people might miss things that could be obvious to someone else, or that if we didn't see things through a strictly technical or mathematical lens that we could see different outcomes and possibly answers. We've progressed this far, in astronomy, because philosophers like to daydream.

 [Reply](#)

○

**Erin O'Connor** (<https://canvas.sbccc.edu/courses/46681/users/24247>)

Wednesday

Great philosophical insights and very good points to make, that sometimes we lose the forest in the trees. Penny had the big world view and sees things how they are, and the rest of the Big Bang group gets all mired down in the weeds, so to speak. I guess we need both in the world around us, people to see the big picture and people to analyze and dissect an explorer the details.

 [Reply](#)

○

**Naomi Xu** (<https://canvas.sbccc.edu/courses/46681/users/27955>)

Thursday

QUESTION

So I'm still a little confused about string theory, was that it? you imagine them as sheets? but even that I don't quite comprehend.

 [Reply](#)