Round Table Talk: Dialogue Between a Philosopher and Physicists

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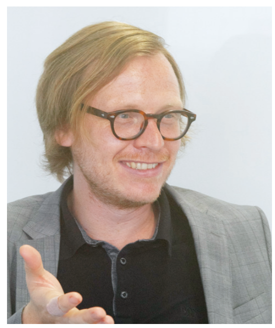
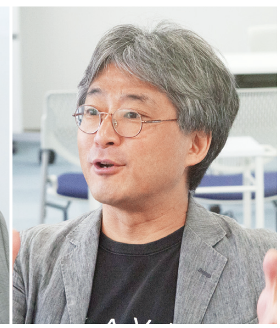

Markus Gabriel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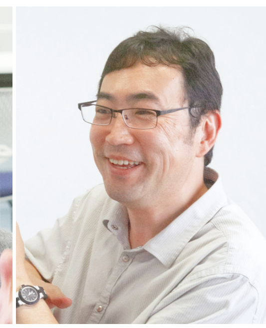
Yasunori Nomura

Physicists Talk about What Science Is

Murayama: I would like to thank Markus for joining us for this conversation shortly after your lecture.[*1] In our earlier conversation you pointed out that, precisely speaking, what people usually attribute to Popper is not what he actually said. So, one thing we can go for is to repeat my understanding of how science is defined according to Popper, though it might not be what Popper actually said. Then, we can discuss what is your real response is on this definition. Is that the right thing to talk about?

Gabriel: Why not? That makes sense.

Murayama: So, first of all, we are scientists and we have been taught in a specific way what science is about, how it should be conducted, and sometimes we find it very constraining. That sort of the narrow definition, which we normally attribute to Popper and which scientists agree, is not really what we would like to do sometimes, especially when we talk about big questions about the universe and so on. So, that's why I would like to get your input on what we think the definition of science is in a traditional sense and what kind of other thinking is going on in the philosophy of science in the past and what your take is on this question. So, that's one thing we can talk about.

Nomura: In fact, Hitoshi, do you and me completely agree? Maybe not.

Murayama: Yeah, we'll see.

Gabriel: Maybe both of you try to just state what you think science is, and then I map this onto a philosophical conceptual space.

Murayama: Okay. Here is, I think, what I was taught in elementary school what science is about. The science is about trying to understand the phenomena around us. To understand this, of course we need to take quantitative data on what is happening around us, and once we have quantitative data, you come up with a theory that tries to explain those data.

Once you have a theory that is successful enough to explain all the data you've got, then you start making further predictions out of the theory and then confront new set of data to see if those predictions will agree with the new set of data, and if they don't, you say, "Aha, I falsify this theory," and this is the process, which we were taught, I thought by Popper, as the definition of science.

Now, if it does succeed to explain the new set of data, then you say, "Okay, my theory is consistent with data." I would never say my theory

[*1] On June 11, 2018, Markus Gabriel gave a talk entitled "Science and Metaphysics" at Kavli IPMU and IRCN joint seminar held at the Faculty of Medicine Experimental Research Bldg., on the University of Tokyo's Hongo campus. This round table discussion was held after the joint seminar.

is true. Then, you repeat the process until you hit the point that is again falsified. Then, you change your theory and then try to, again, address all the data we have explained before to see if that success is still retained, and if it is, then you make further prediction and then start taking data again and compare that to the data to see the theory is still right or wrong. Again, you never say it's right even if it is consistent with the data. You only say it's wrong if it does not explain the data, and then you try to expand the theory further. This is the process we are taught of what science is about.

Nomura: I think that's agreeable. I think no scientist can say that "I disagree."

Murayama: Okay. Maybe some twist?

Nomura: Yeah, small ones. One thing is that you said we never say something is true. Indeed, people sometimes make a statement like "Newtonian Dynamics is wrong" because of the fact that the real dynamics is, at least, special relativity. I think such a statement is misleading. Of course, this is a kind of language issue and in scientist's approach, it doesn't matter. I mean, we don't care if someone wants to say that Newtonian dynamics is wrong because of special relativity, or if someone says that Newtonian mechanics is true because it explains phenomena very well in a certain regime. The fact is that you must first define the word "true." We can use this word to mean "contemporary truth," and then Newtonian dynamics was certainly true, at least in the 19th century. Similarly, we can use the word to mean "true in a certain regime for all practical purposes." In this sense Newtonian dynamics is still true now.

Anyway, I think the basic attitude of science is always like that. We don't care any language issues, as long as we understand what we are talking about. In this case I don't care if you say the theory is true or wrong.

The fact is only that the theory applies in a certain regime in certain precision. In some extreme cases, however, it may become obvious that the theory is simply an approximation of another theory—in the case of Newtonian dynamics the special relativity—and then we must consider this new theory if we want to describe these cases. To me, this way of thinking is one way to define science. In this sense, science is very operational. Having said that, the definition of science, at least natural science, also includes the process of trying to explain the same set of data by the smallest number of assumptions. In fact, this last point is important because otherwise you can just list all the data to describe Nature and call the list a "theory."

Murayama: That's right. You can have one theory for every single data.

Nomura: Yes, that is the worst form of "theory." Then you try to minimize the number of assumptions from there, and then your theory will have an explanatory power. Such a theory usually makes predictions, namely it does not only reproduce what you already observed but also something else—as Hitoshi said; I'm just repeating it here—and then you do experiments and confirm these predictions.

A problem is that some people have gone too far. They say that only if all these processes are completed, say within the time scale of 10 or 20 years, then the theory can be called science.

Murayama: Hopefully, within 10 years.

Nomura: I totally agree with the basic attitude, but the question is that of time scale. This is, for example, an origin of the statement that string theory is not science. I do not agree that the definition of science includes the condition that all these cycles must be completed within a certain time. Falsifiability we talk about should not be like this. Whether a theory is science or not should be determined if it is **in principle** falsifiable—especially if the theory has a reasonable chance to be "true" —though we should of course keep trying to see if there are predictions that can be tested in shorter time scales.

Gabriel: That indeed seems to be a deep disagreement, and that's very interesting but it's a difference.

Nomura: Yeah, the difference is even among scientists.

Of course, if someone says that I don't want to invest my time for something whose confirmation time scale could be 100 years, that's fine. It's their decision, and I don't have any objection. But I strongly disagree with the statement that people working on things that might take long time to confirm are not scientists, the statement that some people actually make. The statement is, in fact, dangerous because no one really knows future technical advancement and also some other predictions may be found which can be confirmed at a shorter time scale.

Murayama: As you know, I sometimes made such a criticism myself but that was not about string theory itself but more about the people who were doing it because they have the attitude that they don't need to bother making predictions or test them, and that's the attitude I was deadly against because then that's not a scientific attitude. It's not the same thing as calling string theory not science but rather calling certain attitude of people doing string theory nonscientific. I made that distinction.

Nomura: Okay, good. Then I might have misunderstood you at some point. But I would still say that even things people whom you criticize are doing are not worthless efforts as human's activity—it is, at least, mathematics. In general, I believe we must be extremely careful in dismissing others or what others are doing.

Murayama: Another thing about—I think what we are taught not in sort of the textbook way but on the way we are doing research—is about the quality of theory, namely, that we highly value theories, which are more universally applicable, a broader range of applicability.

We value theories that look more beautiful and, of course, we can't really define what we mean by beautiful, but there is some aesthetic sense of it, and we also value theories that are useful, and in the case of string theory, it had not been verified experimentally in a way we normally speak of but has been incredibly useful in spawning new ideas and that also created a new connection to mathematics and so on.

So academically, there was a very fruitful ground to conduct research. That's another quality we value. So, in addition to this narrow definition of science we were taught, there are these additional qualities. Somehow we got sort of engrained why we actually keep doing research and what we aim for, and that's a difficult aspect we can define in terms of what is science.

Nomura: Yeah, this may be complicated. At this point we are not precisely defining science in such a way that Markus can comment precisely, but this may be the nature of the issue—I mean, it may have a lot of aspects like Hitoshi mentioned. And some of these aspects are different from what we were talking about when we discussed falsifiability etc. But anyway, listening to all these things what would you say?

What Science is–Philosopher's View

Gabriel: I think that you are highlighting an important part of the scientific activity. So clearly, there is a success criterion as well as an overall legitimacy criterion. The overall legitimacy criterion is what you call falsifiability in principle or testability in principle, right? Science proceeds by making claims about the universe that can be tested. If we assert something that is in principle, or in virtue of the meaning of the terms employed in the statement, beyond the reach of any instrument we use for measurements, we simply make no statement at all about the universe.

Nomura: "God exists" is a good example.

Gabriel: There are other things too, such as "life is a dream." The idea that reality might not be at all what it seems to us is also not a scientific hypothesis, as science minimally relies on the availability of data. If data were not even data, we could not proceed scientifically to establish anything.

If I tell you that life is a dream, there is of course a testable hypothesis available too: how long is the dream and so on. If I then reply that life might be something even crazier, such as a nightmare in the mind of an immaterial demon, this hypothesis would easily explain all the data. However, there are infinitely many other hypotheses which explain all the data in one fell swoop.

Nomura: Yeah, and this is the theory no one can...

Gabriel: It's a very simple theory. It's extremely elegant. It's very universal. But there must be a little bit more action here because there are some non-falsifiable things that are kosher. For instance, if I'm conscious and I think I'm conscious, then that is not falsifiable. To be conscious and to think that one is conscious means that one is right. Not everything that is not falsifiable is problematic and unscientific. Otherwise, we could not formulate the criterion of falsifiability itself.

So, I can be wrong about the state that I am in. I can be wrong about the neural support of consciousness, but not about the fact that I am conscious right now. Being aware and being aware of being aware are the same thing, so there is no falsifiability gap, but that is alright. Therefore not everything which exists is the object of a falsifiable investigation.

Nomura: Okay, there may be something more here.

Murayama: But when you talk to me, if I respond, then you can tell I am conscious.

Gabriel: Yes. Exactly! That can be wrong.

Murayama: That is the external test.

Gabriel: Yes, that's the external test. There is an external test and it's also very important that this fact about consciousness, which I mentioned, is grounded in the brain. If there were no relations between consciousness and the brain, we should conclude that there is something wrong with thinking that we are conscious because then we would have something that is not falsifiable and not grounded in anything that is falsifiable. Hence, there is a deeper relation between existence and falsifiability, maybe even a very deep one. So, that's the in-principle criterion. I think that's kind of fine.

However, I will be careful as a philosopher and let's see how this maps onto science. Scientists are very used to thinking of the in-principle criterion and the success criterion. The one is dynamic, the other one is more static. There is the dynamic side of theory change, the activity of adjusting to incoming data and then changing the model where necessary, and then there is a more general criterion, the demarcation problem as we call it in philosophy of science: falsifiability as an answer to the question what makes an investigation a part of science.

Nomura: Such in-principle falsifiability is, at least, necessary.

Gabriel: Yeah, necessary. Not sufficient.

Nomura: ...to eliminate theories like "God exists"...

Gabriel: Yeah, stuff like that.

Nomura: ...or like "Fossils of dinosaurs were made by UFO" .

Gabriel: The demon stuff, yeah, stuff like that, like demons.

Nomura: Yes, your demon is a good example too.

Gabriel: There are infinitely many such examples.

Discussion about Underdetermination

Nomura: Yeah. Using the falsifiability criterion more than that, however, is dangerous, which some people are doing and I'm against. I also want to talk about your "underdetermination" which you mentioned in your talk. You, as a philosopher, thought about this, but I was also thinking something like that, like underdetermination.

Gabriel: That is what we call underdetermination...

Nomura: For example, Hitoshi said that "I am conscious—you must know I am conscious, right?" But I don't know! Why? Because I don't have his consciousness. I don't really know.

Murayama: But you have seen my function. I responded to your function …

Nomura: Oh, yeah, but that may only be a function, right? I could say that only I am conscious and what I see as Hitoshi is just a function. However, because similar responses are obtained from Hitoshi as those from myself, the simplest assumption is that these two are both conscious. In fact, this is exactly how science goes. Namely, although I cannot exclude the possibility that only I am conscious and you're like, for example, demons, ...

Gabriel: Or everyone is zombie...

Nomura: ... I cannot exclude such a possibility, but I don't need to think about it in doing science. Making this kind of "assumptions" is a very fundamental part of the "definition" of science, which you probably agree.

Gabriel: No doubt. But here's something where I would introduce maybe a more cautionary way of speaking and then let's see what you have to say about this because we got into a discussion about. So, I would stick to a picture where there really are "facts". Now, here's why.

Murayama: So, the "fact" is the same thing as "truth"?

Gabriel: Yes. Let me define this a bit more.

Nomura: Yes, what you talked about in your talk – yeah.

Gabriel: I don't think of truth as representational, so I don't think that truth is a relation between a theory and reality or a statement and a fact. I think of a truth as just a fact.

Murayama: Okay, so that's something that exists.

Gabriel: Yes. Exactly!

Murayama: Whatever the definition.

Gabriel: Yes, exactly. That's how I think about a truth. For instance, when I say it's a truth that I'm here and stuff like that, or it's a truth that there are more than two people in this room, with everything ("people", "room", "in", etc.) well defined...

Nomura: Yeah, you have to define what the people and so on.

Gabriel: Sure. But here's a view that, I think, cannot be correct. A view according to which once all the terms are well defined, there is never a fact. That can't be true, right? Because once your terms are well defined, either things are as presented or not. So, imagine I tell you exactly what I mean by an elementary particle, which is hard enough but okay, then there is going to be an answer to the question whether in a well-delineated space-time region, there is an even or odd number of certain molecules, say. Let's take an even simpler question. I mean that's hard but I'll make it simpler. Let's take a random arm of the milky way, define a precise time slot for it, and now there is either an even or odd number of stars in that part of the milky way.

Nomura: After you define the star.

Gabriel: We assume that we fully settled the meaning of "star" on the basis of astrophysics.

Murayama: Which is hard to answer but anyway.

Gabriel: It's super hard.

Nomura: Practically. We're not talking

about a practical issue...

Gabriel: No. Some of those might be impossible to answer, even when well defined.

Nomura: Do you think so? This is indeed a big question. It is exactly related to your theme, totality etc., namely whether there is something that is not answerable in principle.

Gabriel: Exactly. I have to think about that. Maybe for no good reason, but my bet is that there would be.

Take black holes, you had said very interesting things about black holes yesterday,[*2] anyhow some regions of the universe, meaning the object under investigation by physics, are such that it might indeed be the case that there are properties in that region that we can never figure out because, for instance black holes, given that they suck all the information in and none comes out, and if it's true, which is questionable —you made very interesting points about that in your talk—but if it's true then physics cannot know anything about the region of the universe where no information comes out. Then clearly there are physical facts that physics cannot discover.

Quantum Mechanics and Philosophy Seem to Have Interesting Relation

Nomura: Then, such objects should simply not be included, even in the list of things to describe.

But the issue, in fact, is even deeper. Here is the view I always have had. An important problem in quantum mechanics is that of a measurement. Usually we think we can solve it by the concept of information amplification in many worlds—by the way, this information amplification has potentially very interesting implications for where consciousness is, which we can talk about later—but to actually implement it we always assume the existence of an external object that is observing the system. In classical mechanics, this is not too much of a problem because you can define everything precisely, for example as a kind of computer simulation, but in quantum mechanics the existence of an "external thing" making some sort of observation is deeply ingrained in its formulation.

So, quantum mechanics applies to a subsystem—everybody agrees that it works perfectly then—but what scientists really wanted is to find a framework which includes external observers, namely "full things" including such observers. But your philosophy says that such a framework might not exist. The theory might be consistent without it. I think this is quite possible. Maybe physics can do in principle is only to talk about subsystems.

While I think it quite possible, usual scientists don't think that way, which is striking. Having said that, I would say that the only way scientists can reach that conclusion, if we could reach, is asymptotic. In fact, this is quite a general phenomenon. A "proof" of a theory in natural science does not go like that in mathematics. You just have to keep increasing your confidence about the theory, in some sense by lowering the confidence for alternatives.

Murayama: ...empirical science...

Nomura: Yeah.

Gabriel: That's why it is empirical.

Nomura: Yes, that's why the only way for scientists to reach this conclusion, or confirm Markus's view, is to try to build a theory including external observers and keep failing it. This is the only way science can "reach" there.

Murayama: That's right. I agree with that.

Gabriel: Yes. I agree with that too and I think that this is why this model that I give, of the no-totality view, might be a very good description of what science is doing because science at most is reaching for totality asymptotically, and it keeps failing in that respect but in very specific ways.

Science as an epistemic virtue is the degree of distance between an impossible ideal and its capacity to nevertheless approach it, so science is, if you like, searching for the biggest natural number. Well, there is no such thing. You will never find it, right? But nevertheless, as it does so, it finds always more numbers. It adds and adds, so it's a very successful operation, even though it defines a limit that cannot be reached by the nature of that limit.

Nomura: This analogy is interesting. But I want to be a little more careful about my view. If the world were classical, then I think I might have totally opposed to your thought.

Gabriel: Yeah, of course we can come to it, right.

Nomura: So, it is very interesting that quantum mechanics, which looks like a very physics thing and is not a theory of philosophy per se, seems important. Quantum mechanics is really affecting how I think about the nature. Because of quantum mechanics, I feel that what Markus says might be true, although I certainly can't be conclusive.

Murayama: Can you elaborate on that?

[*2] On June 10, 2018, Y.N. spoke on "Beyond the Universe" and Gabriel on "Universe, World, and Reality" at a public lecture hosted by Kavli IPMU. There was also a dialogue between the two lecturers; see *Kavli IPMU News* No. 42, p. 19.

Nomura: Okay. Although I still think that even a quantum world might ultimately be described internally, at least the issue is there. In the Copenhagen way of thinking, for example, to test a prediction you have to make a measurement.

Usually you just say that such a measurement is described by decoherence.[*3] Suppose you have a quantum state which is an equal superposition of spin up and spin down, and you interact with it. The initial state is then the product of you not knowing the spin state times the spin up plus down, and after you interact with the spin, the state becomes a superposition of "spin up and you think the spin is up" and "spin down and you think the spin is down." Then you may write down the result on a piece of paper, which further amplifies the up/down information, and so on. But at which point did you really make a measurement? To elucidate the issue, suppose we have only two degrees of freedom, a spin and me. Let us, for simplicity, refer to my mental state finding spin up as A and my mental state finding down as B. Then you could say that the state after the interaction is—this is nothing other than von Neumann measurement—equal to "up A" plus "down B," and you may think that you have measured spin up or down. This is wrong.

Murayama: Yeah, because it can still be either way.

Nomura: No. Not in that sense.

Murayama: Oh, not in that sense?

Nomura: No, the conclusion is more fundamentally wrong because you can write down exactly the same state as "(up + down) times (A + B)" plus "(up – down) times (A – B)", since the cross terms cancel. Then

you might say that the measurement was done in the x direction, rather than in the z direction.[*4] A standard answer to this question of what measurement you made is that it is determined through a succession—not just a single interaction—of processes: for example, I also write down the result in a note, somebody reads it, and so on. Namely, the measured information is the information that is amplified in the sense that many people can share it.

Incidentally, you cannot share the entire information about a subsystem because of the no-cloning theorem of quantum mechanics.[*5] Only an exponentially small amount of information can be shared by multiple entities, and if this sharing happens you say that the information is classicalized. But at what point does this really occur? Maybe you always need some external entity, or a sufficiently large amount of amplification may be enough to claim that things are classicalized. In the latter case we don't need to go as far as no-totality, but we don't really know.

Where Is Consciousness?

Nomura: But it is still true that things become classical only after some amplifications. And, since our thinking

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*3 process in which quantum coherence of a state—the origin of strange quantum behaviors—is lost from the system due to its interactions with environment. This makes the system appear classical.

*4 In quantum mechanics, a spin can take only two independent states, which one can take to be "up" and "down." These are the states which, when the z-component of the angular momentum is measured, give definite answers: +1/2 and -1/2 in certain units. An intriguing thing is that the states which give definite answers when the x-component is measurement are given by "superpositions" of these two states: (up plus down) and (up minus down), giving the x-component to be 1/2 and -1/2, respectively.

*5 In quantum mechanics, full information contained in a quantum state cannot be copied faithfully. This results from the fact that any operation in quantum mechanics acts linearly. Suppose there is a copy machine that converts a spin up into two up's—which we write as (up)^2—and a down into (down)^2. Now, imagine that we send a superposition state (up + down) into this copy machine. Since the action of the machine must be linear, this produces the state (up^2 + down^2), which is not a copy of the original state, (up + down)^2, since the information about interference terms is dropped. This obstruction for duplicating information does not occur in classical mechanics, which does not have the concept of a superposition.

is probably classical—we are not having a “superposition thinking”—the question of where consciousness is might be answered only after such amplification, and in this sense consciousness may involve something outside a brain because the brain is interacting with a lot of things. This is what I meant to say in passing earlier.

Gabriel: I'm very happy with what you're saying.

Nomura: Things become classical only after information amplification, but how much amplification you need? This may be a quantitative question associated, for example, with how stable the information needs to become. But it is certainly true that amplification occurs through interactions, so that your brain state is copied to photons in some form, and so on. So, where the information, namely consciousness, actually is?

Gabriel: What you're describing could be a legitimate version of the age-old assumption that consciousness has something to do with quantum mechanics. But it might not be consciousness; it might be thought. The mental state I am in as a theorist right now leads to classicalization. It turns something into classical amplification. So the operation that you're describing, which is obviously related to the measurement problem and so on, that operation could be essentially tied to thought.

Murayama: Can you again define the difference between consciousness and thought?

Gabriel: Okay, so here's what I mean. I'll give you a notion of thought with which I'm working here. We can both think the same thought. For instance, Tokyo is a city. I tell you what I mean by city. I tell you what I mean by Tokyo and so forth. We can then think the same thing, namely that Tokyo is a city. I'll give you another thought. “Tenno” is the Japanese word for emperor. So, that's a thought. Now if you agree and I agree, is there something to which we both agree?

I would say yes and philosophers call—in a certain tradition, which I think is right; the mathematician, Gottlob Frege introduced this notion—he called that to which we both agree a thought and Frege distinguishes between a thought and thinking. I can think that thought and you can think the thought, and we both think the same thought. So, the thought is not in my head. Otherwise, we couldn't be thinking the same thought. The thought is not in my head, only the activity of thinking it is.

Nomura: By the way, the concept you are talking about applies only in classical physics. This is because you are assuming that information can be duplicated. In quantum mechanics, the full information cannot be copied. There is a very simple reason for that—the principle of linearity.[*5]

Gabriel: Interesting.

Nomura: So, you cannot have an exact copy machine in quantum mechanics. This is why our world classicalizes because a definition of being classical is that we can share the information exactly and...

Gabriel: Yes, exactly. Once we share information, we are on the classical level. We have to be. Thought is classical.

Nomura: Yes, a classical thing. But our world is quantum mechanical, deep down. So, the notion you are talking about must become something very interesting at the fundamental level. Perhaps even a concept like two share the same thought might not be precisely defined at such level because in quantum mechanics, to specify the state of the world, you really have to give a quantum state. And the state is a global concept—you have to know everything about the system in principle.

In this context, the relevant question is why we can admit an approximately classical treatment of nature, not—unlike sometimes posed—why quantum mechanics admits nonlocal phenomena, such as an EPR pair.[*6] The nonlocal nature of a state is intrinsic in quantum mechanics. Nevertheless, you can predict what happens if I just dropped this phone which I have in my hand without knowing what's happening in Andromeda, despite the fact that the quantum state must include everything in the world...

So, your information and my information, those are shared—minute you say something like those, you are already separating your quantum state into pieces and entering into a classical regime. So, how does such classicality emerge? I don't know whether this is a philosophical question, but it is very interesting.

Riddle of the Unity of the Proposition

Gabriel: I think it is a very philosophical question that is amenable to a scientific treatment. It is, in a certain sense, **the** philosophical question because it's a question of how thought emerges in a non-thinking environment. Only parts of

[*6] In quantum mechanics, one can consider a quantum state in which two objects, e.g., spins, are correlated in such a way that the state of each object cannot be described independently of that of the other. This phenomenon is called entanglement, and the EPR (Einstein-Podolsky-Rosen) pair is a specific form of entanglement between two objects.

the universe think.

What if we have a picture where reality, indeed, is what we are thinking about, so the thought has a physical trace, a signature in the universe? If we can assign a physically kosher signature to a thought, then we cross the gap between thinking and reality because now we can understand how what we are doing when we are thinking is grasping a thought because we know much more about what we do when we are thinking in the brain and what must happen on the object side when reality stabilizes or classicalizes into a thought.

This might be related to a really famous riddle. It is called the Riddle of the Unity of the Proposition.[*7] This is not solved. A student of mine just wrote a brilliant thesis about it, but it does not amount to a complete solution. It's brilliant but it doesn't work. The other reviewer said we could still give him Ph.D. as he thought the issue through—that's what we do in philosophy—and he indeed got the best grade because the solution was brilliant. But it can't be the whole story.

Here is the problem of the Unity of the Proposition. There must indeed be an answer that physics can give. Bertrand Russell kind of discovered this problem, but it is in fact older—it had already been discussed in Plato. Imagine that I think a certain thought such as that the dog is on the mat. If I think that the dog is on the mat—or let's take something that is actually there in this room, so the bottle is on the table. Alright? Now, on my definition of thought, that the bottle is on the table is the thought that the bottle is on the table.

Murayama: Say that again.

Nomura: Yeah, right. To understand it better...

Gabriel: On my definition of thought, okay, here is what the thought is. The bottle on the table—the thought that the bottle is on the table is not in my mind. It is here. What you perceive is both a bottle on the table, and the thought that the bottle is on the table. There are not two things in reality, but an inseparable unity of information and object.

Murayama: Okay.

Gabriel: So, there is something in my mind right now. I see the bottle from here. You see it from there, but we both see the same thing, the bottle on the table. Hitoshi, you see it from there, I see it from here, and Yasunori, you see it from there, but there is one fact: the bottle on the table. That's why it is fair to say that once I define all of my terms precisely...

Nomura: You have become a scientist!

Gabriel: Philosophers are scientists too, you know...

Nomura: It's a bit nasty to talk about making everything precise every time, but...

Gabriel: Not nasty, ...defining things is very important. Anyway, imagine we completely define our concepts at the highest level—namely giving you the highest, the most fine-grained scientific account of what I mean...

Nomura: Okay. That is not the point here anyway.

Gabriel: You know, we really fix the meaning of bottle, table, etc.

Nomura: Okay.

Gabriel: Now we have the thought the bottle is on the table. You process the thought in the way in which your organism does it for you and I do it for me and let's call that thinking. So, the activity of processing a thought is thinking. What I am thinking is the thought, but what I am thinking when I am thinking that thought is really the bottle on the table.

Murayama: So, you're saying that this object is the thought.

Gabriel: Indeed.

Murayama: Okay.

Gabriel: This is what philosophers call a fact.

Nomura: Okay, but I didn't get what is the puzzle...

Gabriel: I said something which I hope is true, right? So, it doesn't yet come with a puzzle. But here is a problem now. Can thoughts be false? Can there be negative facts?

Murayama: Can thoughts be false?

Gabriel: Yes; "Can there be negative facts?" So, imagine there are no negative facts. Here is a positive fact—the bottle is on the table. Now, is there a negative fact here too, for instance, the fact that there is no pig on the table?

Nomura: Negative fact means... that there is no pig on the table?

Murayama: It's a fact.

Nomura: Yeah, that is a fact.

Gabriel: Yeah, but is the fact negative? The fact that there is a table entails that there is no pig exactly where the table is. Is reality composed of positive and negative facts?

Nomura: It seems that there is only a fact that molecules, or particles or whatever, are configured in a certain way...

Gabriel: For sure, molecules are involved in facts, and those facts are not negative. But now the problem is this. Suppose no fact is ever negative,

[*7] The unity of the proposition is the problem of explaining how a sentence expresses more than just what a list of proper names expresses and how a sentence comes to be true or false? For example, if "Socrates is wise" consists of just a name for Socrates, and a name for the universal concept of Wisdom, how could the sentence be true or false?

and there are just more positive facts. Then, imagine that I change the facts. Currently, the facts are such that there is a bottle. Now, I change them. By this, I didn't create a negative fact. There is just a new fact, not a negative fact.

Murayama: Yeah. That is a new fact.

Nomura: Of course, you could define it as a negative fact, but that would just be a convention...

Gabriel: The question is: If there are no negative facts, then how can I make a mistake in thinking? Imagine I think something. I think a thought. I process reality. How can I make a mistake if there are no negative facts? Then, reality would be coming in all the time and that's it. Facts will be coming in. How do we explain the subjectivity, i.e. fallibility, of our relationship with reality?

Nomura: I would say the following. For example, despite the fact that the bottle is here—in the sense that Hitoshi has a thought that the bottle is here on the table and you also share the thought that the bottle is on the table, and everybody shares the same thought—despite that, if I am having a thought that there is no bottle, then that can be taken as a definition of mistake.

Gabriel: Yes, that would be a mistake. But now that mistake is a relation between something that's going on in you and something that's here on the table, right? And now you see if that's your theory, you see you have the correspondence theory of truth. Because now you're saying that you have a theory of mistakes, and you make a mistake if what's here doesn't correspond to what's there. And correspondingly, now you can define what happens when you don't make a mistake. If you don't make a mistake, then what's here (in my mind) corresponds to what's there on the table. That is the correspondence theory of truth. Now, you have it.

How Truth/Falsity Is Defined in a Quantum Mechanical World?

Nomura: Yeah. I am saying something like that, but not quite. A mistake in my theory is defined only statistically.

At least in a quantum mechanical world, you always have to think about things in terms of a confidence level or something like that. Suppose that—I also gave you this example earlier[*8] —suppose that the mass of a particle called the Z Boson is, let's say for simplicity, 90 GeV. That corresponds to the existence of a peak at 90 GeV in some spectrum —with the existence of such a peak, we usually say that the mass of the particle is 90 GeV. But, maybe the "true value" is 80 GeV. Since in quantum mechanics everything is statistical, a rare coincidence may have happened that the result of an experiment is pretending that the mass is 90 despite the fact that the true value is 80. You might still say that "it can't be the case because other experiments also found 90." But the result of this other experiment may also be a statistical fluke. If you think in this way, you can't do anything.

So, when we do science, we are always using, at least implicitly, the concept of typicality, and we temporarily view a thing as a truth if it is highly confident in this sense. So, if we had 100 people seeing the bottle here on the table and I am the only person who does not see or measure it, then it would give a higher confidence that I am making a mistake. And if you have thousand people seeing it and I am still saying it's not there, then it becomes more confident that I am making a mistake...

Gabriel: Yeah, but here's the problem.

Murayama: Yeah, then you can never say you made a mistake.

Gabriel: Yes, you can never say that you either made a mistake or that you got it right.

Nomura: But I think this logic is still true nevertheless because...

Murayama: What do you think is true then?

Gabriel: Now, Yasunori, what you said seems to imply that there is no falsifiability either. Because if there is no absolute truth, then there is no absolute falsity. You can also not falsify a theory.

Nomura: I agree.

Gabriel: Agree?

Nomura: Yes, I agree.

Gabriel: ...then you can stop using a theory...

Nomura: I mean, I'm saying that falsifiability must also be a statistical statement exactly as the statement "I am making a mistake" in the previous example is a statistical statement. Likewise, "the mass of the Z Boson is 90 GeV" is also a statistical statement, at least in a quantum mechanical world, and practically even in a classical world, I think.

Murayama: That is the standard way of approaching quantum...

Nomura: Yes, I think so.

Gabriel: That's true.

Nomura: Indeed, things are always like that. Any criterion, such as true or false, is in fact almost always continuously connected, and so you must cut somewhere. And your example—a bottle on the table—is not an exception. This is important.

[*8] After M.G.'s seminar, there was a panel discussion by three panelists including M.G. and Y.N., where the example discussed here was talked about prior to this round table discussion.

I claim we must always think in this way at the fundamental level.
Gabriel: Always, and there is no fixed number.
Nomura: Yes, exactly.
Gabriel: You work as you go and then all these contextual parameters are coming in.
Nomura: Exactly!
Gabriel: You work as you go. You cannot give a calculus for it. If there is no absolute certainty, there is no falsifiability either!
Nomura: I'm very sympathetic to that.
Murayama: Yes, that contextual part is really true in a sociological sense in physics community. If you claim to have discovered new particle, like the Higgs Boson, the stake is so high that it requires 99.9997%.
Gabriel: Exactly! You raise the stake.
Murayama: But when you say that somebody is handing you a theory, there should be a new particle, nobody really cares. You take the data. You have excluded the hypothesis. Then, even at the level of 90% confidence level, you would take that as a fact—"Okay it didn't exist."
Nomura: Yes, that's sociological but interesting...
Murayama: Yeah, that's the definition you mentioned.
Gabriel: You see, this shows, in a certain sense, that the falsifiability criterion also fails.
Nomura: In the exact sense.
Gabriel: Yeah, in the exact sense.
Murayama: Because it's not 100%.
Nomura: Yeah. I think the case of a dolphin is also the same—I mean, if we trace the motion of all the atoms by, e.g., a very strong computer, then we don't necessarily have to introduce the concept of dolphin, human, or anything like that, since we just have to follow the motion of all elementary particles, which contains all the information. Almost all the concepts we are talking about are implicitly and intrinsically approximate, like artificially dividing a continuous thing, and this division must even be statistical, at least in a quantum world. In fact, we might even be able to turn the argument around and say that this is the reason why the fundamental law of physics takes the form which quantum mechanics does...
Gabriel: So, what's really going on is a certain—if you like, within thinking—fluctuation, a probability fluctuation at the level of thinking too, right? There are certain points of the wave and they are relative to contextual parameters themselves and then we say, okay, we call this falsification, and this confirming evidence, and this data. But you see this is very different from Popper's picture of falsification because the falsification picture is one which worked like the following: all ravens are black and then you find a white one and it's like, damn, I was wrong. So, you take this back.

That was the model, where really the falsification picture presupposes that there are facts and either you get them or you don't, and Popper just said that you never get all the facts. You always get a partial glimpse and the more facts come in, maybe some disconfirming facts come in too and that's it. So, Popper would say that science goes like this. All ravens are black. False, there is a white raven, and then it's like "damn, forget about the black ravens." What do I know about ravens? That's the conclusion. Then, I'm not interested in ravens anymore.
Murayama: That's a really sad definition of science.
Gabriel: Yeah. That's not what it is, right? So, there has to be middle ground level, where the dynamics simply can't stop. Right? But this is not driven by inductive data sampling.
Nomura: As I emphasized, always you are using statistical inference to reduce the number of assumptions, namely getting a better theory. For example, suppose your theory predicts that all ravens are black, but you observe a white one. Then you usually say that you falsify the theory, and that's okay. But in principle, you cannot exclude the possibility that you instantly became achromatopsia, so that you couldn't process the color correctly, and then got back to normal. You cannot exclude this exactly, so we are implicitly assuming that such a thing occurs only with an extremely small probability, implying that your theory is excluded at a very, very high confidence. Like this, we are always using statistics.
Gabriel: Some version of so-called holism is probably correct here. Quine proposed to think of physical theory as a web of beliefs whose end points are measurements. We are in touch with the universe, but we extend our belief system with the help of physics. Science is not just a collection of sensory data and inductive claims.
Murayama: Does it need to be really human sensory system or it can be extended by instruments?
Gabriel: Yes, it can be extended by instruments and thus by measurements.
Murayama: Okay. That's good.
Nomura: This is precisely why the issue is interesting. In a classical world, the probabilistic nature in these processes is usually attributed to incomplete knowledge, namely you don't know enough with precision.
Murayama: Like a weather forecast.

Nomura: Yeah. But if you know perfectly the location and velocity of all the elementary particles and have a hyper-strong computer, then we don't need to introduce such a probabilistic nature...
Gabriel: Yeah, then it will be fine.

Discussing Consciousness Again

Nomura: But quantum mechanics says that this is not the case. Probability seems to be much more fundamental. But then this brings us to the issue of consciousness. You could say "Oh wait, you say that probabilities are the only thing that can physically exist, but I exist in a specific place in specific time." This may require something like going back to consciousness—do I have to introduce consciousness in the definition of physical law? I doubt, but I don't have a definite conclusion.
Gabriel: But here is how you could maybe map decoherence[*3] onto that picture, so not do it with consciousness but do it with thought. So, what if a measurement—in the sense of the measurement problem—takes place once I stabilize a thought environment, so it's not internal. Consciousness is typically seen as something very private, intimate, right? I can't see your consciousness. That's typically implicit in the concept of consciousness.

But if we have this other concept of thinking, then maybe that could do it, where thinking is putting me as a measurement system—the whole animal that I am—putting me in touch with my environment and my environment now, the environment of an animal, is going to be classical. Otherwise, the animal couldn't survive. The animal doesn't jump over probabilities. That's why Schrödinger's cat is so aptly chosen. It's an animal. That's why we are like "okay, is it dead or alive?" So for that it matters for animals to be dead or alive, so maybe we are the kinds of systems that as thinkers...
Nomura: I'm sympathetic. In fact, in one of the papers[*9] I even said something like that. The classicalization relevant here may just be information amplification—that's the possibility I discussed. I'm not pushing consciousness is very important and necessary.
Gabriel: No. It's not consciousness. We are not talking about consciousness.
Nomura: Maybe yes, but I'm not a proponent of that.
Gabriel: But that's really not the proposal here. It's really a much more objective proposal, nothing having to do with "subjective consciousness".
Murayama: So how does thinking and thought work, to address this question?
Gabriel: Okay. So here is the picture. A thought can be true or false. Determinately it has two states, A or B, on/off. That's why you can translate thoughts into information.
Murayama: Okay. So, that is classical.
Gabriel: That's classical. I think thought is classical.

Liar Paradox

Nomura: Yeah, but because you are referring to "A or B"- or "Yes or No" -type statement often, I would raise this. What do you think about "I am a liar"-type situation?[*10]
Gabriel: Oh, yeah. So, well, I think that can be solved because the liar paradox is the following proposition. L: L is false. So, this is how you formalize it. It's simple. Now, an interesting solution—there are many solutions to it—but here is the one I really like. A recent one by a friend of mine, Sebastian Rödl, a German philosopher, he says the liar paradox is just nonsense. There is no paradox. Here is how.

So, imagine I look at you and I just utter the words "I told you," and now you ask me "What? What did you tell me?" Out of the blue, it's like "I told you" and you look at me "what?" and it's like "well just that. I told you!" Now, "what did you tell me?" is a good question, right? So, I'm not saying anything if I just claim "I told you." I can't tell you **it** without saying what it is. So, the liar paradox just doesn't specify truth conditions. It contains a statement apparently saying about itself that it is false without specifying what "it" is.
Nomura: Yeah, that is interesting. But, is this something you have to "solve"? I thought that when Gödel proposed it, he meant to show that there is an intrinsic limitation in Boolean yes or no logic, and not presented as a paradox. This is just a feature of Boolean logic, that it cannot be complete.
Gabriel: Yeah. That's one way of dealing with it or you can say accept, for instance, dialetheism, which is an interesting logical view. According to this view, you can say that the liar sentence is both true and false.
Murayama: Both true and false?
Nomura: Yeah. You are just saying that Boolean is not enough—you

[*9] Y. Nomura, "Quantum mechanics, spacetime locality, and gravity," *Found. Phys.* 43 (2013) 978, arXiv:1110.4630 [hep-th].

[*10] "I am a liar": if he is correct (TRUE), then he is a liar (FALSE); if what he is saying is wrong (FALSE) then he is not a liar (TRUE). (Perhaps, a better sentence was "This sentence is false.") Y.N. raised this as a possible example for something that cannot be answered simply by Yes or No.

have to extend it.
Gabriel: Exactly, that can be done.
Murayama: That's along the same line of thinking then.
Gabriel: Yes. That can be done. That's one form of paraconsistent logic.
Nomura: Okay.
Gabriel: So, no problem. But my solution is even easier. I think that when I say "I am lying" and I am not telling you anything, then I am not lying. So, that's why there is no paradox. You need to say something in order to create a paradox.
Murayama: But if you say "I **always** lie", then it is a paradox.
Gabriel: Now, yeah. Now, it becomes a paradox. Yeah. I always lie. But, then I would say the answer to this is no. If someone tells me "I always lie" then I could say "no" because what you've just said is neither true nor false, so you don't always lie.

That's why we typically formulate it like this. We abstract from the speakers because otherwise you can just deny that this is a legitimate speech act. You can just say "don't speak this way," right? So, if we formalize it, usually we say something like proposition L, so we call the sentence L and the sentence L says L is false, right? So, now it's true.
Nomura: Exactly, so negative feedback is always outside the Boolean logic.
Gabriel: Indeed. So, we know that this indeed causes problems, and I think that this is part of why I think there is no totality, even in logical space because if there were totality in logical space, the liar would be in there too. So, you have to rule out something, for instance the liar. You have to be justified in ruling out the liar paradox and other paradoxes in order to have a theory at all.
Nomura: Interesting. I believe this

is related with quantum mechanics, why quantum mechanics is formulated in a way that it applies only to subsystems. I've always felt that this may be related with Gödel's.*11
Gabriel: Yes, I think so too.
Murayama: Okay, Yasunori. That's why you brought this up.
Nomura: Yes. I always thought this way.
Gabriel: My theory on the fundamental level is a kind of generalization of what we know from Gödel's theorems and their consequences. There are still problems in Gödel. For instance, if you assign a Gödel number to a sentence without accounting for the fact that the sentence has meaning, you did not really do the trick. Gödel needs a theory of semantic meaning before he can prove what he wanted to prove. Gödel doesn't give you a theory of meaning. He gives you a formal system, which prints out a string of symbols. If no one is around to understand them, no proof ever occurred.

Now, if my arguments are sound, they provide us with a generalized Gödel scenario. I worked out a generalized incompleteness theorem, so wherever you shoot for completeness, you can't get it. That's my argument. It's very strong and general—so it has to apply to quantum mechanics too.
Nomura: Yes, that's what I am saying.
Gabriel: Yes. Absolutely!
Nomura: Wow, it seems we have only 10 minutes. We had a lot fun, but how to assemble all these in the form of an article? Isn't it too difficult? ...

Through an Encounter with Philosophy Science Knows What It Is

Gabriel: Yeah, we can wrap it up. You see, for instance if we tackle this very specific issue, which came out now at the end, I mean I clearly formulate with my theory something that is

*11 A set of two theorems formulated by mathematician Kurt Gödel. They state that every formal axiomatic system capable of modelling basic arithmetic is "incomplete," i.e., has some intrinsic limitations.

in principle falsifiable, in principle testable, then it has consequences for our way of doing and understanding quantum mechanics clearly, because now you have to choose and so you could falsify what I am saying. It's a high-stakes claim. If you can show that quantum mechanics is a complete system, then you would have falsified what I am saying.

Nomura: At least, in a quantum mechanical world.

Gabriel: Yeah, at least. That is something general.

Nomura: Because mathematically Gödel is an example of your...

Gabriel: Yes, mathematically I'm right anyhow.

Nomura: Yeah, because philosophy is more general...

Gabriel: So, I'm right anyhow. (Everyone laughed.) But I have an additional stronger claim. The hypothesis is that the general view, the generalized stable view, my generalized Gödel thing, must have consequences within quantum mechanics too, something I see in work by Carlo Rovelli too with whom I once discussed this in a public event in Marseille.

Nomura: A narrow version of your philosophy seems like the claim that your principle also applies to the physical world.

Gabriel: Yes, that's the narrow hypothesis.

Nomura: I think this is at least a reasonable chance to be true.

Gabriel: Yeah. Yes. That would be remarkable, right? That, I think this has real consequences for physics, right?

Nomura: I think so. What we are searching for, i.e., a complete logical framework of whole Nature, may be something that does not exist, but again the only way to scientifically know it is to keep trying and failing. So, in that sense, what we will be doing must be the same anyway, but it is always good to have in mind the other possibility offered by a big philosophical thinking, which says that failure may not necessarily mean that we are weak but may indicate something fundamental—such a complete framework simply does not exist. This is literally where philosophy and science meet, and it's fun.

Gabriel: Yeah, this is a really fun question. I think we have now achieved an understanding of some of the things I say as a philosopher and things that actually show up in physics that we can continue fully articulating. But if we articulate that, I think this is a philosophy of science that I have never seen. I doubt that the scientific hypothesis that we have formulated and with ramifications and consequences for understanding of science, knowledge, and reality —I doubt that anyone has ever formulated it.

Murayama: So, philosophy of science can be tested experimentally.

Gabriel: Yes. That's the claim. Science can know what science is if it talks to philosophers. Philosophy of science as it is currently practiced in my view is a failure. We need to cooperate and bring actual metaphysics (or rather what I call ontology) and physics together.

Murayama: That's really amazing. Yeah.

Gabriel: So, science itself becomes reflective and thereby we falsify Heidegger's famous claim that science doesn't think. Science itself is a form of philosophy.

Nomura: Yes, I strongly support that idea.

Gabriel: Yeah.

Nomura: Like one branch of philosophy.

Gabriel: It's a branch of philosophy.

Murayama: I think every scientist would agree with that.

Nomura: Yeah. But it's not completely well articulated because it's slightly person dependent, I mean at a detailed level. The basic theme is probably shared by almost all scientists, but it's very interesting to even study this.

Gabriel: Yes, there is no research project on this, right? I mean...

Murayama: One thing I'm sure you know that some scientists use the word philosophy in a somewhat derogatory fashion.

Gabriel: I know. Yeah.

Murayama: In a negative way.

Gabriel: Stephen Hawking and so on, philosophy is dead and so on. But then they don't define philosophy. So, Stephen Hawking's claim "philosophy is dead" is maximally unscientific, right?

Nomura: Because he didn't define...

Gabriel: "Philosophy" or "science" for that matter.

Murayama: Excluding something he didn't define. That's great.

Gabriel: Yeah. Great! Saying that philosophy is dead is like, well, I don't know what they mean but if they mean that Jesus is dead with the word philosophy, then it's true, he died, if he ever lived. But if they really mean philosophy is dead, then they are saying physics is dead too.

Nomura: Yep, because physics is a form of philosophy. That's what we're talking about. Everything is philosophy!

Gabriel: Yes. Absolutely! So, this remarkable feedback loop, you know... So, science can look upon science within science.

Murayama: That's great. Yeah.

Toward Changing Misconception of Science by General Public

Gabriel: You know this as a scientist, but that has never been built into a philosophy of science. All philosophy of science that I know of is dualistic. They think of science there, philosophy there. So, the scientists do their stuff. They are basically super smart engineers, right? They build machines and figure out things, right?

Nomura: And calculate.

Murayama: That's the perception.

Gabriel: Yeah, that's the perception but that's a terrible perception. That's a terrible misunderstanding.

Murayama: Right, exactly! I strongly oppose that.

Nomura: Yeah. That's not what science is.

Gabriel: No, no way.

Nomura: But on the other hand, many scientists seem to be just doing that, so that's why this kind of interaction is interesting and potentially useful because science is not just engineering or calculations.

Gabriel: No, even though you need to do that. You might behave like that but that doesn't mean that what you are doing is that. If we achieve this level of self-reflection, then a lot of public perceptions of both philosophy and science would totally change. And given that modernity—modern democracy and so on—is logically drawing on technology and science but with a bad understanding of what that is, what we are doing now has much bigger consequences than merely answering a certain problem. If you articulate this in the right way... Think of the social consequences if we brought actual science and actual theoretical philosophy together!

Murayama: That's really important too because there was actually new study of truth waves I have seen, which talks about how public perceives science. By and large, people tend to trust science. That's the sort of what comes up in the survey, but they clearly state that they feel decoupled from science because they don't know what scientists are actually doing and how they are thinking and so on and so forth. They aren't quite sure whether they can really trust the stuff. So, that disconnect is actually causing social problems.

Gabriel: Yes. A real social problem, which in turn becomes a scientific problem when we figure out what the social problem is, so we get this loop back into the picture.

Nomura: Two comments. At the very least, what we have demonstrated today and yesterday is that at least in Japan, there is a public demand. Look at today's event! This was done in a room on the 13th floor of some random building, and yet the room was packed. In our dialogue yesterday*2 as well, there was large audience. So, the demand is there.

Gabriel: Yeah. No doubt.

Nomura: The second is that—this is seconding Hitoshi's comment—people may not really know what scientists are doing and how they work. For example, in today's event, someone asked the role of intuition in science, right?

Gabriel: Yeah. Yeah.

Nomura: I said that in doing science we certainly use intuition, but the final outcome, whatever a physical law or alike, should not rely on intuition. And he was like "Wow! That makes things clear!" I thought I just said an obvious thing, but that was eye-opening to someone. So, maybe even intellectual people, like those coming to our events and asking good questions, may not really know what we are doing and under what philosophy. So, discussion like this in public settings would be very helpful.

Murayama: That's absolutely clear.

Gabriel: I think the demand is very large. I mean the fact that—and it's coming from different directions—... So, I became aware of the power of that demand by being contacted by scientists...

Murayama: Uh-huh.

Gabriel: Yeah, Hitoshi, like you, which confirms exactly. I was invited here, right? So, my activity and your activity overlapped, so that at some point I had an e-mail in my e-mail box. And the fact that I got these invitations means that within the system of science itself, that arises, right?

This must have something to do with the state of the art in science, so science itself is even becoming more reflective, and as it does, it changes its nature. So, there is something very progressive going on right now, and then given that the social system of science is deeply interconnected with modern technology, and therefore democracy and so on, there is this additional feedback loop. So, there are a lot going on, and in Germany there is clearly that demand too.

Nomura: Oh, I also had the third comment. I enjoyed today's dialogue a lot!

Gabriel: That's likely the most certain thing.

Nomura: Yeah. This is really true, confidence level 99.99...

Gabriel: Me too. Yeah. This was great!

Murayama: It has always been a question to myself "what exactly I'm doing?" because the scientific methods have been sort of taught and enforced on me—it didn't come out of me. Because I'm practicing myself, and it's my life, why I'm doing this and why that is important and what does it mean. I think those questions would keep coming up. And this dialogue was very helpful —it didn't answer those questions, I have to say, but we've been thinking about it.

Nomura: Yes, that's what we can be thinking about. Philosophy is about thinking!

Gabriel: Yeah, philosophy doesn't answer anything! (laugh)

Nomura: Not necessarily, though sometimes it does...

Gabriel: Within the division of labor, my role, I think, as a general philosopher is to look at different pockets of scientific knowledge and then all these feedback loops are starting. And now we are ready in this whole fluctuating network, and we know if we change something here, then given that it's a field—that's why I have the field metaphor in my philosophy, field of sense—so if you do something in this field, probably there are entanglement phenomena across fields of sense.

Murayama: Okay.

Nomura: Great! Nice meeting you.

Gabriel: Good. We'll continue.

Murayama: Thank you so much, Markus.

Gabriel: Thank you very much.

Kavli IPMU Seminars

→ ***continued from page 35***

48. "Holographic RG flows from 7D gauged Supergravity"
    Speaker: Alessandra Gnecchi (CERN)
    Date: Mar 07, 2019
49. "Coulomb branches of symmetrizable quiver gauge theories"
    Speaker: Hiraku Nakajima (Kavli IPMU)
    Date: Mar 07, 2019
50. "Emergent inflation from a Nambu–Jona-Lasinio mechanism in gravity with non-dynamical torsion"
    Speaker: Antonino Marciano (Fudan U)
    Date: Mar 11, 2019
51. "Integrable coupled sigma-models"
    Speaker: Benoit Vicedo (U York)
    Date: Mar 12, 2019
52. "Higgs signatures in primordial non-Gaussianities"
    Speaker: Yi-Peng Wu (RESCEU, U Tokyo)
    Date: Mar 13, 2019
53. "What are derived manifolds?"
    Speaker: David Carchedi (George Mason U)
    Date: Mar 14, 2019
54. "The Inconsistent Universe: Problems with KiDS, or with LambaCDM?"
    Speaker: Benjamin Joachimi (UCL)
    Date: Mar 19, 2019
55. "The holographic dual of the Omega-background"
    Speaker: Kiril Hristov (Inst for Nuclear Energy and Nuclear Research (INRNE) at Bulgarian Academy of Sciences)
    Date: Mar 19, 2019
56. "Cosmology with weak gravitational lensing: challenges and opportunities"
    Speaker: Elisa Chisari (U Oxford)
    Date: Mar 19, 2019
57. "The Higgs Trilinear Coupling and the Scale of New Physics"
    Speaker: Spencer Chang (U Oregon / National Taiwan U)
    Date: Mar 20, 2019
58. "Black hole information and Reeh-Schlieder theorem"
    Speaker: Kazuya Yonekura (Tohoku U)
    Date: Mar 20, 2019
59. "How Dark is the Universe? Intensity Mapping in Broadband and Beyond"
    Speaker: Yi-Kuan Chiang (Johns Hopkins U)
    Date: Mar 22, 2019
60. "Maximally supersymmetric backgrounds and partial N=2 → N=1 rigid supersymmetry breaking"
    Speaker: Sergei Kuzenko (U Western Australia)
    Date: Mar 25, 2019
61. "Nilpotent Goldstino superfields in supergravity and cosmological constant"
    Speaker: Sergei Kuzenko (U Western Australia)
    Date: Mar 26, 2019
62. "The potential of generalized Kahler geometry"
    Speaker: Marco Gualitieri (U Toronto)
    Date: Mar 26, 2019
63. "Are the small parameters in the quark sector related?"
    Speaker: Dipankar Das (Lund U)
    Date: Mar 27, 2019
64. "Alternative Fayet-Iliopoulos terms in supergravity"
    Speaker: Sergei Kuzenko (U Western Australia)
    Date: Mar 27, 2019
65. "Elliptic Artin groups I"
    Speaker: Kyoji Saito (IPMU)
    Date: Mar 30, 2019
66. "Elliptic Artin groups II"
    Speaker: Yoshihisa Saito (Rikkyo U), Hiroki Aoki (Tokyo U of Science)
    Date: Mar 31, 2019