Transcript: One universe, two perspectives (29)

[00:00:00] Hi, thank you for tuning in, I'm Jennifer Khakshouri and you're listening to the ETH podcast. In our last episode, we reached for the stars
[00:00:12] with the only Swiss astronaut, Claude Nicollier, and with an aspiring astronaut Judit Szulagy.
[00:00:19] And in this episode we continue to hear about the universe and talk to two ETH scientists
[00:00:25] with different perspectives. One of them is Domenico Giardini and the other one is Adrian Glauser. First of all, Domenico where are you right now?
[00:00:35] Oh, I'm in the wide definition of home office, I'm in Calgary a bit far away from Zurich
[00:00:43] but on Zoom, we're all in the same office, so my room is always open. Adrian, where are you? I'm at the ETH Hönggerberg right now in my office. So, I would like both of you to introduce yourselves, Domenico maybe you go first.
[00:00:56] Yes, I'm a professor of seismology and geodynamics since 25 years at ETH in Zurich.
[00:01:03] I directed the Seismological Service of Switzerland for 15 years and after that, I changed, then I moved to coordinate the national research on energy supply for the energy transition.
[00:01:16] In terms of research I participate in two space missions, one is LISA for the detection of gravitational waves from space
[00:01:25] and then I have a seismometer running on Mars on a NASA mission. We'll speak about seismometers later. Adrian, please tell us what you do.
[00:01:34] Yeah, I'm a senior researcher here in the group for exoplanets and habitability in the institute for particle physics and astrophysics. I'm leading the laboratory for astronomical instrumentation, that's also because I am an
[00:01:47] astronomical instrumentalist, as I call myself, meaning I'm developing instruments for the largest telescopes both on home ground and in space.
[00:01:57] When I look up into the sky and see the stars and the moon, I always think about
[00:02:01] my childhood and how many other people in history have seen these stars and moons hundreds and thousands of years ago and somehow, I feel connected
[00:02:11] and very calm but also very little. Is this something you know as a feeling as well? Yes, in a sense the Earth is always very noisy very full of people, very full of everything and
[00:02:22] when you look up
[00:02:24] of course, you lose a bit of the dimension. Things are very far away. They are bigger and noisier than the Earth is, in comparison, a small place where almost nothing happens other than our own lives
[00:02:34] in terms of big scale but obviously, we're looking further away and try to understand that things that appear only are small specks far away is very difficult and very challenging and moves a lot of your own energy to it.
[00:02:48] And you Adrian, do you have this sense of
[00:02:51] remembering childhood as well and feel moved when you look up into the sky nowadays? Absolutely, I mean for me this was always the most inspiring part, looking up and
[00:03:01] thinking about the infinity
[00:03:03] and reflecting about our own space here in our place in the universe: how unique are we, are we unique or is this something that just must happen? This is now on a professional level a question I still try to answer at least
[00:03:18] a small piece of it. Do you both remember a moment for instance in your childhood that led you to what you do today? Yeah, absolutely, I mean

[00:03:27] I think I was 10 when I knew that I want to become an astronomer. The first telescope was a gift from my grandpa, since then I never really left this fascination and
[00:03:37] although I studied physics and not astronomy it was always clear that I want to end up as an astrophysicist and finally became one.
[00:03:46] And you Domenico, was there a magic moment in your life?
[00:03:49] In my case, it came later. Of course, it's impossible not to be fascinated by astronomy in general so I had a small telescope at home, I was looking at things trying to keep following stars, and so on, all of that we've done as kids.
[00:04:04] But professionally I started looking inside the earth in 1996, there was a French mission that wanted to bring a seismometer to Mars and it just blew up on launch.
[00:04:18] And then I got attracted to it. We started talking to French colleagues and I said: sure, what we know how to do on earth of course unless we have 5000 seismic stations running.
[00:04:30] But if you go back 100 years
[00:04:33] on earth, we had only single stations, and nonetheless, the people 100 years ago understood the interior structure of the earth and if you do not understand the interior structure of a planet you don't understand the planet.
[00:04:46] What moved me in a sense was that episode. The last of the rocket with seismometers on board actually brought me to say: ok but we can do it better. But then it took 25 years. But now
[00:04:58] we are on Mars. Adrian, together with many other people you worked on the James Webb telescope, the largest telescope ever and it's supposed to
[00:05:13] uncover the origin of the first galaxies. The James Webb telescope is to launch this fall, what does this mean to you that it will
[00:05:22] leave planet earth in the fall? First of all, it's a big relief if it finally does because I'm waiting for this moment for many many years. I started
[00:05:30] 18 years ago actually, being involved in that mission. It got delayed for various reasons several years and we're seeing this now coming to an end
[00:05:40] and then still we will be involved for the first 6 months for commissioning support, it's a big relief and reward as well.
[00:05:48] And having been able to contribute to the world's biggest space telescope to precise that is also -
[00:05:56] I'm looking very much forward to the all the discoveries that will be made with this facility.
[00:06:03] You just mentioned that the launch was delayed a few times it was
[00:06:08] originally meant to leave 10 years ago but it's common that schedules of projects of this size get postponed and changed a lot. Do you need to be
[00:06:18] patient as a researcher in this field in general? Patient and stubborn, I would say both.
[00:06:25] Many colleagues that were part of the project left either because they got retired or they looked for other positions, I was lucky enough to still
[00:06:34] be involved in that mission so I think it's also a privilege for me. Yes, we need to be patient but it's not that this would be the only project I'm working on. So, I started
[00:06:43] because I was impatient also to now being involved in the world's biggest telescope on ground which is the extremely large telescope and so that makes me busy right now and more actually than the James Webb mission.
[00:06:56] Domenico, you're lucky, your instrument is already on Mars, did you need to be patient with that as well?
[00:07:02] Yes, you need to consider that the last seismometer on Mars was in 1976 and they didn't record anything because it was located on the

lander on the Viking, this was the American Viking, it didn't have any recording.
[00:07:16] It took decades to convince ESA or NASA to actually go up there with a seismometer again. And ESA, the European Space Agency, never landed successfully on Mars.
[00:07:29] You need to consider that Mars looks like it's nearby and easy to reach but more than half of the missions that were launched to Mars - and they're now 45 of them -
[00:07:39] either missed Mars or they arrived at Mars way too fast and crashed, or they simply got lost way before going anywhere, and for every successful mission
[00:07:52] that gets launched there are at least 5 of them that
[00:07:56] get to a certain level of development and then there is no funding, or the priorities are changing. So, it's a business, it's a lifetime business.
[00:08:06] And usually, we think that reaching a planet (such as Mars) is easy once it's reached but it's not easy at all. Actually, what you do is
[00:08:14] contrary to the James Webb project. The James Webb telescope doesn't want to meet anything in the sky, but we have an appointment with the planets.
[00:08:21] After 6 months we are on the project which is the orbit followed by Mars.
[00:08:27] And then Mars arrives very very fast and then you have to make sure that everything is
[00:08:33] very very precisely timed, everything works well so that the planet doesn't catch you because it's a big planet going very fast.
[00:08:42] What is it about Mars quakes that interests you, why are they so interesting?
[00:08:47] There are two reasons, first of all we have them which is good that if we had landed there and we had no mars quakes it would have been very disappointing but we actually we do have them.
[00:08:56] And it's amazing what you can do with a single station and a few quakes on a faraway planet.
[00:09:04] You can see where the core is, how large the core is. Until now from rotation parameters, we knew there was a core, but we couldn't go much further than that. Now we nail it, we know the mental conditions, we know
[00:09:17] the depths of the crafts to the lithosphere - the outer layer of a planet. I'm using technical terms but what it means is that we now can see inside the planet and see how the planet is built.
[00:09:27] And we can start discriminating why did they go in a different direction than the earth or not for example.
[00:09:34] That planet had oceans and an atmosphere in the first billion years of its life and then everything went away. The most likely cause is because it lost the magnetic field, the magnetic field depends on how the core
[00:09:47] rotates and works. Why did the cores low down so that there was no magnetic field, and could this happen on the earth? Usually, you see the things in
[00:09:56] movies but actually here you see it on other planets, and they are there and you can really look at it now that we look inside.
[00:10:04] The second aspect, of course, is that the planet, if it has quakes, it means the crust is active it doesn't have plate tectonics but this
[00:10:13] is subject to strain, to stress, exactly like the earth so we can see the geology, we can see the faults from above, from remote sensing actually better than to see on the earth.
[00:10:24] But we now see what happens inside the craft and so it tells us where it is deforming and how. And does it teach us anything about planet earth?
[00:10:32] Yes, it does. Of course. today we know
[00:10:36] about 4000 exoplanets, as they are called, so planets which have characteristics similar to the earth.

[00:10:43] But in other solar stellar systems in our galaxy, but those planets are very far away we will at most know a few parameters from them.
[00:10:53] But Mars is a planet on which we can actually walk in the sense, quite soon we will if possible, but it's a planet from which we can learn.
[00:11:04] Why did it (planet Mars) follow a path so different from the earth?
[00:11:08] I often show two slides to my students, one is a slide from above, an image of the geology of Mars from above, and one is from Arizona.
[00:11:19] You cannot distinguish the two, we are not so far away. All of our world could be desert-like in Arizona, so we're not that far away.
[00:11:28] Understanding why a planet, what parameters change on the planet in order that the planet takes a different path than another, and why we have a life here other than on Mars? Did we have life on Mars?
[00:11:40] And how did it end, so these questions are
[00:11:43] crucial questions for us. Adrian, what crosses your mind when you hear Domenico talking about
[00:11:54] having his hands-on Mars already?
[00:11:57] Well I'm jealous for two reasons. One is he went through a risky phase of the mission and successfully passed it. The other is that he has
[00:12:06] the possibility to examine a planet that is
[00:12:09] close and he can examine it with parameter space that is inaccessible for us. That sounds like I'm quite jealous because all the exoplanets we are going to observe we have
[00:12:19] always indirect indicators and if we are very lucky in the far future with might also see indications for life.
[00:12:26] But we will not have the same measurements being able to conduct in all those exoplanets. The difference though is because we observe exoplanets
[00:12:36] we have a very big variety of objects and that also constrains questions of how life on earth actually can happen and so it's certainly complementary to the two fields.
[00:12:48] Both of you in a sense of time and the context of space is
[00:12:54] on a much larger scale than our lives. What is it like working for things you might not witness anymore? Adrian, you are working on a future telescope, as you told us, that will be in use at the earliest once you retire - what's that like?
[00:13:08] So you refer to our vision that we would like to launch a space interferometer that really allows us to
[00:13:15] probe earth like planets around other stars and for that you need to go to space you need to go with very long so called
[00:13:21] base lines in order to get the spacial resolutions we need. And yes, this is a very ambitious project and
[00:13:28] hopefully I will still be alive when such a mission is flying but maybe my professional life will already be over by then
[00:13:35] and yet I'm extremely motivated to do it because I think contributing even if it's a very small piece to the big puzzle
[00:13:43] is already a big reward for me. And I think the question at hand how unique life on the earth is
[00:13:49] is so fundamental that I think whatever I can do to contribute to the small part of it is already sufficient even if the answer might be we don't find life outside of earth that would be also enough for me.
[00:14:02] But at the moment we simply don't know, so that's not good enough yet.
[00:14:06] And Domenico, what's it for you I mean you're lucky enough that what you do actually already happened throughout your professional life that you have that you can measure the Mars quakes -
[00:14:17] but what's it like working with these time dimensions that are much larger than a human lifetime? When you talk about this large-scale infrastructure it is normal. I mentioned before you can try for 30 years and then you don't fly.
[00:14:32] Or you fly and:

[00:14:34] What's a rocket with 30 years of your work blowing up after 100 meters? It's the worst thing that can happen to you in a sense. To me it did not happen so far.
[00:14:44] But I'm working on what's called the LISA mission, the LISA interferometer space antenna for the gravitational waves.
[00:14:51] And if we are lucky that will fly in 2037, and we started working on it 20 years ago and so the preparation time of such a launch mission
[00:15:01] it's really decades, it's over two generations.
[00:15:05] I will not be professionally working anymore I hope to watch it from the beach going up I hope to see the results.
[00:15:12] We are training the young generation of scientists that will use those data as that will have seen your science by the time that mission flies
[00:15:20] But you have to do it, if you don't do it, we go nowhere in a sense if we only look at what we can achieve within two years ...
[00:15:27] The bigger things require commitments also of our own funding agency, space agencies and so on.
[00:15:35] We plan to fly for example electronics that will exist 20 years from now not electronics of 20 years in the past because that's already long gone and so planning the future in this way
[00:15:47] you develop the next generation of electronics that also will be used on the earth and so on. So, you really go far ahead the way you are now because you have to anticipate conditions
[00:15:58] a good 15 to 20 years from now and it's always very exciting. So, I don't mind if I won't be there on the day that the equipment starts working.
[00:16:07] I think we should all contribute to these bigger infrastructures.
[00:16:13] So you're both working in a sense in space science, where do you see the chances and the challenges in this field and the perspective of a
[00:16:22] nation as small as Switzerland? I think the dimensions that we just outlined for the big missions that we were referring to is just clearly indicating that for future
[00:16:33] progress a single country whether it's a small or a large one, cannot really
[00:16:37] completely do it on its own. I think only international collaborations, and this goes even beyond the European order, I would say, I think it's really a global effort that one needs to do in order to make the next steps.
[00:16:49] I think in research one is used to global collaborations but also for this kind of project where unfortunately still national interests are sometimes very strong
[00:17:01] one has to overcome this perception and start working also on a national space agency level
[00:17:08] in a very collaborative way. The James Webb telescope is a good example of where this happened. It's a collaboration between the US, Canada, and European countries but I think for
[00:17:17] the space interferometer we're talking about the European scale might be too small and we clearly need to get everyone involved that can.
[00:17:27] In space the things have become so large and so big the so-called large class missions that
[00:17:33] to compete doesn't make any sense. So, in the moment there is still competition with China and Japan but mostly China not all this alliance, so they do things on their own,
[00:17:44] which is ok, a healthy competition in a sense but there is very little point in launching the same instrument twice and in the past this
[00:17:53] happened too often between NASA and ESA, one instrument slightly better and slightly different, but in the end, the difference was not so much.
[00:18:02] On the large class mission this type of global approach is absolutely required otherwise you just

[00:18:09] lose interest and money and everything. And they are all like this now all the last class missions.
[00:18:16] The smaller missions, of course, they're different. Switzerland was a major player on a mission to
observe exoplanets. Cheops, together
with ESA, of course, but a major player, it's a Swiss-dominated mission.
[00:18:29] I think however that Switzerland can really put its hands in sensors and specific
[00:18:37] parts, systems that are flying because in a sense we should leave to the big countries that have strong space agencies and stronger
[00:18:48] national industry that can actually act as what we call prime so that means putting together entire missions, Switzerland usually doesn't do that.
[00:18:58] Switzerland is extremely strong in assembling individual instruments because we do that
[00:19:03] better than the others do in many cases. Our industry is very very specialized in electronics, mechanics, optics and we can do wonderful things in Switzerland
[00:19:13] and this is why we're always preferred partners in many space missions.
[00:19:17] Do you see any chances for Zurich or for ETH Zurich to have its position in this international field?
[00:19:24] I mean the efforts we undertake and also with the inter-context of the
[00:19:28] announcement for the founding of the centre for origin of life I think we also here at ETH build up here a critical mass that allows us also to
[00:19:38] lead scientifically projects on large scales still. That doesn't mean that we
[00:19:43] will found everything ourselves but clearly, on a scientific level, I think we do have the aspiration to have a leadership role here.
[00:19:51] Both of you comprehend on a scientific level how small planet earth actually is in the big picture. What does this knowledge of this size of the dimensions what does it do to you as people, as Domenico, and also Adrian?
[00:20:06] It makes us even smaller. We have a small planet, a small galaxy, small is everything, on a scale of course.
[00:20:18] It really begs for the question of what else is out there. The reason why I started working for example on LISA is
[00:20:27] the gravitational waves, we picked a few of them using earthly instruments, light and so on. This was 5 years ago,
[00:20:37] but really from space we will see.
[00:20:41] What normally we don't realize is that we see in a sense of seeing with our eyes or with our electromagnetic bands infrared, ultraviolet, X-ray, gamma,
[00:20:52] we see only 5% of the universe, we know that 95% of that is not visible to electromagnetic waves.
[00:21:01] That's why we're trying to look with that, so is like you go
[00:21:05] underwater in the night without any mask and then you try to understand what you're seeing, and we really see only 5% of it and in a sense of seeing so we can measure things only
[00:21:17] from 5% of the energy and mass that sits out there.
[00:21:21] And the rest of the 95% we haven't even started and so we are looking forward in the future to major discoveries and that makes us every time smaller and smaller.
[00:21:33] Adrian, what does it do to you the whole question of dimension? I think it makes the view on earth even more valuable and I think
[00:21:42] knowing that we are able to live on this precious place that might be
[00:21:47] if not unique it's certainly isolated for quite some distance and it's probably an unreachable distance, that makes it just clearer that our view or of someone looking outside

[00:21:59] should be more on the view on the planet itself, that we keep care on its future.
[00:22:04] Music.
[00:22:09] Thank you, Domenico Giardini, thank you, Adrian Glauser. Adrian mentioned the new centre at the ETH Zurich looking at the origins of life.
[00:22:18] And one person who will move to Zurich to help establish this new centre is the Swiss Nobel laureate Didier Queloz.
[00:22:25] And we will talk to him in the next episode of the ETH podcast. My name is Jennifer Khakshouri and I produced this podcast together with This Wachter's audio story lab
[00:22:36] and sound designer Lucky Fretz.
[00:22:38] Music.