In These Times, Season 3 | The Large Hadron Collider and the End of the World (Episode 6)

Alex Schein:

The vastness of scientific information can cause us to look up at the stars with awe, but can also cause other reactions like skepticism and disbelief, denial and discomfort, and even fear. On this season of the OMNIA podcast, we talk to scientists and other scholars about scientific ideas that cause big reactions. We'll look at stories of science getting knocked around and standing back up again in a world full of polarization, politics, misrepresentation, and simple misunderstanding. Welcome to "In These Times: Fear and Loathing and Science."

Speaker 2:

It's being called the largest scientific experiment in history. And some say one that could cause Armageddon. This $5.8 billion machine is designed to break up atoms. It's called the Large Hadron Collider or LHC, an underground tunnel, 17 miles wide attached to several particle detectors the size of office buildings. Those detectors will look for signs of invisible dark matter, a so far undiscovered particle smaller than the atom.

Speaker 3:

The powerful collisions created in the particle accelerator also have the potential, in theory at least, to create other exotic particles and perhaps even a black hole, which would be deadly if created. And that has sparked a lawsuit filed in federal court in Hawaii by seven individuals seeking an injunction against the collider, arguing that it could endanger the planet.

Alex Schein:

In this episode, we talk to Evelyn Thomson, Professor of Physics and Astronomy, about early concerns in the public sphere, the media, and even the scientific community surrounding high energy particle collision experiments of particle accelerators, like the Large Hadron Collider. These concerns culminated in lawsuits, accusing researchers of conducting experiments that could cause a creation of many black holes or even spell the end of the world. Professor Thomson was instrumental in the design of the Atlas Experiment, the largest general purpose particle detector experiment of the Large Hadron Collider, a collaborative installation, which offers research access to over 10,000 scientists and hundreds of universities and laboratories, as well as more than 100 countries. Atlas facilitated discovery of the Higgs Boson, the fundamental particle associated with a field that gives mass to particles such as electrons and quirks. The discovery went on to win the Nobel Prize in physics.

Evelyn Thomson:

My name is Evelyn Thomson. I'm a professor in physics and astronomy at the University of Pennsylvania, and I'm an experimental particle physicist, which means I get to collide particles at very high energies and look at what happens to try and see if we can see new particles that haven't been seen since the start of the universe.

Alex Schein:

The collaborative study of theories in particle physics using particle accelerators like the Large Hadron Collider, or LHC, is invaluable to researchers in the field. Thomson discusses the importance of these collaborative efforts by organizations such as the European Organization for Nuclear Research. More commonly referred to as CERN.

Evelyn Thomson:

CERN is a collaboration between many European countries with also international contributors like the United States. And when we're doing these particle physics experiments, we need giant accelerators to be able to accelerate the particles up to very high energies. We need the high energies because we want to use Einstein's famous equation E=MC^2 to turn that energy into the mass of a new particle that we can then study and learn about as properties. We only really have a couple of facilities around the world where we can conduct these experiments. And that's because we've all pooled our resources into these few places to build these extraordinary experiments.

Evelyn Thomson:

The LHC is basically a racetrack that's 17 miles around and there are beams of protons, so the core of a hydrogen atom. Beams of protons that go in one direction close to the speed of light. And there's another beam of protons that goes in the other direction, close to the speed of light. And we collide those beams at a couple of places around the ring. It's kind of the opposite of Ghostbusters. We do actually want to cross the beams if we want to make new particles. And the idea of these big experiments is that we're trying to study the fundamental particles that make up the universe around us and govern the interactions in the universe around us.

Alex Schein:

Modern particle accelerators represent a huge jump in technology. And Thomson says scientific evolutions like this have often caused public unease, such as when Serbian-American inventor, Nikola Tesla made breakthroughs in electric power.

Evelyn Thomson:

Anytime that you have a new accelerator that's capable of going higher in energy, you can suddenly explore new territory that you wouldn't be able to see in previous experiments that only had lower energies. It means a lot to have these new accelerators that can go to higher energy. It takes a long time to plan. And as I said earlier, we pool our resources. We only have one of these accelerators now on the entire planet. It's a big international effort to build it and operate it. The experiment I work on has over 3000 scientists from all around the world. It's a really great privilege and honor to get to work with so many people from other places.

Evelyn Thomson:

You can go back to Tesla, who's the one who would have all these experiments with lots of sparks flying everywhere from high voltages. And it would actually be perfectly safe. There's a famous picture of him sitting in some kind of cage and he's got this experiment that's generating off lots of huge sparks and it looks very dangerous, but because he is inside a metal cage, he's perfectly safe because the metal cage shields him from the high voltage and the currents from the sparks. There's things that can look extremely risky, but if you have the science to know how to handle them and how to shield yourself from them, then it can be perfectly safe.

Alex Schein:

In the lead up to the launch of the Large Hadron Collider in the fall of 2008, the public, media, and even some scientists voice concerns over several extreme scenarios, like the creation of many black holes.

Speaker 5:

Scientists in Switzerland fired up the world's largest particle Collider, shooting a beam of protons around a 17- mile underground ring in hopes of better understanding the makeup of the universe. But the start of the Collider came with objections. Some feared the collision of protons could destroy the earth by creating micro black holes, a kind of collapsed star with gravity so strong they could suck in planets.

Evelyn Thomson:

When people think about dangers from particle collision that we're making here in the lab, one thing you have to remember is that we get bombarded by particles from outer space every second. And those particles are called cosmic grays. They're very high energy particles that are traveling across the vastness of space, usually high energy protons or other light atomic nuclei. And those are slamming into the Earth's atmosphere every second. And those collisions are much higher energy than anything we can achieve in the lab. As experimentalists, we're very proud to say that the LHC gives us the highest energy collisions in the world, but we should really qualify that. It gives us the highest energy collisions in the world that we can achieve in a lab setting. There are many higher energy collisions going on from these cosmic rays coming in from outer space into the atmosphere.

Evelyn Thomson:

To put it in context, we have a big jump in energy for the LHC, but we're talking about a jump of energy that's like a factor of 10 from the previous experiments that we've done before. And it's exciting to us as experimentalists, because we think that there are many new particles that could be within reach, but these are not, how do I say it? They're not dangerous new particles. They are particles that we know how they would behave and how they would decay. I know there was a lot of publicity back early on about the micro black holes because some theorists had a theory that said we could produce those with the LHC.

Evelyn Thomson:

But on the other hand, Steven Hawking, who's very well known, I think his predictions would say that those micro black holes would evaporate, so they would be able to emit Hawking radiation, which is named after him. And so they would evaporate and disappear. I think the theorists have some predictions that would say that anything's possible, right? But one thing I think the public can have a hard time of understanding is it may be possible, but is it probable? And I think the probability of that happening is just so low. And then there's also the fact that if it did happen, it would've happened in the atmosphere many times by now. And our planet has been around for four billion years and we're still here. We're probably pretty safe.

Alex Schein:

As Professor Thomson says, sometimes theories trumpeting that a certain experiment might spell the end of the world developed due to a lack of diligence and how scientists explain their research to the public.

Evelyn Thomson:

I remember growing up as a child and black holes were talked about on the TV and it was really exciting because we didn't know if they really existed or not. The public has definitely heard of that. And as a nine year old or an eight year old, I remember reading books about it from the public library and there's this great fascination with science out there in the general public. One thing one has to be careful of is using words that are... People are using the words because they're excited about, oh, we could actually produce these in this experiment. And that would be really cool if we could make them and study them, but then you have to back it up that it's not this thing at the center of our galaxy that's going to suddenly eat the entire planet. Instead it's something that would evaporate very quickly into particles that we would see in our detector. We might make it, but we might make it for a trillionth of a trillionth of a second and then it would decay into regular particles.

Evelyn Thomson:

The other thing one is to be careful of is risk. And I think everyone's pretty bad at judging risk. You can see it with coronavirus vaccines. The risk of getting the disease is much higher than the risk of the vaccine, but people will say things like, well, I've always been healthy and I've heard bad things about something that I'm definitely going to go get if I go get a shot in my arm, but on the other hand that's a very low risk compared to the extremely high risk of catching a pretty deadly virus.

Alex Schein:

Because physics deals with big picture ideas and often includes larger than life installations, it is often viewed through the lens of science fiction.

Evelyn Thomson:

The things that we work on I think are pretty fascinating. And you have these giant experiments that look really out this world. They look like some sort of alien spaceship. I've seen pictures of the Atlas experiment when it was being built, where we only had the outer part of the experiment there, and that picture has shown up in at least two or three sci-fi movies or sci-fi series that I've seen. The artists were obviously really fascinated by the idea of what it looked like. And I think what should be taken away from that is that it's amazing that we can work together as a collective group to make these big science experiments work and put all our ingenuity together to try and discover the secrets of the universe. That I don't think is unique to the physics. I think what's unique to the science experiments is just the scale of the experiments. The accelerator is 17 miles around. The detectors would fill up half of Franklin Field. The rate at which we read out the data is so incredibly fast. All of those things I think are impressive rather than scary.

Alex Schein:

Safety reports were released by the European Organization for Nuclear Research in an effort to curb concerns.

Evelyn Thomson:

I view it as due diligence. If we're funded by taxpayers to try and explore the secrets of the universe, then we're responsible for answering their questions. And if they have a question about is this safe then CERN is doing due diligence by carrying out the study and writing up the report and saying, here are the facts and this is why it's safe to do this. I think taking the questions head on and answering them with facts and then communicating the results of the study, I think that's responsible science. It's what we do. We publish things. We make them available for anyone to read. We have to use our language carefully as we spoke about before so that things don't get misinterpreted.

Evelyn Thomson:

And that's always the challenge, when you take a bunch of technical experts to translate things from the technical jargon into things that people who don't have that technical jargon can understand. It's an issue we have even in our own presentations where there's so many acronyms on the experiment, it's very easy to start using them all and you have to back up and remember that, Hey, I'm talking to high schoolers here. I can't assume that they know what this is. And if you're given a colloquium, you're esteemed colleagues in other fields will pretty quickly remind you, Hey, you're using acronyms that I don't know because you're working in a different field of science.

Alex Schein:

Professor Thomson says the biggest failure would be to stop investigating the mysteries of the universe.

Evelyn Thomson:

I think as an experimentalist, the biggest risk that we have is that there's some new particle in the data we've already taken that we haven't thought to look for. And there's some evidence of physics beyond the standard model that we know about that we haven't been smart enough to look in our data to find. And I think that's why new ideas are always important and questioning assumptions is always important for searching for particles. I think if we stop investigating things, then we're losing our curiosity about the universe around us. And I think that's very dangerous. If you can go back a long way to the 1600s, Queen Elizabeth I and her court at the time were very interested in magnetism. Magnetism was strange, but they were very interested in it because it allowed you to have compasses and that allowed you to navigate across the open sea and to explore the rest of the world. You can jump forward to the 1800s where people are doing lots of experiments with electricity and magnetism. Just a very different time.

People are burning coal for heat. They have ice that has to get shipped in to keep things cool. Factories have to be next to running water to power the mills. You understand electricity and magnetism and suddenly you have electricity that you can transmit hundreds of miles and you can use electricity for heating and for cooling. Then it completely changes the way that your whole economy works, but we don't know what four-fifths, what 80% of the universe is made of and the year is 2021. I think we've got a lot of questions still to answer. And how do those help us in our daily lives? I don't have good answer from that apart from to say that some of the things that we find out along the way will help us in ways that we can't yet guess. Just like the people investigating electricity and magnetism back in the 1800s couldn't have told you that it would lead to electrical light and fiber optics and all the technology that we're using to talk to each other today.

Alex Schein:

Better communication by researchers and a focus in education and science is key to public understanding of technology, like particle accelerators.

Evelyn Thomson:

For a while, a lot of my colleagues were doing things like diaries to try and show you what life as a scientist was really like, or they were spending a lot of time on blogs to try and communicate that. Some of my colleagues are really talented and have written nice books. Daniel Whiteson who is a postdoc at Penn, he's written a book called "We Absolutely Have No Idea" to try and address some of the questions. I think it's not something that you're really going to be able to understand on Twitter or Snapchat or any of these instant things aren't really enough to understand these topics. I think you have to be willing to invest some time in watching a documentary like Nova or reading a five-page article in

Scientific American, and maybe checking a book out of the library on some of the modern physics questions to really learn more about these kind of things.

Because a lot of the science is really fascinating, but if you just go from the headline, you could jump to the wrong conclusion about what it is that we're trying to say. You see the word black hole in a headline and you jump to the conclusion that, oh, that's really scary. I don't want them making those. But if one has more than the headline to explain things, then one can explain what's really going on. And I think that's much more interesting than the headline.

Alex Schein:

This concludes episode six, "The Large Hadron Collider and the End of the World." We'll be back in two weeks with the seventh and final episode of season three, "Climate Change and the Problem with Time." The episode features an oceanographer and a climate model on what could be in store for our planet and a geophysicist and historian sharing thoughts about the challenges to understanding the scale of Earth's 4.6-billion-year history and how our actions in the present will shape a future we can only imagine.

The OMNIA podcast is a production of Penn Arts and Sciences. Special thanks to professor Evelyn Thomson. I'm Alex Schein. Thanks for listening.

Be sure to subscribe to the OMNIA podcast by Penn Arts and Sciences on Apple iTunes or wherever you find your podcasts to listen to all seven episodes of season three of "In These Times, Fear and Loathing and Science."