Transcript of the Audimax Podcast
with Anne-Catherine de la Hamette and Lee Rozema

Daniel Schenz:
Hello and welcome to this podcast conversation on the current Rudolphina focus on "What's Next in Quantum Physics". I'm Daniel, and I'll be guiding through this conversation.

Anne-Catherine de la Hamette:
Hi, my name's Anne-Catherine. I'm a third year PhD student in the group of quantum foundations and quantum information at the University of Vienna. I work on the foundational questions of quantum theory, especially at the border with gravity.

Lee Rozema:
My name's Lee and I also work at the University of Vienna. I work in the group of Philip Walther on, quantum optics and quantum information. And we are trying to build different quantum photonic technologies for applications in quantum computing and quantum communication.

Daniel Schenz:
Great, thank you. Let's get to know each other a little bit. I would like to ask each of you to pick two questions to ask the other from this list that I've put in front of you. Anne-Catherine, do you want to start?

Anne-Catherine de la Hamette:
Yes. So Lee, what's your favourite tool?

Lee Rozema:
That would have to be the laser, I think. It's really ubiquitous in modern day science. It kind of revolutionised a lot of experimental techniques. In our lab, we use it we use it for making entangled photons, but other sorts of quantum researchers use it to control the atomic states of atoms and they can manipulate information with an incredibly high precision—all thanks to the laser. And Anne-Catherine, what's on your desk right now?

Anne-Catherine de la Hamette:
Yeah, so on my desk right now, there's, first of all, my laptop and a notepad to make any calculations that I need to do. My water bottle, my phone, my plant. That's about it.

Daniel Schenz:
It's quite clean, no?

Anne-Catherine de la Hamette:
It's, a clean desk, yeah. I keep it organised. Okay, Lee, do you have any morning ritual?

Lee Rozema:
Yeah. So my morning always starts with dragging my kids out of bed, getting them off to school. But once they're out of the house, I like to kind of quickly check my emails, think about what I wanna do for the day, and then I like to go for a run. Or if I'm too tired from the previous day, then I'll, you know, just go for a walk in the morning with my dog. But I like to have this time to myself where I kind of mull about what I'm gonna be doing during the day. And sometimes I just, you know, blank out and just stare at the trail as I'm running. But that's my morning and then off to work. And so, Anne-Catherine, do you have a favourite number?

Anne-Catherine de la Hamette:
Yeah, if I would have to pick, I would say, as any good quantum information theorist, two square root of two. That's the so-called Tsirelson bound and it tells us how strong so-called quantum correlations can be. And it tells us what is different about quantum theory compared to classical theory.

Daniel Schenz:
Okay, cool. Then let's dive into your work, what you're doing. Anne-Catherine, is there a question you are thinking about currently?

Anne-Catherine de la Hamette:
Yeah, so kind of the big question that we're thinking about right now is how space and time are affected when the massive bodies that source gravity have quantum properties. So at the moment, we have two big theories that work really well in their own realm, which is quantum theory, which describes very small objects; and we have the theory of gravity, which describes very massive things like the sun or planets or how a satellite moves around the earth. And for essentially a century, we have had the problem of combining these two theories. And we are trying out an approach that is different from the approaches that people might have heard of before, like string theory which we call a high energy approach. What we try to do is a bit different. We try to take really simple, so-called low energy scenarios and we try to let ourselves be guided by the things we know already about these theories and then try to see where we get. So one very simple example that we're working on forces us to consider something like Schrödinger's cat. So, I assume that most people have heard of this weird concept of superposition before, but instead of talking about a cat that is dead and alive at the same time, which may be a bit cruel, let's just take something like a massive ball. And in our classical world, we know that this ball will be in some single well-defined location. Even if I don't know where the ball is, I know that it's only gonna be in one single position. Now, if we go into the realm of quantum theory where things are a bit weird this ball can technically be in a state where it's at two positions at the same time. So I think we've all heard of this before, and we wanna take this weird concept and add gravity to it. So if you've ever seen an illustration of Einstein's theory of gravity, maybe you've seen this sort of net that is curved by some big ball in the middle. And what we want to illustrate with that is that space time is curved by a very massive object. And now if we combine these two simple ideas, we may wanna ask the question, what happens if this big ball that is curving space time—curving this net—is in two positions at the same time? What would happen to the net itself? Would space time itself also be in some sort of superposition? So, become quantum? And people are

actually fighting about this, very intensely. And some say, yes, the net itself will also be quantum. Others say, not at all, gravity is truly classical, this cannot happen. And so this is the kind of question where addressing at the moment.

Daniel Schenz:
Lee, how about you?

Lee Rozema:
Yeah, so, I'm actually also thinking about some topics related to superposition. So in our lab, we have a, a really a variety of different research projects we're looking into. Some of the things are related to quantum cryptography, so this idea that you can encode messages securely in a quantum state. So we encode our information in photons, and then we send our photons from one party to another. And one thing where we've been thinking about recently is how we can kind of encode more information per photon. So normally, when we talk about encoding information, we think about encoding it in two different states. So if you think about like the Schrödinger's cat, it's either dead or alive. But now we wanna add another state. So maybe the cat is dead, alive or a zombie. So now there's, you know, these three levels that we wanna distinguish. And we know how to make these superpositions, of course not with a cat. We do this instead with a photon, and we can, you know, put the photon in one of three locations. But now the challenge is we want to actually verify that the photon is in a superposition of these three locations when we want to figure out if the photon is in all three of these positions at once, or if, you know, just sometimes it's in the first position, sometimes it's the second, or sometimes in, it's in the third. And this turns out to be a pretty challenging thing to do on paper. And even in the lab, in order to build an apparatus which can kind of deterministically in a single shot tell you whether your photon was in a superposition, it's quite difficult to do. So we're working on different techniques, really using optical components where we can try to identify the superposition and determine which type of a superposition it is.

Daniel Schenz:
Great, thank you. Well, each of you brought an object that you would use in your everyday work life. Can you describe what you brought and how you use it? Shall we start with you again, Anne-Catherine?

Anne-Catherine de la Hamette:
Yes. So when you asked me to bring an object that I use regularly the first thing that really popped into my mind was this piece of chalk. It's a bit of a funny thing to bring, but it's honestly one of the items that I use the most. Because the way we approach our research questions in our group is not at all this idea of the lone physicists all by himself in his office. Our way of working is extremely collaborative. So we spend a good chunk of our day at the blackboard discussing together and disagreeing on things, disagreeing on what certain results could mean and in order to really visualise our thoughts and write down some equations we like to do that with some chalk on the blackboard.

Daniel Schenz:
I guess you also use chalk?

Lee Rozema:
We actually try to avoid chalk. We prefer whiteboards because you know, we have whiteboards in the lab, and you know, also when we're in the lab, things are usually going wrong rather than going right. So we'll go over to the board to try to figure out what's wrong. But all of our optics are extremely sensitive. So if we use chalk, it kicks up a lot of dust, which then lands on our optics, and you have an intense laser beam shining on the optics, so this will then burn and and just lead to general badness.

Anne-Catherine de la Hamette:
Yeah, it's the infinite fight between whether whiteboards or blackboards are better.

Lee Rozema:
Yeah, I do prefer blackboards when I'm giving a lecture though, so.

Anne-Catherine de la Hamette:
See, yeah!

Daniel Schenz:
All right. Lee, what did you bring?

Lee Rozema:
So I brought with me what we call a non-linear crystal. When you look at it, it looks just like a yellowish piece of glass, so it doesn't look too exciting. But it turns out that we've designed this crystal in a very specific way, so that if we shine the right kind of laser on it, it will shoot out pairs of photons, and it will do this in a very clean manner. So now we can say, because we know that it always spits up two photons at a time, if we detect one of those photons, then we know that there's a second photon in our experiment. So we call this a "heralded single photon source", because measuring this photon heralds the arrival of the second photon. And this is a technique we use really at the start of almost every experiment in our lab. So, our lab really wouldn't work without these sorts of crystals.

Daniel Schenz:
Do you also use these crystals in your work?

Anne-Catherine de la Hamette:
I don't use these crystals ever in my work, but whenever we write in a paper the sentence "Consider a pair of two entangled photos", then of course we rely on the fact that somewhere in the lab, for instance, in Lee's lab, people are actually able to produce these photons. And in this way, we of course connect our theoretical results to something that could actually be tested in the lab.

Daniel Schenz:
So then after you are done using your tools that you used, you will have some results. What do they look like physically?

Anne-Catherine de la Hamette:
Yeah, I would say, I mean, of course the main result is the idea, the principles that we find, the end equations, the end results, some predictions that could be implemented in an experiment. In the end I end up with a big pile of notes. And we try to condense all of that into a nice and clean research paper in order to communicate our results to the rest of the community. But of course, the results themselves are ideas, they're concepts.

Daniel Schenz:
Lee?

Lee Rozema:
Yeah, so I guess I have several different stages of my results. So, you know, usually when we're starting a new experiment, we go to the lab and we have an empty table. So the first thing we do is, you know, we put down the laser and maybe one of these non-linear crystals to start building up the apparatus. And then we have different mirrors and beam splitters to bounce the photons around and have them interact in the specific way which we want for our given experiment. So at one level, we have this this apparatus that we've built in the lab, but that's not the final result. That's just an intermediate step. And then we wanna measure, so for example, we may want to measure if our photons are entangled, but the photons are so faint you don't actually see them. So we see a crystal, we have a laser, which you can see by eye going through the crystal, and then we have these kind of imaginary beams, or we imagine these beams where the photons are going, and you can't resolve that with your eye. So we need to develop sensitive detectors that can produce some signal when they see a photon. So although we don't see a photon, we have some detector which will, a photon will hit it, and we say it clicks. But in practice, what that means is it puts out an electrical pulse, then this electrical pulse will go to some other set of electronics, which will then turn that pulse into a number. And then this number gets displayed on a computer screen. So then the next level I would say is, you know, some number is flashing on a computer screen, and then whether the number is high or low or in some given range, that tells us something about the experiment, given that we've, we've designed our measurement apparatus in a specific way. And this is what the PhD students and what I used to do when I was in the lab more, we'd spend hours in a dark room staring at a computer screen, trying to make a number bigger or smaller. And then from there, we need to take these results to some computer, typically to run some data analysis algorithms. And then we end up with some plot on a computer screen. So multiple levels of results, I guess.

Daniel Schenz:
I see. So since you've started to talk about a process, let's talk about the research environment and start with the process of your workday. So can you please describe a typical day in your work life? Let's start with you this time, Lee.

Lee Rozema:
Yeah, so, it's changed recently in my role as a Senior Scientist. So when I was a PhD student and an earlier stage postdoc, I would really be in the lab. So then I would kind of get to work, you know, maybe do a little bit of stuff on the computer, check some emails and so on, and

then get to the lab to try to build one of these you know, some experiments. Nowadays, my role is more supervising PhD students, so I'll typically get in, I try to get some alone time in the office so that I can, you know, deal with the emails that have come in, referee some papers. But I try to meet with at least one or two of my PhD students every day. And I really enjoy spending time with them, talking about their results trying to help them understand what's usually going wrong in the lab, and try also to enjoy and celebrate when things are going right. So a big part of my day is really troubleshooting with students, helping them design and analyse their their results. On top of that, I have some teaching duties and, you know, writing papers, writing up our results so that we can publish them and let other people know what we've been doing. So these are all things, I don't really have a structure to my day. They just kind of all, I deal with them when they arise, let's say. So.

Daniel Schenz:
Thank you. Anne-Catherine?

Anne-Catherine de la Hamette:
Yeah, so typically I get to the office around 9:00 AM. The first thing I do is to start my laptop and check my emails and also check the "arXiv", which is the website on which all of the new pre-prints arrive. And so I tend to check the new papers in quantum physics and also general relativity sometimes. And after I know what's new on the arXiv, I start my actual work, which consists of some alone time as well to do some calculations or some numerical stuff on the computer. And then I have some meetings where we discuss any new progress that we've made or any new directions that we could go into. I also teach once a week, so I prepare my teaching, I go there, or I prepare some tests. And then of course, there's the whole work of writing up your results, writing papers, replying to referees that are unhappy about certain details in the work and so on.

Daniel Schenz:
Okay. So as a PhD student what are the things you enjoy most about this stage in your career?

Anne-Catherine de la Hamette:
Yeah, what I enjoy most right now is really the freedom that I have to choose the specific topics that I want to work on, but also the freedom to travel around and attend lots of conferences present posters about my work, give some talks about my work and just getting to interact with other younger or more senior researchers in my field, being able to exchange ideas and so on. So just a few days ago, I've come back from a research trip to Brazil where we visited several research groups working in different cities on topics very related to the work that I do. And I got to learn an immense amount about the specifics of what people do there and, yeah, make some connections for future collaborations potentially but also, of course, get to know the new places that we visited. Overall other things that I also enjoy is that I that I get to be very involved in organising community events, especially at the University of Vienna. So just about a couple of months ago, we organised some public talks on topics like the funding system and the publishing system in academia. So, here in Vienna, I've really found kind of a group of people that are interested in exploring how we can make the system better, what are the issues that we're facing as scientists and people are very open to discuss potential changes.

Daniel Schenz:
So when you say community events, that's the community of PhD students?

Anne-Catherine de la Hamette:
It can be the community of PhD students or I mean, physicists in general working here at academic institutions. But some of the events are also open for the general public trying to inform them both about the actual content of our research, but also about the way in which the academic system works. So what does it mean to do research? How do you overcome like what do you do if your results turn out to be wrong? What does it mean to have an hypotheses and actually test it? So what does it mean to have something that's scientifically proven, for instance. All of the science communication is also something that we aim for in these events,

Daniel Schenz:
Lee, you as Senior Scientist, is there anything you would've liked to know as a PhD student, and how did you learn it?

Lee Rozema:
So I guess one thing that really I struggled with as a PhD student, and it really became clear as I moved through my career, is that almost everybody has this impostor syndrome. So this impostor syndrome is kind of this idea that everyone around you is smarter than you, and you've been somehow faking your way through your career so far. And I mean, I think most people by the time they're in their PhD, are just objectively by the fact that they've made it this far know that, you know, you're not in impostor, but somehow still academia promotes this feeling or, or doesn't promote it, but it kind of gives rise to the conditions that push this feeling of impostor syndrome. And I, I think we should acknowledge it and recognise that, you know, most people have it. And the way it kind of became evident to me, especially at this point in my career, is that now I'm in a role where I'm supervising people a little bit more and I can see different students I work with struggling with it. And I know that I've certainly gone through these things. So, so yeah, you just kind of observe it after being in the field for so long and talking to your colleagues.

Daniel Schenz:
Do you still have it?

Lee Rozema:
Of course, yeah. I mean, it's funny because, you know, now, especially at this point in my career, you know, I've gotten this far, I have a permanent position, but still, somehow there's this sense that you know, that I could be doing more or that other people at the same stage in my career have gone further. Yeah. So maybe one day it'll go away, but I mean, I know how to live with it. It's not like it's something that I lay awake at night thinking about. But yeah.

Daniel Schenz:
How about you, Anne-Catherine, do you have impostor syndrome?

Anne-Catherine de la Hamette:
Of course I do. I think I don't really know anyone who doesn't. I think the important thing is that you don't let it block you in a too significant way. In a sense, it's always good to question yourself, and it's something that we need in science, we need to question the work that we do, and we need to be open to criticism. But of course, you are probably your own worst critic, and you need to learn how to deal with that and, and still have the confidence that you're probably where you're supposed to be. So that's something I try to do. But it's work in progress.

Lee Rozema:
Yeah. And I think it also comes up a lot because, you know, we're all such experts on such specific topics, so, you know, I know a lot about a very, very specific thing, and if I go talk to someone else who knows a lot about something else that's very, very niche, very specific, it's very hard for me to follow. So we have a tendency just to focus on one problem and think that because everyone else knows so much about something that you just not aware of everything in the field that you should be.

Anne-Catherine de la Hamette:
And the thing is, if you become an expert or very knowledgeable about one specific topic, all the things that seemed hard before suddenly seem rather obvious or easy, but that's just a sign that you start to understand them. But often we forget that we had to put in some work to get there, and that it's not obvious or trivial to understand these things.

Lee Rozema:
Yeah, definitely. I even see it though with things I know very well. So, you know, now I'm supervising PhD students and I have students who are actually working on some problem that, you know, I even designed maybe half a year ago or something, and I'm like, yeah, I know this because we came up with this experiment together, and they come and talk to me about some results, and it'll take me some time before I even remember what they're doing. So, you know, even though you know the subject matter so well, you can still get this impostor syndrome lurking up because it just takes some time to get back on the level you should when you get back to an old topic.

Anne-Catherine de la Hamette:
Yeah. What helped me a lot was that in discussions, the more senior people that I was working with were extremely open about not knowing things. So having my supervisor who's a university professor, say "Oh, I don't actually remember the full detail of this calculation" or having a postdoc say "Oh, yeah I've done this mistake before, you have to do such and such", really being open about this impostor syndrome, just making it a topic that you feel comfortable talking about makes it go away in a large chunk.

Daniel Schenz:
Nice. So now that you've started to talk about life in your groups, right? When I prepared for this, I try to find out what your respective groups are working on. And I found that they sound very similar. The words I've seen is "gravitational quantum physics", "indefinite causal

structures", "quantum information theory", in both of these groups, yet you work in different groups. Lee, can you explain what the differences between the groups are?

Lee Rozema:
Yeah, I mean, so at the basic level, Anne-Catherine is a theorist and I'm an experimentalist. So that, that's the first and biggest difference I think is, you know, I'm in the lab trying to build some device to measure some phenomenon, but their group is, roughly speaking, kind of predicting the phenomena that we're trying to observe. And both of these fields require so much expertise and knowledge that it's almost impossible for someone to be successful as both a theorist and an experimentalist. So, you know, even though I've learned the math and everything the stuff that they're doing in their group is so much more sophisticated and there's no way I can really keep up with all of the details. But we pull out what we can from the results and we try to follow with guidance from our theory collaborators of course and try to work together.

Daniel Schenz:
So how do you work together, Anne-Catherine?

Anne-Catherine de la Hamette:
Yeah, I think one very good example of very successful collaboration between our groups is when the Walther group implemented the so-called "quantum switch". So the quantum switch is this this idea or this setup where we have a photon, so a light particle traveling through the setup, and the experiment is designed in such a way that afterwards you can say the photon was in a superposition of different causal orders. So that means that in the one branch of the superposition it first went through a lab that we call A and then it goes through a lab that we call B. And in the other branch it went through B first and then through A, but it does both things at the same time, so in superposition. And this is what we call a superposition of causal order. So we cannot even say what is happening first and what is happening second. And so this idea has been around in the theory part of the community for over a decade, and it was predicted to be this really new phenomenon that hasn't been observed before. And there was a very strong collaboration between the Brukner group and the Walther group where the Walther group were the ones to really experimentally implement this experiment. And this was done successfully couple of years, three, four years ago. So that I think is like the prime example of what can happen if you combine both experimentalists and theorists.

Lee Rozema:
Yeah, that was actually the first project I worked on when I came to Vienna.

Daniel Schenz:
Do you have any special kind of formats where you meet and discuss these things?

Lee Rozema:
We used to have joint group meetings where we would do more stuff together, but in the recent years our groups have really grown. So sometimes it's even difficult within our own group to talk to everyone in our group. So I think the formats would be at these sort of social events, which are departmental talks and so on, that we kind of bump into each other in the

halls, we share a lunchroom, that kind of thing. I dunno, maybe, you know, some more formal meetings?

Anne-Catherine de la Hamette:
No, I mean, we're generally I would say, at the moment we're kind of back to really working out the theoretical details of the next big experiment. And this requires some work really working out the actual framework, the formalism that we want to use. And before, we first have to do that before we can say very concretely what should the experiment look like. But overall we try to have some joint seminars where we look at the newest papers together, both from an experimentalist and a theorist perspective.

Daniel Schenz:
Are your groups physically neighbors?

Lee Rozema:
Yes. And that helps a lot.

Anne-Catherine de la Hamette:
Yeah, we share a kitchen, so we meet at the coffee machine.

Lee Rozema:
Yeah. And there's definitely times, more in the past when we were collaborating more heavily on these quantum switch experiments where we'd come up with some problem, we didn't know what to do, and we could just pop in and talk to Časlav directly. And it's a very nice community. Most of us have kind of a doors open approach where you can knock on the door and most of the time make time just to sit and chat about what's going on.

Anne-Catherine de la Hamette:
Yeah, there have been other times when we were wondering what certain experimental setups really mean, and then it's possible to just go there and ask "So how do you actually do this? What does this look like in the lab?" And that's very helpful for us as well.

Daniel Schenz:
Cool. How do you choose to work on your respective topics? How, what inspires you to come up with new things? Anne-Catherine?

Anne-Catherine de la Hamette:
Well, I think as most physicists probably, I decided or chose to study physics because I wanted to understand how the world works. And then as you go about your undergrad studies and then you move on to more advanced topics, you kind of start digging into the details of thoroughly worked-out theories. And I noticed that a lot of researchers in the end work on details of already established theories. And then at the end of my bachelor's, I kind of got to know or heard about people working on the foundations of quantum physics. And I had this moment where I was really excited again because I felt like these people were still questioning the fundamental principles on which the theory of quantum mechanics is built on. And it seems quantum physics is still challenging us to keep questioning essentially everything—all assumptions that the theory works with. So there was this really famous result called Bell's

Theorem, about half a century ago, which is very closely connected to the Nobel Prize of this year. And this result forced us to question principles that physicists have held onto for centuries, if not thousands of years. So this is really something that excites me a lot because I feel like what we do matters in the sense of how we understand the world. Um, yeah.

Lee Rozema:
Yeah, yeah. So for me, I think when I was going through quantum, well learning physics during my bachelor's, I got to quantum mechanics and I started just reading about some of these predictions that, you know, that there were these things like Schrödinger's cat and entanglement, and it just seemed so kind of bizarre as Anne-Catherine said, it really challenges the way you're trained to think about the world and just by your everyday life you know, we don't observe superpositions or entanglement with the objects we regularly interact with. So when I saw these predictions, I just really wanted to know what it would take to test these things in the lab and what these results looked like, what these experiments looked like. So I reached out to a bunch of different groups in quantum mechanics and studying quantum foundations. And the group I actually did my PhD with, they had done an experiment observing kind of the wave particle duality idea, this idea that a photon can both act as a wave and a particle in the same experiment. So they had done an experiment on this, and to me, this was just fascinating because it was this really second-year physics thing that you learn about but you don't really know what the experiments look like, how would you build some, an apparatus to test this? So I reached out to them and yeah, I joined their lab, did my PhD with them. And along the way I realised that we have all of these new technologies that we've been developing to test these sorts of questions. And there's also applications to them. So this idea of quantum computing and quantum cryptography, they all kind of came from these foundational questions. So I had started throughout my PhD learning how to work with particles of light, single photons, and now there's these proposals for doing things like building a quantum computer. So then I thought, well, what does that take? And then the group in Vienna, especially Philip's group here, is very focused on really scaling things up. So, you know, during my PhD, I was, say, entangling two particles of light, and Philip was, at the time, entangling six particles of light. So, you know, that was a very big deal at the time. And now we've gone even further where people are observing these sorts of entanglement or quantum aspects of, you know, 10 or 20 photons at the same time. So I really see the field progressing and it kind of just excites me to think about what's coming next, what we can do with these technologies, both for applications and for what what sort of fundamental physics we might be able to discover in the future with them.

Daniel Schenz:
So I just ask you, what's next in quantum physics?

Lee Rozema:
I don't know. So I think the, it's very clear that there's this trajectory of going bigger. So, like I said, you know, entangling more and more particles for applications in quantum computing, and I definitely think that's going to continue. When exactly the quantum computer's coming, I can't say, but I can say that we've really been seeing a rapid progress in what we've been able to accomplish in the lab. And I mean, I hope that we get to a point where we really can build a quantum computer, but even if we don't, just the techniques we've developed so far have

allowed us to explore all kinds of new fundamental questions. And, and that excites me, and I hope that this push continues and that we don't get too focused on the applications, and we can still stay interested in the fundamental questions.

Daniel Schenz:
So what's next on the front of fundamental questions?

Anne-Catherine de la Hamette:
Yeah, so on a more fundamental note, not thinking too much about applications in the industry, there is one experiment that a lot of people are really excited about and optimistic that it may be implemented within the next 10 to 20 years, which on an experimentalist's scale, that's a very short time. And that is the so-called "verification of gravity induced entanglement". And this is an experiment, or it was one of the first proposals of an experiment, really, about five years ago that aims to experimentally verify effects of quantum gravity, if I wanna put it that boldly, in the laboratory. So for a really long time, we thought that experiments or experimental data for something like quantum gravity was really out of reach because the orders of magnitude on which we expect these effects are so ridiculously small that, I mean, people estimated that we would have to build something like CERN but at the size of the diameter of the galaxy. That's not something we're ever gonna do. And now this proposal, or generally these low-energy proposals are about experiments that could really be done in an experiment, in a lab like these and the Walther group's lab. And the idea is to take two particles and implement them in a way that they can only interact, only talk with each other via gravity. So we have to really shield all of the other interactions very well and be sure that they can only interact with each other gravitationally. And if we were to observe that over time, they would get entangled, a lot of people say that this would be proof that gravity has to be quantum. And so all of the people saying "No, the space time net needs to be classical" would be proven wrong by that. So that's, I guess, the next big experiment that a lot of people are very excited about. And yeah, I think there's some chance that we're gonna see the results within our lifetimes.

Daniel Schenz:
Okay. Thank you very much. I think we should come to an end. So I have one last question for each of you. Going home, how does your work as a quantum physicist change your everyday life? Let's start with you, Anne-Catherine.

Anne-Catherine de la Hamette:
Yeah, I think just my days or my life, my work as a researcher have made me develop a very high level of frustration tolerance. I still tend to get very frustrated about things not working or things going wrong, or getting anxious about things, maybe not working out. But I feel like studying physics and working on really hard questions and seeing that everyone struggles with them has given me this kind of confidence in everyday life that every problem can be solved eventually, or at least be made smaller. And I've, through my work, have learned to reach out to other people, ask for their expertise. It's made me trust that other people can help me, and that together we can figure out some solution. So this sounds very big, but it's really about very basic things like my sink breaking or me getting lost in the airport when I'm late for a flight. I

have learned that nothing's as dramatic as it as it seems. And if you just breathe and you try to rationalise the problem, you will get it solved.

Lee Rozema:
It's actually somewhat similar to what I was going to say. So I was going to say, as an experimental physicist, you know, we are, we spend a lot of time fixing things that are broken. So, you know, I like to do whatever I can myself. So if my car breaks, or to some extent, I like to work on it myself and get my hands on things, and because I work with very sensitive equipment every day worth a fair bit of money, so I've kind of developed a bit of confidence that I can at least open it up and try to see what's going on without breaking it. And then I also try to learn the boundary of when to stop because there's some things you just can't fix and you need to call the experts in. But yeah, I guess it's this troubleshooting idea. You know, when things go wrong, you can try to rationally address the problem, figure out what you can do, what you can't do. And yeah, as Anne-Catherine said, when to call the experts.

Daniel Schenz:
Thank you very much, both of you. It was a huge pleasure talking to you. Thank you very much.

Lee Rozema:
Thank you.

Anne-Catherine de la Hamette:
Thank you.