Round Table Talk (continued from No. 26, p. 21) : Peter Goddard with Hitoshi Murayama and Hirosi Ooguri

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As Governments Are More and More Dirigiste, Private Grants Are Very Important

Ooguri: You mentioned the raising of funds and you did that while in Cambridge in building this mathematical science complex in particular and then subsequently, you moved to the Institute for Advanced Study and I imagine you have been heavily involved in that. It seems to me that this kind of private philanthropy in helping basic science is very much in the Anglo-Saxon or British-American tradition.

Goddard: Yes, in recent decades, the last century or so, it's been particularly American. If you look back over the centuries, there was a long, strong tradition in the UK. That's how Oxford and Cambridge in particular had got their resources and the extent of independence that they have, through the resources that people gave to the colleges. That has become eroded as the sole method of finance.

Ooguri: In the UK, you say.

Goddard: In the UK, it has, from about the beginning of the 20th century, as a result of a combination of the expansion and the diversification of higher education, which meant that you needed university laboratories, in particular. It was getting more expensive to teach and do research in universities because until the middle of the 19th century, people were doing the traditional curriculum or they were studying mathematics or classics. These were not expensive things. But from the middle of the 19th century, you needed laboratory facilities, the Cavendish laboratory and so on, for research. On the graduate level, you needed more and more resources and that combined also with the First World War meant there was crisis in Cambridge and Oxford at that point. And the government started giving money to the universities initially through university commissioners which separated the government from the process in the sense that the giving of money was not meant to be an instrument of government policy with government influencing the university. That arrangement was eroded from the 70s and 80s in particular into the situation now that the government certainly takes the view that it gives money to universities in order that they should do things the government would like.

Ooguri: Are there incentives?

Goddard: Yes. From about 1990, in particular, a big emphasis started on wealth creation as an objective rather than saying that we just let universities do what they want, and they should be an independent force in society. And so, that change has meant that government financing tends to come with strings. Also because government, at least in the UK, and I think in the United States, has become more short term in its perspective. It's more responsive to public opinion. It's more concerned with getting reelected and that means that it's looking for results on a timescale of two or three years because otherwise you can't influence the next election. All of those features influenced us when we needed new buildings and so on. We decided that we needed to raise the money for Cambridge because you just couldn't rely on the government coming up with funds.

Ooguri: Yes. It's a very interesting trend. It goes both ways. There was an article in the New York Times recently about danger of relying too much on private philanthropies, but on the other hand there are benefits of private philanthropies such as—well, I'm in a private university in the US and Berkeley is almost like a private university.

Murayama: Yes, only 10% public funds these days.

Ooguri: We do recognize, for example, that if there are new breakthroughs, sometimes we cannot wait for the government funding to follow. If you have private funding at your discretion, you can pick low-hanging fruit, which may not be easy to do if you wait for government to react. I guess it goes both ways. The Kavli IPMU is sort of unusual in Japan in that we have been successful in getting private fundings.

Murayama: Right. You wanted to, for example, start a workshop on a wall-crossing formula and then immediately, I could allocate some funds to get the workshop started, and that would produce lot of activities afterwards.

Ooguri: That's what's pretty amazing. It was a workshop that I proposed to Hitoshi because I wrote some paper with Masahito Yamazaki who is now a postdoc at the Institute for Advanced Study and that was starting a new field, so we wanted to have a workshop quickly. I talked to Hitoshi and he immediately granted funding and then the workshop was put together within 3 months or so. Usually, those kinds of workshops take a year to prepare but, thankfully, we had the funding, we had a very talented and dedicated team of international office and so we were able to have this workshop and that was very, very helpful for my research as well as many other researchers at the IPMU. And so those kinds of things make a big difference.

Murayama: Right. Flexibility is very important indeed, yes.

Goddard: Yes. So I certainly came to the conclusion that private grants would be very important because governments, everywhere, I think, are more and more dirigiste. They're more and more trying to set agendas and these agendas are often short term. There's this other aspect that goes along with that, *managerialism*—the idea that you can address issues by managerial action: suppose, hypothetically, you have decided that the UK was weak in functional analysis, I don't know that it is, then you put in a few million for a few years and then you can turn it around. But it doesn't happen like that. That isn't the way that you build up strengths academically. You may make some short term effect but the idea that by managerial action, you can make, on a timescale of 2 or 3 years, important developments in academia, I think is just wrong. But, the bureaucrats have to believe in that because that's their raison d'être.

Progress of Science Is Far More Exciting Than We Could Have Anticipated

Goddard: Then the other aspect that accompanies this is the audit culture—the idea that you have to be able to justify to the taxpayer that you have spent the money on what it was intended to be spent on. The problem with that is that it implies that, at the time you get the money, you should know what is going to be spent on, but we don't know what we're going to do. I remember just after I left the UK and went to Princeton, I was asked to report on somebody who had held a senior fellowship from one of the research councils in the UK. This gives money for five years to a senior professor to do research. What I was asked to do was to report on what this person had done. I was sent all of the details of the papers he had written and so on. And I remember that the first question was, "Has he done what he said he was going to do?"—and I said, "No," of course.

Ooguri: What was the issue?

Goddard: Of course, what he said he was going to do was interesting but as you would have hoped, he has done things that were far more interesting. I think this is something in which the bureaucratic arrangements that fund science in many countries consistently fail to be able to grasp.

Ooguri: Open-ended research ...

Goddard: Yes. The way I would put it to incoming members of institute was that if you know what you're going to do and how you're going to do it and when you're going to do it by, it is not going to be truly original research. We are finding out things we couldn't imagine. The excitement is that we may have fertile imaginations, but what happens is far more miraculous than we could have anticipated. If you look at the great writers of science fiction, Jules Verne and H. G. Wells, they were writing these marvelous stories at the end of the 19th, and the beginning of the 20th century. And if you think of what actually happened in science compared to what they wrote about, it's far more exciting.

Ooguri: Right. The progress of science surpassed their imagination. So, you cannot plan those fundamental researches ahead, especially the goal of the research.

Goddard: Right. If you look at the development of string theory at any stage, it was never what people would…

Ooguri: On the other hand, there are lots of unintended applications of the results that you obtained by wandering through this process.

Goddard: Yes. It even goes for practical results, I mean, if you think about one of the things that has changed, more than anything else, the way we live our lives, or many of us live our lives, and it's made more commercial possibilities available than anything else, is the worldwide web, and that was not the result of some R&D department in some company sitting down and thinking: we have the Internet now; how can we make this a commercial possibility or how can we make it more useful! It was the result of scientific challenges.

Relationship between Mathematics and Fundamental Physics

Ooguri: I also wanted to ask you about your view on interdisciplinary research between mathematics and physics. I guess in the UK, the division between physics and mathematics is somewhat different from that in the continental mathematics. Has that influenced your view on the interdisciplinary activities? In the UK, the interaction between physics and mathematics is tighter in the sense that some of the physicists are even regarded as mathematicians.

Goddard: I think always the boundary is artificial and determined by the local culture. It has been a tradition in the UK that you can approach physics in various ways, particularly in Cambridge. You can trace it back into the history of the organization of the university which was, say, different in Cambridge from Oxford and other places. In Cambridge, the dominant subject from the 18th century onwards was not actually classics but mathematics. The first honours examinations in Cambridge were in mathematics.

Ooguri: Is that for all students you mean?

Goddard: Yes. From the 18th century onwards, they developed special examinations in mathematics, and so if you wished to obtain the highest honours, you would have to take mathematics. That was true up until about 1820 when classics became available as a first honours subject to study alongside mathematics. It meant that people like William Wordsworth, the poet, studied mathematics. He didn't do very well, even though he came to Cambridge with a scholarship in mathematics. But then it meant that great figures in the later part of the 19th century came out of mathematics and went into the Cavendish; from James Clerk Maxwell onwards. Then even people like Maynard Keynes, the economist, started off in mathematics at the very beginning of the 20th century. That tradition was always there in the background. Now you have to dig down to find it but it has influenced the way that things have grown up.

Ooguri: That's very interesting.

Goddard: That's a Cambridge phenomenon but within the mathematics framework, then, people split off in various ways. I think the main thing that has changed over time, viewed internationally, is that the relationship between mathematics and fundamental physics has changed just enormously, clearly.

Ooguri: What's your view? How has it changed?

Goddard: I think if in the 1960s, there were very few people who knew very much mathematics of the sort that is now taken for granted in your seminar, for example.

In Early 70s, Marriage between Mathematics and Physics Ended in Divorce?

Ooguri: Right. Well, I guess I remember there was an article written by Freeman Dyson. That was written probably in early 70s...

Goddard: *Missed opportunities*?

Ooguri: Yes, *Missed Opportunities*, where he says, "the marriage between mathematics and physics, which was so enormously fruitful in past centuries, has recently ended in divorce."

Murayama: Yes, that's right. Did it elaborate on what the cause of the divorce was?

Ooguri: It was partly because elementary particle physics was chaotic. That was before the standard model of particle physics was established and the gauge theory became the main stream.

Murayama: That's interesting.

Goddard: It was odd timing because I would say that the time when ...

Ooguri: It was just about the time when gauge theory actually started to fly.

Goddard: Well, the triumph of gauge theory came along with Gerard 't Hooft in the 70s, 71 or 72. Then it went on from there to the building of the standard model, but the dominant influences that really, I think, started changing things here were the work in the mid-1970s of Michael Atiyah and others, and then the sort of growing influence of Edward Witten. I think that that really changed how people perceived what is regarded as a reasonable amount of mathematics for a physicist to learn. For example, when I was a graduate student, the initial problem that I studied was the singularities of the scattering matrix in the complex plane. It was thought that there was a reasonable grasp of the singularities and their discontinuities in the physical region, but attempts within the context of perturbation theory to get a handle on complex singularities had been limited and so it was suggested that I should think about singularities outside the physical region and complex singularities. There was work on this using homological techniques and so on, but very few people knew about it and when you spoke about it, you really had to, in some sense, translate all of that.

Ooguri: That was not a standard language?

Goddard: It was not a standard language at all. In fact, it was slightly suspect. At various times, people have worked things out in one language and then translated them into another. There's argument about to what extent this is true in Newton. He wrote everything in classical geometry, the geometry of the Greeks—Apollonius and so on—and didn't write it using calculus. But, that's how he had worked things out. He suppressed the calculus because what people spoke was classical geometry.

Then, Dirac at some point says that he used geometry in his work. And there's an argument there about exactly how did he use geometry. He used geometry to think about space and time, to think about with the relativistic equations, and so on. Did he also use it in the context of the Hilbert space? Probably it was the former rather than the latter. Anyway, he does say at some point that he thought geometrically but translated that into algebra because that's what ...

Ooguri: That's what people understand.

Goddard: ...understand. These processes go on at various points but, now...

Ooguri: Now, we don't have to hide.

Goddard: No, we don't have to. It is no longer terribly suspect. So what do you think about the relationship of mathematics and physics?

Ooguri: Clearly, it has been very, very productive in both ways. I think that, as you've said, modern mathematics has very much strengthened our understanding of gauge theory and string theory and other areas for fundamental physics, but I think the insight from physics has also influenced mathematics in a positive way and provided them, for example, conjectures to prove or a new way to think about geometry. Especially the quantum nature of geometry is something that the mathematician, of course, didn't know about but now very much in the common trend in the forefront of mathematics, especially in the area of geometry and representation theory. So it has been very, very beneficial for both I think. It's quite natural that, whenever we try to understand more and more fundamental laws of nature, which is one of the things we are doing at this institute, the existing mathematics is often not useful. Newton had to invent calculus, Maxwell had to use the partial differential equations, and Einstein had to use Riemannian geometry.

Goddard: But that existed already.

Ooguri: It existed already, but at that time it was quite modern mathematics. It is very natural that when we try to push the boundary of human knowledge in that way, there is no guarantee that the existing mathematics could be useful. So, interactions between physicists and mathematicians can be useful for both. For mathematicians, it's going to give them a new problem to work on and open new areas and also connect the different areas of mathematics.

Now Mathematics and Physics Have Areas Developing Simultaneously

Goddard: You have areas developing in mathematics and in physics now simultaneously. In some sense, it seems fortuitous that they are developing at the same time. For example, the theory of infinite dimensional Lie algebras and how that related to ideas in physics and vertex operators and so on. These developments happened in parallel, but they started completely independently of one another in a completely unrelated way, but at the same time. I always find it fascinating to wonder whether those things are really accidents, or there is something you don't understand. What would have been true in the 70s and perhaps the 80s is that people who were interested in the more mathematical questions would be prepared to use it in talking about physics but people interested in more phenomenological questions would not, tending to create a certain gulf. But, now, that seems to have eroded because many of the people who —like you, Hitoshi, who are also interested in phenomenological questions and are also very prepared to talk in ways that relate to mathematics. So things really have changed in that sense, I think.

Ooguri: I think for people, like Hitoshi, who built a model of elementary particle which you hope to actually test experimentally—maybe I'm putting words into your mouth— but it seems that the ideas and the mathematics that come out from this kind of development have been useful in building models that you had not thought about before, like large extra dimensions and ...

Murayama: Going back in history, for example, when Gell-Mann came up with the quark model then that's the first time people started using bigger group than *SU(2)*. That was the first time, right? People complained about group theory fever. Apparently that was the people who would not be able to catch up with this level of group theory. And then language was felt to be left out, but that actually turned out to be the right language, not just for the quark flavor symmetry, but also for the gauge symmetry, and so forth. Without that, I don't think particle physics would have existed the way we know now.

Goddard: That's true, but I think also the other side of that. I think, somewhere in the 1950s, when Gell-Mann realized that having introduced strangeness and so on, you needed a bigger group than *SU(2)*, some people started talking about *SU(2)* × *SU(2)*, and so on. They didn't know of this to be compact Lie groups. They didn't immediately go and ask—they didn't know who to ask, I guess. Gell-Mann, at one point, said that he sat there trying to work it out himself. I think he gave up when he got seven generators.

So, it's amazing when you think back to that. Now, you only have to say something and you go and look at Borel's work or whatever on the classification, the spaces and so on. We immediately plug in to the mathematical literature.

Ooguri: Yes. So we got remarried.

Goddard: No, I think the divorce didn't ...

Ooguri: ...didn't happen?

Goddard: No, I think it was a trial separation.

Ooguri: It was kind of a probation for a while, then.

Goddard: I think that, of course, is a very good argument for your institute. I mean this is now not just some esoteric or small group interest. It's part of the culture that's generally accepted by people of various inclinations. Whether they want to think about very theoretical problems or whether they want to really understand the latest results from the LHC, everybody has more of a common culture.

Murayama: How do you think we can protect this kind of area which doesn't have an immediate impact on the society?

Basic Science Has a Valuable Cultural Impact Though Not Having an Immediate Practical One

Goddard: It doesn't have an immediate practical impact in terms of producing what might be a cure for some disease but it obviously does have a valuable cultural impact. I am conscious of it talking to my friends who are not academics. They now know more about what is happening in basic science. It's very much more than it would have been 30 years ago. Look at the interest in the discovery of the Higgs, it is absolutely enormous compared with, say, what arguably had more importance in conceptual terms, the discovery of the W and the Z. I mean, we'd all have had a collective mental breakdown if they hadn't been there. I think that was partly because we were decades waiting for this event, the discovery of the Higgs.

Murayama: Yes, that's right. So, a historic event.

Goddard: I think also that places like CERN and the people concerned with funding them in the various countries had realized that they had to do more in explaining to the taxpayers and others what was going on. So they couldn't just let this be the press office putting out some press release. It had to be a whole process of getting people to understand what was about to happen. That all feeds in to, I think, the position of institutes like ours in the public perception, in that they're much more likely to understand what we are about. The attitude that existed many years ago, 50 years ago or 80 years ago, was that you really needed to have ivory towers. If you look at the history of the institute in Princeton, I think in the early decades, people in the institute felt that there wasn't anything wrong with practical applications but this was not what happened here and in order to make sure this was an environment in which people stayed pure, so to speak, you had to have an ivory tower with polished walls and people couldn't come in.

Now the attitude is everywhere, I think, different. That is to say, it is important to protect the academic environment in that we need to give space to people and not ask them all the time to produce a practical result tomorrow. But that is completely compatible with our explaining what we do to people outside, inviting them in, giving them talks, and discussing what we do with them, because we don't have to isolate ourselves into some monastic community that has no contact with the outside world. It's actually good for us and it's good for the outside world to have this contact.

Murayama: But that's in the UK, right? The science café—that was actually a British invention?

Goddard: Yes. But it has to go along with explaining to people that it's important that opportunity is given to people to do things where you don't know what the outcome is going to be, where you can't imagine that outcome. That is what will change our understanding of the universe and will change in the end the practical aspects of lives. But there's no easy prescription for this, I think. But I think it is incumbent on all of us who feel any ability or any inclination to do it to engage in that. So at the institute in Princeton, I'm sure Robbert (Dijkgraaf, Director) will continue this even more, putting increasing effort into our publications and our public dissemination of research. In fact, compared to the institute I went to in '74, which was a marvelous place, but there wasn't very much of this going on, now it's going on all the time. It's not the case that at the institute you can't go and be quiet, you can't go into a room, you can't walk in the woods and have those peaceful and inspiring experiences. But at the same time, the institute is interacting more or less continuously with the outside world.

Murayama: That's an important point. Maybe the last question I would like to ask. Now that you oversaw the founding of a new institution in the Newton Institute and oversaw the progress of the Institute for Advanced Study in Princeton, you gained some insight on what should not be done to run a truly tremendous academic institute. I'd like to hear your lessons about that. Maybe you never fell in any pitfalls?

A Truly Academic Institute Should Stay Focused within a Defined Mission

Goddard: No, I've been there. Probably, there've been lots of pitfalls but I think that, along with what I just said, it's possible to have these interactions with the outside world but still to make sure that priority is given to having an environment where science can happen. I see here that you made great efforts, very successful efforts, to make sure that the bureaucracy that surrounds any institution doesn't intrude because it can have a major impact particularly on people coming for a few months somewhere. I think the other aspect is that in funding, when seeking support—this is in the American and UK context—you have to be very careful about sticking to the mission because one thing that happens, when you try to raise money is that you have objectives and then somebody comes along and offers money which is only partly for what you want. Maybe it isn't really even for what you want, but you want to make your fundraising target and so you accept money to do things which weren't your main objective. These may be very good things to do. But, in the end, I think in an institution like this, there are only a limited number of things that you can do. There may be excellent things that people suggest, but they aren't part of what the institute is for, and I think then one has to say, "Well, let's try and find someone else for you to do that."

Murayama: That's important.

Goddard: I think it is important to have a defined mission and not just do everything that's good.

Ooguri: Yes. There can be opportunity cost.

Goddard: Yes. Now, I think somebody can come along and say, "Well, I'll pay for your time," but they can't pay for your time, and you can't be duplicated. I mean, everything that happens in the end impinges on the administration. It impinges on the director. It impinges on the institute. I think it's very important to be broad but to stay focused within that mission but not to do arbitrary things.

Murayama: That's a profound advice I would say. Thank you.

Ooguri: Thank you very much.

Goddard: Thank you for the discussion and I'm really, really impressed with this place. It's a great development, I think, for Tokyo, for Japan, and for the world, actually. Each of these institutes makes a statement about what is important, and so together, the network is really saying something about what the important ideals are. Thank you.

Murayama, Ooguri: Thank you, Peter.