WE ARE ETH, Episode 54

Fabio Scafirimuto, Education and Workforce Lead for IBM Quantum

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[00:00:14] **Susan Kish:** You have a wide range of quantum literacy.

[00:00:16] **Fabio Scafirimuto:** Exactly. Perfectly defined. I think this is one, maybe it's not the biggest challenge, but is indeed in my specific job where it's really training and educating people is indeed a big challenge.

[00:00:32] **Susan Kish:** In this episode, I'm talking with Fabio Scaffidimutto, PhD in Experimental and Quantum Optics from the ETH and Education and Workforce Lead for IBM Quantum for Middle East, Europe, and Africa. This is the We Are ETH podcast, and I'm Susan Kish, your host.

So good morning, good afternoon, Fabio. Delighted to have you here. I have to tell you, every time I read about anything quantum I feel like I'm in a foreign country learning a foreign language, right? You got qubits, you got two bits, you got gates, you got utilities and circuits, running circuses, a hundred by a hundred challenges, parametric spin, chain modeling, and Polaritronics.

So can just give us a basics in quantum just to get us started, because it feels like it should frame these kinds of conversations?

[00:01:32] **Fabio Scafirimuto:** Of course. And, uh, first of all, thank you for having me. Um, so quantum, if it can be a little bit complicated at, at first, at the beginning, but then, uh, is indeed a very interesting topic.

You say some of the keywords as well as some of the buzzwords. And these are things are the, I guess, are the terms that can confuse a little bit at the, in a first approach to the topic. So Q, maybe, maybe the first, uh, the very, uh, the very first word that comes, uh, to our mind when we talk about quantum and quantum computing in particular, it's qubit.

Qubit is really the building block of this, of this quantum computers. And they represent the quantum.

[00:02:13] **Susan Kish:** Is it a physical, is a qubit a physical thing?

[00:02:16] **Fabio Scafirimuto:** It is a physical thing. It's first of all, of course, it's a concept, uh, was developed first in theory, but then it was, uh, also experimentally proven in different, uh, uh, systems.

And a cubit can be different type of things, but ultimately those things that implement a qubit, they have, uh, a very unique property. The one that they can stay, they can create a quantum state of superposition. It's a term that I need to explain. Um, of quantum state of zero and one. So as in a classical bit, we have zero and one.

In a quantum state, the main difference is that this zero and one can coexist, can be at the same time with a certain probability. And this is what we call superposition.

[00:03:09] **Susan Kish:** In a normal bit it's 0 or 1, in a quantum bit it's 0 and 1.

[00:03:15] **Fabio Scafirimuto:** It's in addition. It could be 0 or 1, but it could also be 0 and 1, as you said.

[00:03:20] **Susan Kish:** Oh, okay, cool.

[00:03:24] **Fabio Scafirimuto:** And this is really opens something simple as that, at least simple in, of course, in words, in explaining it. This opens lots of possibility when we work with those qubits. This is, I would say, is, uh, uh, probably the first, uh, the very fundamental building block, uh, a qubit, which already explains this coexistence of, uh, zero and one is what we call superposition.

It is a basic principle of quantum, uh, physics. And then the other very fundamental principle of quantum computing is, and quantum physics in general, is entanglement. Entanglement is this property of quantum systems of being, this is a bit of a misuse of the word, but the influencing. So if we have two quantum systems that are entangled, these two quantum systems influence each other.

It's a sort of correlation and this property, it's the incredible things of this property is that it's not like a force that is depending on the distance of these two objects, for example, a gravitational force, but it's actually something more fundamental and it's independent from the distance and it's always the same at which, uh, whichever distance, uh, this two quantum system are at a put.

So this is what we call entanglement. So there's two basic properties are superpositionand entangelement.

This I would say are the first two building blocks of this construction, this castle that we call quantum, uh, uh, computers.

[00:05:03] **Susan Kish:** And this is true in the hardware as well as sort of in the concepts of the software that is built? Is that right?

[00:05:09] **Fabio Scafirimuto:** Yes, What we do with the hardware is We're using a quantum system, these states, these qubits, and creating states of these qubits that are entangled.

And once we do this experimentally, and this can be done with electronics, like more, let's say, classical or regular computers, but can also be done in photonics environments, so manipulating these qubits with lights and lasers. Uh, or in other, in other, uh, quantum systems. So there are a variety of implementation. At IBM we have choose a superconductive qubits, but it's one choice. There are, there's a variety of choice that can be of experimental systems can be, that can be used. And then once this building block has been created, what we want to do is manipulating this qubit. And the manipulation is done by using those one that you call gate that are actually called gates.

And these gates can operate on single or two qubits and manipulate these qubits in a certain way.

[00:06:16] **Susan Kish:** So I don't understand. I think of a gate as something that swings open and closed.

[00:06:20] **Fabio Scafirimuto:** Actually, that can be one type of gate. In a quantum computer, you have one gate that we call bit flip. For example, this switch, this state.

Now, let's imagine that this is zero and this is one in a quantum computer.

[00:06:33] **Susan Kish:** Right.

[00:06:34] **Fabio Scafirimuto:** And my hand is a qubit. Now, there are gates that, for example, do this, exactly this operation you mentioned. It's a switch. Let's call this a switch. And we call it bit flip, for example, but it acts in this way. But this is one option.

Now, I don't know how many gates we have, but we have many gates. Gates that makes a qubit rotating of a certain angle, makes that create this flipping gates that operates on two qubits and control the action on one qubit based or depending on the state of this other qubit. So there are a bunch of things that we can do with gates on qubits.

[00:07:14] **Susan Kish:** It would seem that in your mandate focused on outreach and workforce and advocacy and community implicitly, you must have to explain this a lot.

[00:07:28] **Fabio Scafirimuto:** Yes, indeed. That's, uh, has been, it's not my first time that I explain what a qubit and what a gate is. It's definitely part of my job. Although I have to say that while, uh, several years ago, this was kind of a very, uh, it was a new topic and that's actually also not true because quantum computing in the theoretical or a more academic way has been exis uh, has existed for decades.

It came out from, uh, academia only being exclusively, uh, focus of research institutions or universities. Maybe a bit less than 10 years ago, when companies started to invest in these technology companies, of course, as, uh, IBM. And at the beginning, when we started with this, uh, endeavor of explaining quantum computing to people, really, we had to focus a lot on those building blocks or so what is a qubit, what are gates and what we can do, what is entanglement, how those measurements scale up with the quantum computers compared to classical computers and so on.

Now we start to see that the lots and lots of people, like thousands of people, they start to be a little bit more familiar with this concept, not just researchers coming from the lab, but also some people at companies or even in some parts of some government entities that maybe, of course, are more in direct contact with researchers.

So there is a certain familiarity with those topic. Of course, this is still growing, but I have to say that we are now moving in not only talking about the very basic building blocks of this quantum computer, but really upskilling people to use this quantum computers. Are

[00:09:12] **Susan Kish:** you in your advocacy role seeing a lot of people?

push towards regulation. Do we understand it enough to start regulating it?

[00:09:20] **Fabio Scafirimuto:** Exactly. So I think I was going there. I think often happens in a technology field that at first the technology is developed. And then once it's spread enough, uh, then the, uh, policymaker starts to intervene and right, regulate the technology.

I think we, we are definitely not there yet, although I think also policymakers are interested in the technology. We have seen that there are events really gathering on

one hand who people that develop the technology and also people that there are, let's say, the policymakers or the politicians, the diplomats.

So I think that there are also movements in this direction, but it's a little bit too early to talk about policy in quantum computing.

[00:10:05] **Susan Kish:** So what do you see as the biggest challenge when you're leading this kind of outreach and community development and workforce development? What's the hardest thing you have to do?

[00:10:15] **Fabio Scafirimuto:** I think the biggest challenge is really being ready to adapt to a large variety of audience. I mentioned a little bit on this topic, but expanding on what I already said, we see people that are completely, let's say, like a blank page. They, a blank page. They don't know anything about quantum computing. So you need to be able to speak to those people, there are people that know a little bit, know some basics, then people that know a little bit more, people that are experts, people that think that they are experts, I think there is a variety of, of, of people.

[00:10:55] **Susan Kish:** So you have a wide range of quantum literacy.

[00:10:58] **Fabio Scafirimuto:** Exactly. Perfectly defined. I think this is one, uh, maybe it's not the biggest challenge, but is indeed in my specific job where it's really training and educating people is indeed a big challenge.

And often what you have in you in the audience is a mix, maybe not completely from zero to hero or from zero to 100, but you have a good mix in your audience. And ultimately As an educator, what you want to do, it's engaging the people, you want them to learn. But when you prepare the material that you're teaching, you need to have an audience in mind, a target audience.

Now, if this is too different, because there are a large variety of people in the audience, it's extremely hard, it's extremely challenging to find something that is engaging for everybody in the audience. So I find, I find this aspect indeed a challenge in, in my, uh, in my job specifically.

[00:11:55] **Susan Kish:** Well, they do often say that teaching and explaining about something is the ultimate test of your understanding of the topic, right?

The ability to make it easy. So let's say you are a really smart physics, physics aspirant, somebody who wants to pursue physics, and you're sort of intrigued in this quantum thing, and you've, you've read your magazines, and articles and blogs. How would you, is this a place where, let's say, young people looking at their career going forward in science and physics should be pursuing and, and what advice would you give them?

Where should they go study? What kind of topics, what kind of questions?

[00:12:37] **Fabio Scafirimuto:** So that's also great question because part of my role, it's, it's workforce development. So actually my ultimate goal after teaching people is also that people get into this field. Possibly find a job and, uh, so. Indeed my suggestion.

[00:12:53] **Susan Kish:** So you have to go ignite their passion, huh?

[00:12:56] **Fabio Scafirimuto:** Exactly. not only upskilling and train them, but also ignite their passion. So I would say yes indeed. It's definitely a topic already now, not just in few years where people can find a job, can start a career and I'm sure that this career will grow in the next years because this is all the projections are quite optimistic, uh, for the quantum computing industry and the market, uh, we all hope is going to look very bright for people that are in the field at the moment that they will jump in this, in this field soon enough.

So I would say yes, obviously, we are still in a very early phase of the industry. There are not too many job opportunities, there are not too many companies and research institutes really focusing on quantum computing, but there are quite a few. There are a few opportunities in all geographies, I would say, of course, not, uh, um, maybe equally spread, but people can find job, uh, in, in many, many countries in quantum computing.

And, um, so where to start? Indeed, uh, since we are, uh, at the ETH podcast, I can only recommend to study at ETH because it's indeed, by far, one of the top universities, not only in Europe and only Switzerland, but worldwide. So ETH is a great place where to start. A lot of people that work with me in quantum computing come directly from ETH and have studied quantum computing or quantum information theory um, at ETH, I also know a lot of people coming from EPFL, also really extremely good and talented people, but going beyond and in Switzerland, there are also many other good universities and institutions, but I think there are many other out there. Of course, we have excellence, obviously in the U S. In the UK, in Germany, and it is spreading.

[00:14:48] **Susan Kish:** So it must be in China.

[00:14:50] **Fabio Scafirimuto:** In China as well, of course, in Japan, and groups in South Africa, just to mention also other parts of the world. There are many opportunities. What I've seen is also that the number of quantum computing courses at universities or quantum master programs, quantum computing master programs is growing.

Thank you. So that is a clear response for a demanding industry that is upcoming and the sort of the education system in many countries is adapting and adapting means creating new courses and new programs into quantum computing or quantum technologies that can prepare students for their next steps into, into this, into this field.

[00:15:36] **Susan Kish:** So let's talk about your journey, right? You studied at the University of Palermo. Then you did a master's in physics at the University of Trieste. And then did you get hired by IBM and then do a physics Ph. D. at ETH or how did your progression go?

[00:15:54] **Fabio Scafirimuto:** So yes, after my bachelor, master in Italy, and then I also did a master thesis in another city in Turin because I knew I wanted to do some quantum optics projects.

Really, I get my hands dirty and, uh, doing something in an experimental laboratory. After that, I knew I wanted to go abroad. I wanted to study. I want to continue with my PhD somewhere else. And I was exploring different opportunities in the UK, in Spain, in France and also in Switzerland, and actually it happened that I saw that IBM was part of a European project together with other partners, and this European project was extremely interesting, was really in something that I was keen on.

Uh, which is this field of quantum optics, which is quite a broad field. That was, of course, a sub project or a project within the field of quantum optics. And, and I applied, and then we, of course, the interview went well. And then, um, together with my advisor at IBM, we were looking for, uh, an academic advisor.

And IBM in Switzerland, as an IBM research lab in Switzerland, as a

[00:17:08] **Susan Kish:** In Rüschlikon, no less, right?

[00:17:10] **Fabio Scafirimuto:** Rüschlikon, exactly. Uh, not far away from the Zurich city center. So the connection with ETH is very strong. Lots of ETH students go to IBM vice versa. There is a strong connection. There are collaborations in, in the research projects and all in quantum computing.

So it was natural for, for us and for my team, for my advisor to, to look for an advisor at ETH. And this is how I ended up in the physics department, because my topic was very close to what some people in the physics department were doing. And this is how we created this collaboration. And I was part of this European network, this European project, and this is where it all started.

[00:17:50] **Susan Kish:** Fantastic. So it sort of went study, study, study, job study.

[00:17:56] **Fabio Scafirimuto:** And then job, job, job.

[00:17:58] **Susan Kish:** And then job. So I have to ask this other question. Do you miss doing research? Because it sounds like that you have such a broad mandate, you probably don't have time to do your own projects?

[00:18:09] **Fabio Scafirimuto:** Very true. And yes, I do miss doing research. So on one hand, my job is close enough to research and to working with researchers. That somehow I, yeah, that still close enough, but on the other hand, I really don't do

research myself. And sometimes I really miss this pleasure of focusing your time in trying to discover something that nobody else has done before.

So that pleasure is, this is definitely something which also leads to a lot of frustration, I have to say, but that's, I think, it's part of the game. So that part is something that I definitely miss, but I'm happy where I am. Indeed, there are also other way of being satisfied for what I do. And for me, my mission of educating and inspiring other people is also extremely motivating for me.

[00:19:06] **Susan Kish:** How did your work at the ETH influence your work at IBM and influence your choices?

[00:19:14] **Fabio Scafirimuto:** ETH, as well as IBM, in my mind and I hope in the mind of many, at least in Switzerland, really top places. So I think this puts you in a perspective of once you think yourself in, uh, there are graduating in a top institution and working in a top institution.

This puts you in a sort of mindset where you really then want to be driving something meaningful and that drives impact.

[00:19:43] **Susan Kish:** Are you still active at the ETH, or I must imagine you recruit there and do some as you called it delicately workforce development with the various departments who are relevant.

[00:19:57] **Fabio Scafirimuto:** Yes. As you said, it's really with, I still collaborate. IBM, of course, collaborates a lot with ETH in that in several projects, but personally, I'm still in contact with ETH. Um, as you say, in particular with the physics department and the quantum engineering master, because lots of the students that have already graduated there or they're studying in this, in this program, they're really excellent students and they have great prospect also in, they are very interested of course in quantum computing and they've, they are great prospects.

[00:20:29] **Susan Kish:** You've been working in quantum computing for many years. Sounds like you're going to be working on it for many years going forward. What really fascinates you about the world of quantum? What keeps that passion going?

[00:20:43] **Fabio Scafirimuto:** Um, I think the first probably I would have this would have answered the same years ago when I started studying physics and for me, quantum, not only quantum computing, quantum computing is indeed super interesting that it's an application of quantum theory of quantum mechanics.

And quantum mechanics, I think, is extremely fascinating, the possibility of explaining the microscopic world of atoms, molecules, photons, and how they interact and how this and now how this can impact also because people tend to think, Oh, okay, this is really, yes, interesting, but it's actually maybe call for a documentary or a National Geographic or something, you know, a niche because it's not real, has no real impact in our daily lives, but it's actually not true.

There are so many applications that have come from a laboratory that have worked in quantum physics and they've seen and are seeing, uh, or technological applications, uh, nowadays. And I really believe that quantum computers is going to be one of them.

[00:21:55] **Susan Kish:** Fabio, thank you so much. I can see why you're an effective leader and communicator and that this outreach mandate from IBM quantum is a great fit.

Thank you so much for joining us.

[00:22:08] **Fabio Scafirimuto:** Thank you so much. For having me.

[00:22:10] **Susan Kish:** I'd like to close with some of the questions we ask all our guests. And the first one really is when you were a little boy, eight, nine years old, what did you want to be when you grew up?

[00:22:20] **Fabio Scafirimuto:** I loved animals and probably also at some point an astronaut came to my mind, but passion for the night sky, so the stars in the sky for me was something really from a very early stage. So astrophysics, not astronomy, but astrophysics was something that immediately it came, uh, interesting for me and actually I did not expect to become a quantum physicist, in the sense, more focusing on quantum computing. But my initial object or objective when I started to study physics was becoming an astrophysicist.

[00:22:56] **Susan Kish:** And what are you curious about now? What are you learning now?

[00:23:00] **Fabio Scafirimuto:** I'm very much interested in communications. Communication as a general topic. So I like to listen to podcasts, to watch TED talks, to read books on the, on the topic. I find generally, actually, the aspect, the communication is very close to psychology and how to deal with people and how to interact with people.

And I think for me, this is an extremely interesting topic. And other things I'm very, very interested in is actually geopolitics, which they're quite different, but I still think it's a very, actually very, um, important at the moment, but this is something I'm also typically in my free time, watching videos, reading, uh, and so on.

So that's also another topic and then many others like guitars and playing guitars and music and so on. But again, enough for now.

[00:23:54] **Susan Kish:** No, that's a lot. And there is a magical venn diagram where politics and communication overlap without question, um, and psychology and all those things. So you spoke about books.

What are you reading right now? What's on your bedside table?

[00:24:11] **Fabio Scafirimuto:** So, uh, one of the books that I'm reading is, uh, Surrounded by Idiots. And that is a book on communication. So categorize people in four different, now, I don't remember the theory behind it. There is a theory behind it. Categorize people in four group, main groups, and let's say tag them with a color. So there are the red people, the yellow people, the green people, and the blue people. And all those in these categories, peoples have certain common traits. So we develop a whole theory on how, based on, so once we, of course, we find out which, with which type of people we are interacting, then sort of our communication needs to adapt to the, which means, of course, adapting to the audience.

So, that is, I think, is very interesting for me. As I said, I'm, I like communication as a topic. My job is really focused on communication. So for me, this book is very, very inspiring.

[00:25:10] **Susan Kish:** And then finally, what is your favorite place in Zurich? Where is it you'd like to go? It can be at the ETH, it can be in the town in general, where do you like to hang out in Zurich?

[00:25:19] **Fabio Scafirimuto:** That for me, I, I come from Palermo, I come from an island, so for me, the presence of the sea was always, it was something, it was a given. Was always there being able to look at the horizon and of course in Switzerland, you can do that, but I have to say having this beautiful lake with a mountain at the very end and you see this sort of make frame the lake in this super beautiful landscape that for me was very important.

So let's say walks around the lake. that very, a very nice thing to do. And every time that somebody visits me in Zurich, it's definitely something I won't, I won't miss.

[00:25:59] **Susan Kish:** Fabulous. Fabulous. Fabio, thank you so much. That was a great conversation. And thank you for explaining the complicated and fascinating world of quantum and quantum physics.

Where it's going.

[00:26:12] **Fabio Scafirimuto:** Thank you, Susan, and thank you everyone.

[00:26:15] **Susan Kish:** I'm Susan Kish, host of the We Are ETH podcast, telling the story of the alumni and friends of the ETH Zurich, the Swiss Federal Institute of Technology. ETH regularly ranks amongst the top universities of the world in terms of research, in terms of science, and in terms of people.

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