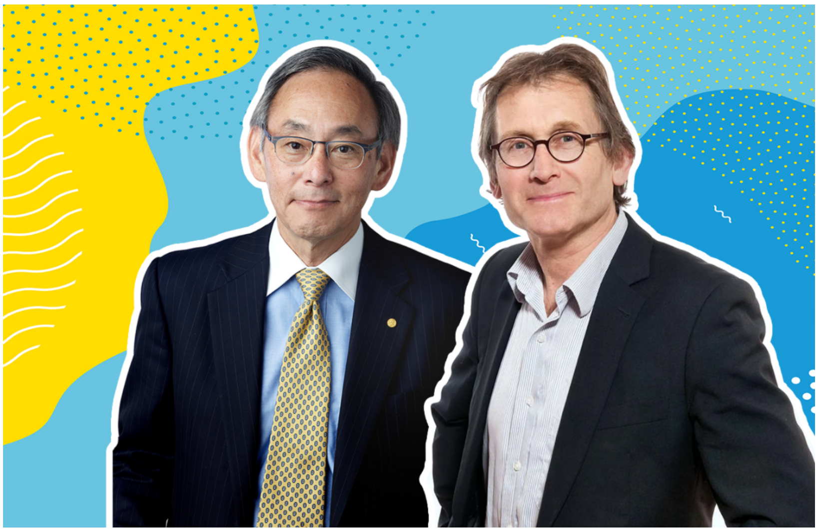
EPISODE 1 | Science AND the service of humanity

with Professors Steven Chu and Ben Feringa



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Passion for science

Ilham Kadri: Hello everyone. Today I'm so excited to be speaking with not just one, but two Nobel Prize laureates, Professor Steven Chu and Professor Ben Feringa. They are both part of the jury that chose our amazing winner for the Solvay prize, which we will talk about in a few minutes. Steven Chu is a professor of Molecular and Cellular Physiology at Stanford University, and the former US Secretary of Energy. In 1997, he was awarded the Nobel Prize in Physics for developing methods to cool and trap atoms with laser lights. Ben Feringa is a Professor at the University of Groningen, and I'm very happy to say the winner of the 2015 Solvay prize. In 2016, he won the Nobel Prize in Chemistry for his groundbreaking research on the design and synthesis of molecular machines. As a scientist myself who has long admired your work, it's such an honor to be speaking with both of you today. Thank you so much for being here, Steven and Ben.

So now I know that a lot of people know you well from your scientific achievements, but I want to start this podcast getting to know more about your background and what motivates your passion for science. So let me start with you Ben, Professor Feringa. You have such an interesting story, and you told me that a few times. You grew up on a farm in the beautiful country and land of the Netherlands, where I lived personally, the second of 10 children. And I've heard you talk a lot about how impactful that was for you right? Your youth, how it gave you a great love of nature and put you on the path to becoming a scientist. And Professor Chu, I read that when you were young, you created homemade rockets, and you started a small business testing the chemistry of the soil in your neighbor's lawn. I hope they were happy, right? So I want to ask you both, was there a specific moment in your life that made you really realize that science was your passion and your calling. Ben, can I start with you?

[03:04] Ben Feringa: Yeah, very briefly indeed you mentioned I grew up on a farm in a fairly small village on the German border, a fairly remote area. And behind our farm, behind the fields, there was the German border and wilderness. And you know, crossing borders, that is what a scientist does. And I think it started there. Because we illegally crossed the German border because at that time it was for me then when I was a kid, but my father looked in the other direction and said, go ahead boys, discover. And so on the farm, there is a lot to be discovered and to find out. Hey, you ask these questions. I think I asked my father when we were in the fields, why is the sky blue? Yeah. And how is it possible that from this small corn, you know, this grain, this huge corn or sunflower growing? But my real interest in science came when I was in highschool. When for the first time I had teachers in Chemistry and Physics, and Mathematics, and I've asked typically I think a natural science kid, so I got really interested, by this experiment, by thinking about the stars, thinking about mathematical formulas, I always wanted to solve every formula, you know? My best marks where in Mathematics for sure. But then I got so inspired by doing experiments, my Chemistry teacher was absolutely fabulous. And I think a great teacher makes the difference. And of course I did not build rockets like Steve Chu, but I think I did at that time, some experiments on the loft in the farm. And my mother was really scared, you know? Because you imagine this is above the animals and there was a lot of hay and straw, and so I easily could have burned the whole farm. Everything went well. And I decided to move not into mathematics, but to go into Chemistry because I liked the experiments.

Ilham Kadri: So it's all about professors, right?

Ben Feringa: It is.

Ilham Kadri: It's being contagious. Yeah. Inspiration. My experience is the same. Steven, what about you?

[05:05] Steven Chu: I love playing with my hands, I had a chemistry set. But if you have a chemistry set in those days, you could go to local chemistry supply stores and buy other chemicals. You didn't need a permit. And so, when you start doing chemistry sets, of course, sometimes people gravitate towards more spectacular things you can do in chemistry, hence bombs and rockets. I did lots of experiments. I built model airplanes. I made things with my hands. You know, Ben talks about family perhaps a little bit concerned that he would set the barn on fire. I was playing with little matchstick rockets as little wooden matchsticks you wrap in aluminum foil, you put it on a paperclip saying to heat it up. If you get the nozzle right, you can send it all the way across the kitchen. And of course, some of the match heads fell down and they scorched the table. So I didn't burn down the house, but I ruined the kitchen, family kitchen table where we ate. My mother came home, she looked at it, she started to cry. I said, don't worry, mom, just take us to the lumber yard we'll buy a new piece of plastic, I'll fix it. This was when I was in grade school, five to sixth grade, I too loved mathematics. When I was an undergraduate, I majored in Physics and Mathematics. But in the end, it was actually thinking it's the science that really mattered. In mathematics, you can stay up all hours of the night, proving things that perhaps I thought in the end, 50 people in the world might care about. Whereas if you discover something about nature, a lot more people might care about it and it could also do some good.

Winner of the Solvay Prize

Ilham Kadri: So let me now switch gears and since you have recently finished choosing the Solvay prize winner, let's take a moment to celebrate the laureate, Professor Katalin Karikó. Her groundbreaking research led to the creation of the RNA messenger COVID-19 vaccine, which has saved so many lives and helped curb the impact of the pandemic. I talked to her recently last week and she's a role model, she's an inspiration, right? And what's so exciting is that she's the second woman to win the Solvay prize. And thank you guys for bringing diversity into the mix. And I had nothing to do with this by the way, but you did. So Professors Chu and Feringa, can you explain why you and your fellow jury members chose her as the winner and how her incredible scientific achievements will change the way we fight diseases? Maybe Steven, can we start with you?

[07:55] Steven Chu: I think, you know, her contributions are undeniable. She did the groundbreaking science that discovered you can, well, we knew that you can synthesize messenger RNA and DNA outside with mathematical precision. You can type in what you want and it, a machine spits it out. And so given that, there was a desire to perhaps use messenger RNA getting inside the cell, and that would be the instruction set that a molecule that resists instruction can assemble an amino acid chain that makes proteins. And so by doing so you can skip all the DNA stuff and you can get the cell to produce something you want. And she thought this was going to be fantastic. But as soon as she started doing experiments in animals, she found the animal rejects it. And so it was her groundbreaking research to discover why it naturally rejects the RNA, even though cells every day make RNA that turns into messenger RNA, that's the instruction set. And she found that it's a protection mechanism against foreign invaders. And looking at that, she stuck in other artificially made RNA, and said, well, it doesn't work, there's no rejection of this, why is this happening, not that happening? And together with a colleague of hers, discovered that if you change chemically one of the bases from the one you naturally synthesize to one that's found in nature, then you can fool the immune system of the organism, the animal. And it was that breakthrough that made it so: Ah, now we can program the RNA, and it was that seminal paper and some follow up papers that really led the way.

Ilham Kadri: Fabulous. And you Ben, what's impressed you?

[10:01] Ben Feringa: I am extremely pleased that she got this award because it's a Solvay prize for the future of Chemistry. And of course, at the end, basically, it's about molecules. This is biomolecules, it's about synthesis. And so this is a clear message, but there is another very important message here with this award and that is to the society. Because recently we heard a lot about oh these vaccines cannot be any good because they have been developed fairly quickly in one or two years ago, realized this is fundamental science and discoveries that were made decades ago. And this is the basis that makes these facts in technology possible. These are due to this long development; this is how science works. And furthermore, it's multidisciplinary in nature, this is more than science. You have to look across borders, you know? You can be very good in Chemistry or Physics or Biology, but usually big discoveries are made at the edges, and thirdly, I think it also recognizes discoveries that were probably not recognized at that stage. I think Steve mentioned it. At that time, people maybe did not entirely believe that it would be useful or it would be viable or whatever. This happens, you know? With big discoveries sometimes people, not even the scientific community immediately sees the impact, the potential impact. So this is really important also to our politicians and scientists. Yeah, look ahead. Scientists should look at discoveries that might have a major impact several decades ahead. And this what is the importance of science, you know? To have this freedom also to make these fantastic discoveries and to bring the world forward.

Ilham Kadri: Yeah. And Ben, this is a great segue because when I talk to Kati, the most inspiring thing I found about her is her incredible story of determination. She faced failures and many challenges, getting the funding throughout her career. She persevered. Yeah.

[12:01] Ben Feringa: Science comes with failures and perseverance. But Steve knows the story much better than I do of her early days. But I got the impression that indeed it was not recognized at all.

[12:13] Steven Chu: Well, she started as assistant professor, was doing this groundbreaking work, but she wasn't getting grants. As Ben said. It wasn't fashionable. Most of the biology, immunology community said, "Oh, this will never work." But she had faith that it would work. Now of course, initially it did not work, but what makes great science is some insight, well, why isn't it working? And tracing down why it isn't working and then getting it to work. And again, this is 2005, then another seminal paper in 2008, it's been a long time. However, with this technology, Pfizer and Moderna, Biotech Pfizer and Moderna knowing this technology, it took them less than a week to design the amino acid sequence that ended up being the vaccine. Because all the other places, you know, the computer design of which amino acid, how they would fold onto - once you knew the invader and the biological structure of the invader, you can predict with small molecules, how they might fold. And so the time that took the thing is just test the safety and efficacy in patients. But now that we've had these two examples of it, the world is exploding because the pharmaceutical companies have realized it's just not for COVID. It's going to be for many, many other vaccines, for many other diseases, and not only viral diseases, but many other things. So it's very exciting that it's going to have a huge impact on the way we prevent and treat disease.

The art of failure

Ilham Kadri: Absolutely. And this is more than COVID by the way, Steven, right? So it goes beyond. And I remember, Professor Feringa, Ben when I met you a year ago, I remember you addressing the audience here in the Maison Ernest Solvay where I'm sitting today, and you spoke very eloquently about failure I remember. And you once said that if you want to be a scientist, you have to stand failures and disappointments.

[14:22] Ben Feringa: Well, we all think we are very smart, but honestly, you know, we have ideas, theories, you know? We set up models, but often we are wrong and as Steve mentioned it, just mentioned it, why doesn't it work? Why does the experiment not work or why does it have a different outcome? Or why does the theory not fit? And this gives you the right questions. Because science is not about the answers, science is about the questions, you know? And this sharpens our questions. We were working on catalysis for 20 years. Yeah. For a certain problem the carbon - carbon bond formation, which is crucial in chemistry, you know to build chemical structures. And for 20 years, we did not know how to do it. And then one of my PhD students on a Monday morning made a failure, a complete failure. I couldn't imagine why he did it, but I think he took the wrong bottle or whatever, you know. And then suddenly it worked. And we learned after 20 years and within two weeks we knew what was going on and why it worked and what we have not seen. So these are these eye-opening moments for scientists. So failure is also important because this is a learning point where you can sharpen your questions and maybe get to the right answer.

Ilham Kadri: So some of the biggest inventions and innovations happen because of failures and serendipity, right?

Ben Feringa: Serendipity is certainly part of science. Yes, we should not forget that.

Ilham Kadri: Absolutely. So aside from being okay with failure, Steven, what does it take to be a good scientist, according to you?

[15:54] Steven Chu: Well let me first reinforce what Ben said. I'm going to quote, I think, Winston Churchill that said about prioritizing terms of successful scientists, is that you go from failure to failure to failure with continued enthusiasm. And I think in addition to doing this, it's not failing the same way, the same time again and again and again, that's not productive. After once or twice, maybe three times then you think, oh right, something's wrong, something's missing, then you look for clues. And one of the things that I learned was when you do experiments, some people do an experiment expecting a certain outcome, and when something else is different, they say, No, I can't be. And then they do something else. And a good experimentalist will let nature talk to them. And when nature talks, listen. So when you do an experiment, there might be something going on, it's not exactly the outcome. And then also do things slightly different, even if it's sort of working. Again, you know, coaxing out more of the answer. And so that's more of an art, I’m not sure we can put this in textbooks yet. That's one of the things about failure. Failure in a different way actually tells you something. And so a good scientist can take that all in. And we live with the ambiguity.

[17:41] Ben Feringa: Ilham, if I may add to this, maybe you can call it all failures, but in fact, a lot of these failures are messages to us. A clear message is to think sharper or to reformulate, you know how we do things or how we think about it or whatever. That is integral to science.

Future energy mix

Ilham Kadri: So let me now switch gears to energy and molecular motors, right? Which are your sweet spots. And one of the objectives of this podcast is really to explore how businesses can ensure that scientific innovation is at the service of humanity. So I'd like to talk about practical applications. Professor Chu, let's start with you, because in your former role as the Secretary of Energy, you have been at the heart of the energy transition and you see firsthand how sciences has been the key to making it happen. We at Solvay, we are working on EV batteries, right? It is booming. We are working on green hydrogen right and all things renewable at the service of cleaner mobility as an example. So tell us what scientific breakthroughs are you seeing in the energy sectors and what do you think is the best energy mix for the future?

[18:52] Steven Chu: Well, the best energy mix, so let's start at the end. The best energy mix is something where we have clean energy, carbon-free energy, non-polluting energy, ideally compact energy. Meaning that you don't need, you know, in hundreds and hundreds of square miles. But it's greenhouse gases and it's all the other pollutants. But this goes beyond when people think of energy, they think of, well, they think of electrical power, they think of transportation. But in fact, energy pervades everything. We use energy to make the fertilizer and the diesels. But in addition to that, the fertilizer, when not absorbed by the plants ends up being a greenhouse gas effect. And so if we think of sustainability, then we have to think of all the things that lead to greenhouse gas emissions, agriculture and land use is more than electricity, power generation around the world. Most of chemistry is Thermochemistry. And up until very recently unthinkable to think of Electrochemistry as being a mainstay on electricity. Aside from a few things, aluminum chlorine, a few of them, most of it is

Thermochemistry. So we have an opportunity if we have very inexpensive electric energy that you can branch out. But going beyond that, if you think about all the things that we've grown used to and depend on, we are used to having lights on when it gets dark outside. We're used to having our homes warm when it's cooler or cold at night, or more recently, perhaps cooler than normal as certain parts of the world get hotter and hotter. These are things that we've gotten used to. Transportation we've gotten used to. We never dreamed of these things 500 years ago.

Ilham Kadri: Yeah.

Steven Chu: It would be unthinkable to think you'd be eating fruits and vegetables from halfway around the world.

Ilham Kadri: Yeah.

[20:58] Steven Chu: Okay. And so, now, some of these things we should rethink. But other things, I think science, technology, policy, all these things could say, we can have these things, but we can have these things but we can have it in a way that preserves the resources far longer into the future. And especially to stop the greenhouse gas emissions and the local pollution of the water, the air, the everything. So now, in doing so, chemistry actually lies at the heart of many of these potential solutions. And so this is one of the things, you know, I'm a physicist. So you would say, the king of science, but Chemistry is the linking science to all the other things, the Chemistry, the Biology, the Physics, the Earth Science, you name it. And so you know, it's good to be king maybe, but it's better to be connected to everything.

Ilham Kadri: Yeah. And I'm sure our Solvay employees and researchers, they will love it. I used to say that Chemistry is the mother of all industries. So at the end of the day, it's at the heart of it. To finish on, on maybe batteries because it's very close to our hearts at Solvay and we commercialize generation two Steven, we're working on generation five, which is pure, solid, right? And much safer, cheaper, affordable, et cetera. What do you think will be the next big thing in batteries?

[22:25] Steven Chu: Well, two things. If we can get a solid state, a battery that has a solid state electrolytes, so I would say conductor, that would be great. As you say, it's going to be safer, the electrolytes, current electrolytes are flammable. You've got them to get them to work at room temperature and even freezing temperatures in order for that to be practical. You need cheaper batteries, you need higher energy density batteries, and you need faster charging batteries. I do battery research myself, and we're working on higher energy density, batteries, and ones that can weigh half or a one third, what they weigh now. Faster charging batteries are going to become a reality. If you can imagine a car with a battery and electric motor that weighs the same as a one and a half or two liter engine, transmission, and a fuel tank, but can go as far and can charge maybe 200 miles in five minutes, you would never think of buying an internal combustion engine car, because it's so much cheaper to operate an electric vehicle and the maintenance is far less. And so the battery is the key and we are now testing batteries that can go 200 miles in maybe eight minutes. Right. Now, these are not on the market yet, but it's getting better. The next thing is you know, to half the weight, So that half the weight means you're not looking at a heavy battery, which means you need a smaller battery. Many, many things, these are very exciting. It's a matter of when, not if. Now, we will never charge as fast as you can to fuel an internal combustion engine car, because when you put gasoline or petrol in your car, the power is 5 million watts of power going through that tube into your car. But you can transform the world with a half a million watts of [recharging] power. And this is what I'm talking about. These [recharging] times of five minutes. Because the battery and electric motors are two times more efficient, and so you gain back a little . So it's going to be a very exciting time. But remember, batteries are going to transform personal electrification, but long range, heavy duty air transport is going to need probably, chemical, liquid, hydrocarbon that's renewable.

Ilham Kadri: Are you a believer in green hydrogen, Steven?

[25:12] Steven Chu: Well, I believe in hydrogen. Green hydrogen is great if you can see sequester safely all the CO2, hydrogen is fine also. But I think liquid hydrocarbons are different. It's much higher energy density. And so while you can imagine battery airplanes for small short range things for transcontinental distance and huge payloads, the liquid hydrocarbon still has the highest energy density. And so we need physicists, biologists, chemists to figure out how to make carbon neutral liquid hydrocarbons. So when you burn it, you release carbon dioxide, but in producing it, you're actually grabbing carbon dioxide out of the air, out of something else. And plants do this very well.

Molecular motors

Ilham Kadri: Yeah. Yeah. Well, it's a fascinating conversation. And we'll follow it up. We at Solvay, we have a membrane for green hydrogen, for electrolyzers out of solar and wind. So fascinating conversation. Let me switch gears here, Professor Feringa, your work on molecular motors has incredible potential, especially in health care. Can you explain to our audience and innovators, explain the molecular motors? And what do you think are the most exciting applications for molecular motors in healthcare that you see coming.

[26:43] Ben Feringa: Yeah. First of all, let me briefly explain these molecular machines. And of course there are many people in the world working around it. And I got this award together with my colleagues. So Fraser Stoddart and Jean-Pierre Sauvage, we are also pioneering on different concepts of molecular machines. We have been working on light driven rotary motors, so to use light, energy, to make something moving. Now, why do we think this is fundamentally so important? Because think of your body, you know? I mean, everything moves, that we can talk with each other, we can see each other, you can move your muscles, et cetera. Mother nature invented how to move things, although they never made a fuel driven machine, like in your car or in an airplane, but your body is full of machines, you know? And the most beautiful example is the ATPases rotary motor. This is by far the most fantastic rotary motor that is there in the book. Yeah, that makes the fuel in your body, the ATP. Having said that, moving from static material, like a piece of plastic to something that is dynamic, et cetera, I think it by itself will be really important for the future. And why is that? Because you can make all kinds of smart, adaptive materials, like functional materials that can adapt and reshape, and whatever. And also for recycling of polymers in the future, plastics, all these materials, it's really important that we not only have static function, but we bring in dynamic function. I'm not saying that our motors will do that, but once you learn the principles how to do that, it will be much easier to make robust materials, but also that have the propensity that they began easily recycle. And this is exactly what our body does. Your body does not fall spontaneously apart, but still 40% of your body also is recycled everyday as far as I learned from my colleagues in Biology. Now in medicine, think about smart medicine. For instance, what we do, we built now drugs, pharmaceuticals, where we build in light switches so that we can switch on and off the light. And this is now a whole community in the world. You know, when you engineer the neurons and you can then tune, you know the signals in the brain, but there you need genetic modifications. But what we do is we take artificial switches, like the switching your eye. For instance, we modify it, we bring it to a biomolecule. And the whole idea is that when you have a tumor, you can detect it with this modern detection technique, the modern imaging techniques that you would be able to switch an anticancer compound on the activity on right on the spot. And it does not have all these nasty side effects. The same for an antibiotic. Activating an antibiotic on the spot and it does not harm the rest of your body. It does not build up resistance. That is a bit the idea. So this goes all the way from self-cleaning windows, coatings on your car that you don't have to wash your car anymore, or you don't have to repair it because itself heals like scratching your finger to smart drugs. That is the perspective for the future. It will take a couple of decades, but I'm convinced that it will come. We have to learn how to do it.

Ilham Kadri: So it's more than healthcare, right? Everything at the service of humanity, hygiene, cleaning.

[30:10] Ben Feringa: Hygiene, cleaning, self repair, I think mother nature, does it, why cannot we do it? We just have to be smarter to develop it.

Chemistry as the key for sustainable solutions

Ilham Kadri: Absolutely. So I know that you both have a strong, very strong interest in environmental sustainability. You have a passion for sustainable chemistry. Can you tell us Ben more about how you see science and chemistry enable that more sustainable future in a time where climate change, the risk of pandemic, look at what's happened, the world stopped because of COVID-19. It brings the sense of urgency to take care of our home, the planet, and obviously the next generation, our kids want us to leave a legacy, which is a cleaner planet, right? So how do you see chemistry, which sometimes has a bad label, specifically in the industry I belong to, you know?

[31:07] Ben Feringa: Let me make one thing clear. Of course there are serious issues, but I see it as tremendous challenges for us. I realize that if I would tell my students, you know, that I was teaching today and I will tell them- "Oh, it's disastrous. You know what happens in the world." They will not have a spirit for the future. These are all these bright, young people. We have to tell them, see it as challenges and reshape chemistry. For instance, you know, I'm a chemist and the same holds for parts of physics, material, science, engineering, biology. How can we reshape and help to change this? See it as a challenge, you know? To bring the world forward to sustainable solutions. And I think we can do it. In the past 100, 120, 140 years, we have all benefited from Petrochemistry. This is the basis of a lot of things we make. From the fuels in our planes, to the cars, to your clothes, to our food, whatever, the fertilizers. Now, we cannot continue with building everything based on Petrochemistry, so we have to come up with alternatives. But I think we have only scratched the surface of what is possible. So I think there are tremendous opportunities here to come up with cleaner processes. Steve mentioned Electrochemistry. We can do a lot with electricity, because a lot of chemical processes are redox processes, just adding electrons or taking charges away. If we better use that and explore that, I think we will have much cleaner processes in the future. Recycling is another thing. We are extremely good in making all kinds of materials, building all the materials for an airplane or in the car, the isolation materials, all the plastics, et cetera, but we are not very good at recycling things. So, if you think about designing materials and this is also for companies like Solvay, designing the materials now within the back of your head, not only to design a robust material, but also design the property, that it can be properly recycled into useful materials, starting materials and whatever. That's a different attitude. And that's a challenge for us. And I think, yeah, it will be difficult, but we can do it.

Ilham Kadri: Yeah, this is very inspiring. And you're right. I mean I remember when I was a chemist in the lab 25 years ago, doing my PhD, I was asked to make a polymer, which works not to design a polymer, which can have a second life after its end of life in current life. And I think this is circularity and we are working on batteries for example at Solvay to recycle batteries at the end of life. We just started our first pilot, yeah.

[33:52] Ben Feringa: Yeah. And honestly, we are a bit spoiled because a lot of the materials that the chemists and the physicists, and so our communities designed and made, they are simply too good. They are so good, you know? For all these kinds of tasks and duties that we did not really think about how to go to the next steps. So we have to rethink a lot of these concepts, you know? But that can be done. I'm convinced.

Ilham Kadri: Do you agree, Steven, that circularity is part of the answer to sustainable challenges? Yeah.

[34:22] Steven Chu: Absolutely. I think as Ben said, due to discovering oil, discovering the chemistry that comes with oil, natural gas, and the petrochemical industry, things got very good, they got very inexpensive, they got very durable. Before that, when we made things of natural materials, wood, for example or rubber, there's some value inherent value in this. We made things that were repairable because the starting products were not, you know, sold pennies to the kilogram. And so now what we have is we have something different. Yes, it could still be inexpensive, but the full cost to our lives, to the environment are much higher. And so now we have to think of recycling because recycling means in a certain sense, repairable. We went to a disposable economy because people figured out- Oh, you build a refrigerator, make it last 10 years, not 50 years, throw it away, and buy another one. This does not do the environment any good. And so this whole business of making things last longer, repairable, ultimately recyclable has to be designed in from the ground up. And in terms of petrochemicals, it is a very ticklish question. It is how you actually designed this stuff that was so durable, so inexpensive to say, come apart when we want you to come apart, back to the original building blocks and then reassemble. That's what life does. The building blocks of proteins are amino acids, they recycle them. They are things, little machines that chop them up in the amino acids again.

Ilham Kadri: So recycling, we should be greedy with the resources and use them again and again.

[36:15] Ben Feringa: Honestly, living nature, mother nature, doesn't spoil so much.

Ilham Kadri: Yeah, yeah, yeah,

[36:21] Ben Feringa: They are very good in recycling and reusing. The bacteria use it for instance, or the plants grow on it, yeah?

Diversity in STEM

Ilham Kadri: This is exceptional. So I will have another podcast on recycling and circularity with you guys. We are getting to the end of the podcast and I would like to end with the note of honoring again, Katalin Karikó, but before her Carolyn Bertozzi was known for her Bioorthogonal Chemistry. These are the two women winners of the Solvay prize. I want to ask you in general about diversity, equality, and inclusion. I used to say diversity is what you see, inclusion and equality is what you do. And it's very crucial in the field of science and for any business. And as you well know, there aren't enough women and girls, even in the science, technology, engineering, and mathematics, the STEM careers, and we lose them. There is an attrition at one point of time, from the academics to the industrial side. What are your thoughts on diversity and inclusion, and what are you seeing? Are you seeing improvements really from your leadership position in the universities?

[37:32] Steven Chu: Well, let me begin. There are improvements. But I think there is still a fundamental issue and that fundamental issue is in the raising of families. The raising of families should be a joint venture between the husband and the wife. If the majority of child bearing falls on the woman, that in itself is going to have an issue with the careers. And so I actually used to tell my graduate students, you know, when you marry someone who's committed to both partners, are equally committed to raising your children of equal time invested in their children. Now, I have to tell you a story. Now I had an aunt, she was a chemist. But it was very unusual. She was born at a time when women's feet were bound in China. But by the time she was in her thirties, she became a professor at Tsinghua University and she's listed in the history of Chinese Science Chemistry as the most influential woman scientist in Chemistry. She was one of the most influential chemists of her time. Okay. Then, then during World War II, she too had to leave. Otherwise, she would have been killed. She comes to the United States, but she's Chinese and a woman, both two strikes. She could not get a job in any distinguished research university in the United States, so she ended up as a job in a school that trained women to become high school and grade school teachers. But she was so good that she was able to secure NIH funding and maintain a lab for decades in a school that never had research. Now, those people are very rare because usually when there's no infrastructure, there's no support, there's no anything. And so I think you need all these things so that people like that can flourish. And now things are different, but it goes back to this issue. And we see this with COVID as soon as there's no more school and the kids have to stay at home, the burden seems to fall more on the women than the men.

Ilham Kadri: Yeah, no, it's a great wisdom. And Steven, you will be happy to hear that at Solvay we extended our maternity leave last year, January 2021 from 14 weeks to 16 weeks. So all future fathers and co-parents, regardless of their orientation around the world, in China, in the US, in Europe. Because we believe that if you want to help women to get to the top, you need to help their spouses to help them during critical times in their lives, which is welcoming a new baby or adopting a child. And I love your joint-venture word. I will steal it from you. And then, lots of young female scientists will tune into this podcast to listen. What advice would you give to these scientists and girls who are starting out.

[41:02] Ben Feringa: Yeah, my best advice is follow your dreams, you know? I've said that at many occasions don't give up, although it might be something, sometimes difficult. But realize things are changing, you know? Because when I started as a student in a Chemistry, Physics, et cetera, there were hardly any girls. Now, I have a sizable group and a half of them, when you see a picture, Half of them are girls and they are from India and America, from everywhere, you know? So they come from 14 different countries all over the world. So things are changing, also in the natural sciences. But on the other hand, Steve is right, it is tough, you know, sometimes because let me give the example of our eldest daughter. She is a post-doc, she is a cell biologist, she is working in the Alzheimer's Center of the medical school in Amsterdam. And she has two small kids, you know? And now especially what I see with the young people in this COVID situation, when you are experimental scientists and you are at the beginning of your career, it's particularly difficult because you bring your kids to the, to the, to the kindergarten or the daycare, but then they cough a little bit and then they call you in your lab, come home. Yeah. This is what my daughter tells me come home because they are coughing and you have to go home with them because they cannot stay there. And so it is difficult. And we have to help our young people. And especially in these difficult times, it is more than ever important that the organizations, the universities, the institutes, the companies see this, that they need some help to get to the next steps of their career. Because honestly, I think we have so many fantastic young talents, and it doesn't matter, you know, which gender or whatever. Yeah. It is important that we help them and stimulate them that they make their own dreams come true. And luckily also with the Solvay prize, we have now some very good role models. And that helps also a lot. Because of course also Solvay prize winners, they had their difficult times. Yeah. And so we have to emphasize, you know, how important it is, especially to the girls.

Winning the Nobel Prize

Ilham Kadri: And thank you, thank you as a member of the jury on the behalf of the whole scientific community, that you are bringing those woman role models. Because frankly, when I was young, medically made me dream out of this, a photo of 1911 with our founder Ernest Solvay. And you guys now giving the same wisdom. I think it really resonates with many, many young scientists, female scientists around the world. So, one last question. What did winning the Nobel Prize mean to you both?

[43:49] Ben Feringa: Now for me, of course it was a dream coming true, yeah? And that having said that, you know, I was not busy with a Nobel Prize or whatever, you know? I was fascinated by this scientific adventure, the discovery that started already when I was a kid. I mentioned, yeah, the adventure of wanting to know. And I was reading these books of Humboldt and about adventurers, discoverers. And then suddenly you realize at a certain point that you are a discoverer that is recognized in the world and it's like a dream coming true, you know? And I wish every talent, you know, to have these kind of dreams.

Ilham Kadri: Steven?

[44:37] Steven Chu: Well, you know, I did not appreciate it, it took me a while. In the sense that, you know, people begin to say, well, maybe you're going to get a Nobel prize. And I just shrug my shoulders. And because I'm thinking, well, I got to know a few Nobel laureates. Before the prize, they were very good scientists. After prize, they didn't suddenly become better scientists. And so it never hit me that, yeah, among the scientists, maybe it's all right, to the general public, it was very different. And it actually didn't hit me until the night of the ceremony. When you march out into this converted opera house that I realized, wait a minute, this is different. You know, you're going to become part of history. But the other thing that I did not fully appreciate as fully as I appreciate now. I said, [at the time I was awarded the Prize], "I'm never going to speak about something I don't know anything about." That's a Nobel Prize disease. But as a citizen of the world, what does that mean? And I started this around the year 2000. I got my prize in 97, but around 2000, I got interested. Maybe these people talking about climate change perhaps was skeptical. I started reading. I kept my word. I was never going to talk about anything I didn't know anything about, what it made me do is to learn about it,

Ilham Kadri: Yeah.

Steven Chu: Because if you are informed, you do have another voice, an extra voice that other scientists don't have. But it's the duty of people in this position to become very well informed before they start talking. And it also changed my life because, since the middle 2000s, I put my scientific career sort of on hold for a decade, and said, I'm gonna try to do what I can in order to let people understand what the challenges are and try to inspire them to go in and change their careers, and use what they know in science to help with climate sustainability, energy, all of these things.

[47:00] Ben Feringa: What changed in my life was that of course I still do science, but the opportunity to go to advocate the importance of science to society, to the general public, you know? Appearance on radio and whatever, to go to schools, to encourage the young students, you know, in high schools, in elementary schools, all these kinds of things that never was so intense then after the Nobel Prize. And apparently this is a fantastic opportunity to do that. And it helps a lot. Yeah, to advocate the importance of science, to bring our future forward, to bring the talents forward. And also you should be, how do you call it, what Steve said. Certainly they think, you know, you have an opinion about everything. Yeah. So I want to quote my wife who was asked by a journalist on television- How is that to be married to a Nobel Prize winner? And you know, her answer was- He seems to know a lot about Chemistry. [00:58:16]

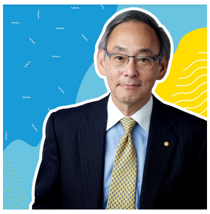
Ilham Kadri: Fabulous. So it's another proof of your leadership. Humility is the best and one of the most fascinating attributes of great leaders. And my takeaway is that the journey, focus on the journey. The journey is fascinating, brilliant. The destination can be as bright as bringing you to the Nobel Prize. And listen, you are part of the history of the Nobel Prize, but I know that your legacy and your work and contribution are invaluable and part of our future. So thank you so much for joining me today, Professor Feringa and Professor Chu, this was a fascinating discussion, most inspiring. And I'm sure will be so inspiring for our listeners, for scientists, and business people alike, by the way, as we strive to ensure our scientific innovations are the service of humanity and its progress. Thank you both.

Ben Feringa: Pleasure.

Steven Chu: Thank you.

Ben Feringa: Thank you so much.

ABOUT THE GUESTS



Steven Chu is a professor of Molecular and Cellular Physiology at Stanford University, and the former US Secretary of Energy. In 1997, he was awarded the Nobel Prize in Physics for developing methods to cool and trap atoms with laser lights.

Ben Feringa is a Professor at the University of Groningen and the winner of the 2015 Solvay prize. In 2016, he won the Nobel Prize in Chemistry for his groundbreaking research on the design and synthesis of molecular machines.

They are both part of the jury that chose the winner for the 2022 Solvay prize, Katalin Karikó.

ABOUT THE HOST

Ilham Kadri is a purpose-driven business leader, scientist, optimist and world citizen who is passionate about making businesses sustainable AND profitable, science-based AND human, daring AND caring.

Full bio

ABOUT THE PODCAST

AND is the future is a podcast hosted by Solvay CEO Ilham Kadri that brings together great minds to address the opportunities and challenges of making businesses both sustainable AND profitable. The podcast will gather thought leaders across the globe to discuss how businesses can profitably reach carbon neutrality and sustainability goals, ensure that innovation is at the service of humanity and its progress, protect biodiversity, transform the value chain, unleash peoples' full potential through diversity, equity and inclusion, and much more! Find more on solvay.com.