Panel Discussion

Monastic graduates on the panel:

Trulku Ngawang Kunga

Geshe Lobsang Dhondhen

Geshe Dawa Namgyal

Chris Impey (Moderator): Welcome everyone to the general panel discussion, where we can revisit any of the topics discussed today. I will start with a question for Paul, and for general discussion, on the limits of knowledge. There is an optimism, which may in scientists shade into hubris, which suggests that we can understand everything, but we ourselves may pose one limit to science. For instance, the master of string theory, Ed Witten, said that string theory was some 21st century physics that dropped in to the late 20th century, and we may not be smart enough to figure it out. Theories of mind may be in that category too. Do you think it's possible that this is a problem we are just not smart enough to figure out?

Paul Doherty: I agree. At the end of the 19th century La Plosse found out that there was some very simple systems of planets going around stars that Newtonian mechanics—the ruling paradigm of science which held that things could behave like balls that fall under gravity and given their initial conditions you could predict their positions forever—could no longer explain. The interactions of three simple bodies could be so complicated that none of our mathematics could

predict beyond a certain period of time where these bodies would be. Even in the case of seemingly simple Newtonian mechanics, we know there are limits to our actual ability to predict the future. When we think of the emerging properties, like consciousness, they simply may not be understandable in our current framework of science and mathematics.

Chris Impey (Moderator): Here is a question from the audience for the *geshes*. In your view, what has been, or is, or will be, the benefit of the dialogue between Buddhism and science? What, from your perspective, is the point of it or the benefit of it?

Monastic Graduate: In Buddhism there are areas of study, like particles, that are not clearly discussed in the texts. Modern science has a much deeper understanding of these subjects. As Buddhists, we can take this knowledge from the scientific community and we can learn from the scientific community through engaging in dialogue. When we talk about the mind and the concept of consciousness, Buddhism offers detailed descriptions of different mental states and mental factors that provide insights for the scientific community. This dialogue provides scientists and Buddhists with the opportunity both to share and enhance their existing knowledge.

Monastic Graduate: Thank you for this question. Thanks to His Holiness the Dalai Lama we have increasing opportunities for dialogue and it's important to know the objective. Whether you are a Buddhist or not, you need to be aware of developments in science because they have universal implications. For example, when scientists talk about neurons, they are actually talking about me. There are parallels here with Buddhism. We say, "He is not a bad guy, he is just angry." In science, you might say, "He is not a bad guy, he just has different chemical reactions in his brain." Or to detach yourself, you can say, "She's not so beautiful, it's just the way her skin cells are formed," or, "His skin tone is not so bad, it's just the way wavelengths deflect from it." His Holiness is not suggesting that scientists accept a consciousness that is other than mind and brain. I think he wants

scientists to apply the knowledge of ancient traditions in their own fields to better understand how the brain works.

Chris Impey (Moderator): I think you are pointing out, as was very clear throughout the day, that the traditional scientific approach—which is not just Western science—has had some phenomenal successes, some things that have not succeeded at all, some things it has ignored. Maybe it is time to change that. What resonated with me this morning were the personal subjective states that are extremely clear to the individual. You don't need Western scientists to explain your sense of being; you have your sense of being, right? Western science cannot validate it. A theory of mind cannot validate something that you experience, nor can it validate a sense of contemplation or meditation or the well-being that results from it. What western science clearly seems to need is new methodology for moving in the direction of being able to benefit from the awareness of Eastern religions, and other ways of thinking about being. I'm interested in other people's thoughts on how we get beyond this third-person and first-person issue, or have new approaches.

David Presti: When I first read about William James a hundred years ago talking about how an empirical science of subjective observation was needed to move the science of mind forward, I resonated with that. I believe that it is really the methodology, which the contemplative traditions are so well versed in, that needs to be introduced into the domain of Western science.

Two years ago I was giving a talk to some of my colleagues in Psychology at UC Berkeley, and they said, "But what are you talking about? We already have the methodology to empirically describe subjective experiences. It's called the Likert scale." That's a technical scale in experimental psychology that rates how you're feeling on a scale of 1 to 10. That's the level of sophistication of a lot of Western psychology and that doesn't go very far toward understanding the deepest recesses and connections of consciousness.

To introduce this methodology of looking inward into Western science, and to incorporate that in some way with all the power and technology of Western science, is huge. This is something Western science is very good at. I referred briefly at the end of my talk to an "expanded metaphysical framework," where experience is essentially given a similar status to that which we give space and time in our current metaphysical framework. This would mean that there would be some kind of fundamental acknowledgement that from the beginning one needed to have an experiential component to explain all of reality at the next level of incorporation. Now, that may not explain everything, but it is an interesting hypothesis. There were philosophers who introduced these ideas into Western science a hundred years ago, but they never really got very far. It's an interesting hypothesis to entertain: if you adopt this expanded framework, does it take you in to some new places and provide some experimental tests and so forth?

Chris Impey (Moderator): This question is from the audience. It is almost a generalization of the previous question, and maybe it foreshadows the last panel discussion tomorrow, when we will talk about serving humanity. The question is: What is the purpose of doing never-ending research in science?

David Presti: It is a really interesting question, a profoundly interesting question, and an important question. We humans seem to be eminently curious beings, and it is something that may have evolved along with our greater cognitive capacities to help us get along in a complicated world. If you take the standard perspective in biological evolution, our brains and our mental capacities have developed over evolutionary time to facilitate our survival in this complex environment. Part of that has involved being adventurous and curious about exploring new places to live and sources of food and new ways to survive and so forth. In some sense our intellectual curiosity about all of this is part of that evolutionary tradition. We do it because we are curious beings, and for me personally that is part of the motivation. I think it is a fascinating challenge to address this. The most interesting question that I can think of asking is, "Who am I and how do I know what I

know, and how do I fit in to the rest of reality?"

An even bigger motivation for me is that the kinds of things that we are discovering in this endeavor are allowing us to develop a greater appreciation of how interconnected everything is. Even if we just think about what's already happening in conventional Western science, we appreciate more and more deeply how interconnected everything on planet Earth is: all the environmental impacts that we have, the biological processes, with the geology and the atmosphere and the weather, and this is a tremendously important lesson.

When it comes to human consciousness, I believe that the results of this kind of investigation will lead us to a place of greater appreciation for how interconnected we all are as humans and how interconnected all of life is, and that will foster more compassion and improved ethics in the way that we conduct our lives. It can't help but have the side effect of increasing our appreciation of more deep interconnections.

Paul Doherty: I agree. Science is useful and changes our lives. I would like to add one more point. For me, to find out something that nobody has found out before is just plain fun. It's good to have the joy in your life of discovering things, and it's also a joy to share it with people, to be a teacher, to share what you have discovered. The sciences provide this double opportunity to bring joy to my life and to many others I am sure.

Monastic Graduate: This question is for Paul and it is related to the limits of knowledge in science. When you talk about the limits of knowledge you talk about the event-horizons of the black holes, and about fundamental particles, such as quarks at the quantum level. When you talk about quarks, you talk about a specific wavelength, or the smallest possible wavelength beyond which you cannot go deeper or smaller. When you talk about those wavelengths, do you mean that this wavelength is a property of that particle or quark, or that the wavelength itself is the quark? And do quarks have colors, or maybe

shapes?

Paul Doherty: David concluded with a very nice slide that showed all the particles of the standard model in physics, and one of those is called a quark. All particles are wave-like and particle-like, and those words sound like common words, but we scientists layer some other meanings onto those terms. What a scientist means by a quark being a particle, or an electron being a particle, or a photon being a particle, is that its energy is created all at once, all or nothing at all, and is destroyed all or nothing at all. It's a unit. It comes as a whole. Yet, as we calculate where it's transmitted and where it originates and where it's absorbed—the path in-between—we have to use its wave-like nature to calculate.

I think the answer is that the quark, or the particle, is both wave and particle, always created and destroyed as a particle, and it travels as a wave. There are properties to this particle, other properties like its mass, its energy, its electric charge, and there are some other properties that we would attribute to waves, and we might have to name them. Quarks, which are the particles that might make up the protons in a nucleus, have this other property, and it has three possible values. Electric charge has two values. Benjamin Franklin picked out the names for the electron charges: he called them plus and minus to remind us of the two properties of positive and negative numbers. The scientists, when faced with picking out the names for three properties for quarks, used this metaphor of color because you can make the largest number of colors by adding three primary colors of light: red, green and blue. So we chose those as the names for the quarks, but they have nothing to do with the actual colors that your eye can see. It's just a metaphor that helps scientists to remember the zoo of particles.

Monastic Graduate: I have two questions. The first question is related to the limits of knowledge and paradigm shifts in science. When we talk about a paradigm shift in science, we feel that a paradigm shift is necessary when we face some challenges or problems, and thus

limits in the scientific field. When we talk about consciousness and non-material phenomenon, have scientists envisioned a paradigm or a scientific framework in which you can actually talk about consciousness and non-material phenomenon?

The second question is about neurotransmitters. After listening to the science teachers in the past month, and especially the neuroscience teacher, it seems that whatever we think or whatever we see, all consciousness or perceptions, are due to neurotransmitters or chemicals that are related to our thoughts and dreams. If this is the case, when we talk about the idea of self, or the theory of the self, is this self also related to a neurotransmitter? Is there a specific chemical substance or a neurotransmitter that is responsible for the idea of self? If this is the case, that neurotransmitter only exists in the brain, and because of that the self can only exist in the head, above the shoulder. In Buddhism, we think of the self as the whole body. What is your take on this?

Chris Impey (Moderator): As to the first question, the answer is no. There is no theoretical framework in physical science that is suitable for addressing the phenomenon that we've been talking about. Unfortunately, the successes of physical theory result from a paradigm that involves interchangeable mass and energy and four fundamental forces. The mechanisms that relate those fundamental forces into a unified theory are the subject of current research and speculation. It is conceivable that on the cutting edge of string theory other manifestations of these underlying elements of nature will manifest other mechanisms, other manifestations, but the theory is extremely immature and extremely difficult to advance. The problems physicists are trying to solve are very challenging. They are busy trying to reproduce standard quantum theory from a much more difficult basis in string theory. There is no sense in which they are in a position to address the issues we've been talking about. The simple answer to the question is that there is a theory deficit, but where there is deficit, there is opportunity.

The second question is a great one. Let me attach it to a question from the audience. Very simply phrased: What is the relationship between self and consciousness?

David Presti: To address the neurotransmitter question first—certainly neurotransmitters are the chemicals that the brain uses to send signals between cells. The brain is extremely complicated, with billions and billions and billions of nerve cells continuously signaling one another with dozens of different neurotransmitter chemicals, trillions of times every second probably. So it's never possible to say that there is one neurotransmitter that's responsible for a particular kind of perception, or emotion, or sense of self, or something like that. It's always a complex symphony of many different things happening at the same time all over the brain and interacting in a highly complex way. However, the question of whether the sense of self is somehow mediated by the brain in some complex way involving many chemicals and many kinds of signaling is certainly one taken seriously by neuroscientists, and the conventional view would be that it is.

I keep saying brain, but any sophisticated neuroscientist would say that the brain is highly interconnected with the rest of the body, and we sometimes don't know what's going on in the brain, or what's going on in the body. All of this is important, but there is some kind of neural integration of information that's coming in from our sensory perception of the world around us, and how our body is moving in the world, and what we see, and what we touch, and what all of our muscles and joints are feeling, and the way we move, and out of that we build up some sense of our body, a perception of our body. You can do simple things to the brain, or you can do things to the body, to manipulate how we actually perceive our body. For example, if you do a simple experiment where you are tapping on somebody's leg under the table and then tapping on the table with exactly the same rhythm as the leg, and you do that for a while, the person begins to identify with the table. How would you prove that? How would you do an experiment to measure that? Well, you can show that if you then take

a hammer and you get ready to hit the table, the person will react much more strongly if this tapping has produced this rhythmic connection with the table. It's as if they have extended their body to become the table in some strange way. You can do more sophisticated versions of that test to show that our sense of what we consider to be our body is somewhat distortable.

There is no doubt that we have a map of our body in our brain that is corresponding to the way that we perceive touch and temperature changes in our body. There is no doubt that whatever our sense of self it is partly related to this body sense and how the body moves through the world. Whether that's everything is certainly unknown, because that gets at the nature of our ability to be aware at all. That's part of our sense of self, and since we don't know what the basis of that is, it is not possible to say. There is something going on in the brain, but whether that's the whole picture is still part of the mystery that remains to be explored.

Monastic Graduate: Scientists have given detailed explanations of many external phenomena, and also about how our neurons work, but something you said struck me. You said that everything we know comes from our sensory organs and mind? If that's true, then how can we be sure of anything outside when we don't really know much about the mind? In many cases, we know that what our mind projects is not really what's outside, as in the case of color.

A second question is, when you talk about a paradigm shift, are you suggesting that scientists move towards the possibility of consciousness as something other than the brain? Or are you saying that scientists should use the Buddhist viewpoint to enlarge their understanding?

David Presti: Let me address the question about the paradigm shift first. It kind of follows on from what Chris was just saying, in the answer to the previous question, that we currently do not have a framework in the physical sciences to accommodate consciousness and that some

kind of expansion will be needed to do that. Maybe it will emerge if we can solve string theory and unify the forces and better understand the brain, maybe an experience will somehow be there, but I doubt it. My money is on us needing some kind of expanded framework. We don't know what that is, and I think the contemplative perspective is a powerful way of expanding our understanding of what the mind is and what consciousness is, and that has valuable contributions to make. I don't believe that that's the paradigm shift. The paradigm shift is in a new direction that will come from an appreciation of what the contemplative traditions have to offer as inner telescopes, and what can be built on the foundation of a very powerful physical science by expanding it in someway. One possibility is that some kind of consciousness dimension, or component, or coordinate, or whatever we want to call it using mathematical metaphors, will need to be added in as somehow fundamental. I know one person who works in string theory, at the periphery of string theory, who has suggested that maybe some of the extra dimensions in string theory, those that the mathematical string theorists don't yet understand, may provide some room for mentality. Maybe that will be a way of introducing some of these ideas into physical science. It's kind of an interesting idea to explore.

Chris Impey (Moderator): Is that progress when we go from grass being in straws to grass being in extra dimensions?

David Presti: Yes, it is progress, though I doubt it's that easy. But it's interesting at least metaphorically. What was your other question?

Monastic Graduate: If everything that we know comes from the sensory organs and mind, how can we be sure of the outside world?

David Presti: I am not sure of the outside world. I think that we infer some kind of existence because in science we make these measurements, we agree on repeatability, and we build up this picture that has been reliably reproduced over centuries now. It gives at least a very powerful illusion that we know the Universe has a particular

structure to it. But what really is going on out there, I really don't know.

Chris Impey (Moderator): To follow that up and to be very provocative, there is a perspective—if you take it seriously—that we are neither the first nor the most advanced intelligent civilization by far in the Universe.

Using only modest projections of our own capability, there could be a civilization that would be able to create synthetic creature like us computationally, without biology. That's a materialist philosophy, but if you work out the numbers the computational power required to create the history of all human thought processes on Earth is within reach in a century. Once a civilization could do that, and it's cheap for them to do, simulated entities like us are likely to outnumber the real biological ones. That's one proposal that's out there. A physicalized version of that includes the fact that we harness a ten-billionth of the energy of our star, and not very efficiently, using fossil fuel. If you are a more advanced civilization that can harness maybe one, even ten, percent of the energy of your star, you would have enough resources and energy to create a physical simulation whereby everything we experience and measure with our science methods is constructed. You only need to simulate the Universe with sufficient veracity to image the stars and the galaxies that we see with our telescopes. We've only just pin pricked the Earth, so you just need to make the physical Earth. It could be hollow, and the planets that we've just inspected just facsimiles, and we could just be all the play things of some civilization, and all this that we know and love is just a little playground that they created for us.

These are extreme positions, but philosophically they are worth pursuing because they actually are quite hard to negate.

Here is one for Paul. Is it possible to create a black hole on the Earth, or has anyone tried?

Paul Doherty: There was some worry that when we turned on the Large Hadron Collider it might create a black hole, which would then have enough—small though it might be—gravity to pull in adjacent atoms and become larger and more massive and eventually swallow the entire Earth. Luckily for us, that didn't happen, and nor was it likely to happen, because nature has been conducting this experiment on Earth for the entire age of the Earth. For the last four and a half billion years, the projected age of the Earth, cosmic rays with very large energies have been hitting the Earth, striking the Earth with the same energy that the Large Hadron Collider would be producing, and they have yet to produce black holes that ate the Earth.

The black holes that we are beginning to have evidence of now are all more massive than three times the mass of the Sun, and they go up to billions of times the mass of the Sun. We've not seen any smaller black holes. Theoretically during the Big Bang some small black holes could be created, and so some day we may have one pass through and detect it, but we haven't detected them yet. I would say the experimentalist answer is that we haven't seen one yet, and the theoretician answer is possibly that they could have been made, but it takes a lot of energy, a lot more than the Earth has experienced in its whole history.

Chris Impey (Moderator): A lot of physics concepts have a mathematical basis and therefore might not even necessarily exist. I will comment briefly on this, and Paul may want to say more.

It's interesting; the mathematical basis of physical theory is profound. You said that if Feynman were given one sentence to capture the most important thing about science, it's that everything is made of atoms. In the same interview, he was asked what he would add if he could say a second thing, and what he said is a little more esoteric. It's that symmetry principles underlie all the laws of physics, by which he meant that the conservation laws that are the basis of physics—conservation of energy, conservation of charge, the symmetry between matter and antimatter—all have a mathematical

basis. General Relativity, of course, has an extremely elegant and profound mathematical basis, just as all of our most successful physical theories are mathematical in essence, and that is a counterpoint to Paul's correctly posited experimental basis for science. There is some Platonic thread in science that has a very mathematical and abstract basis. It's an open question as to whether that mathematical basis could ever extend to consciousness in the brain. It's why I feel a theoretical insight or revolution may be needed, rather than an experimental revolution.

In terms of the limits of knowledge and the nature of knowledge, do you have a comment?

Paul Doherty: It's been said by other scientists, and I find this to be true, that it's amazing that we can write things using the language of mathematics that describe the world in the following way: If I tell you what I am going to do, what the experiment I am going to conduct is, very often these mathematics predict what the outcome would be to within some error. It's just amazing that mathematics actually works in physics.

Chris Impey (Moderator): Another question from the audience: According to Stephen Hawking, if the "unified theory" is successfully constructed then we can explain anything. Please explain. That's interesting because the idea of the "unified theory of nature" is that you attain some very high degree of unification and simplicity in your mathematics, and in some ideal case you have one equation, or one set of equations, to explain everything. Of course, the irony is that if you ever attain that, you don't explain everything because of the hierarchy problems I mentioned where your grandiose physical theory with that beautiful elegant basis is completely inadequate to explain the complex scales of 10^{12} neurons and their 10^{15} connections, or the 10^{28} atoms in the human body, and so on. The reductionist approach fails and the deterministic idea fails, so the mathematics doesn't help you, unfortunately. Even if you get that wonderful so-called "theory of everything," it's not obvious that it helps you with the topics we

have been discussing.

David Presti: The "theory of everything" never includes consciousness in everything. The people who talk about the "theory of everything" are not interested in the mind, mentality, and consciousness. They tacitly believe that somehow that will pop out of understanding the brain better.

Chris Impey (Moderator): I have a request for the *geshes*. A comment was made this morning I think, and in passing, and after hearing Paul talk very elegantly about the triangular bounds on knowledge—the knowledge in mass and radius and the theories that underlie them—that in Buddhist philosophy and understanding there are ways in which you could know everything, that those boundaries are illusions of our approach. I would like to hear more about that.

Monastic Graduate: When we talk about the limits of knowledge in Tibetan, we talk about *shija*, which means "something that is knowable." When we talk about phenomena that are knowable, or knowable by our consciousness, there are no limits to these knowable phenomena. I think from both a scientific perspective and a Buddhist perspective, knowable phenomena are unlimited. When we talk about the limits of knowledge we are talking about the ability of our consciousness.

When we talk about knowable phenomena in Buddhism, we differentiate between different types and different levels of phenomena. The most physical level is physical phenomena. From the Buddhist point of view, physical phenomena include *form realms* and *formless realms*. When we talk about knowledge in science, we only talk about physical realms; we don't talk about *formless realms*. We only talk about human beings and sentient beings in the physical world that we know about. That's why, from the Buddhist point of view, knowable phenomena is unlimited, and you cannot know everything and learn everything without changing your mind, opening this closed level of your mind. Instead of trying to know everything that is there in the Universe, our consciousness knows the knowable phenomena.

Instead of approaching the phenomena, you can change your mind or your consciousness.

From the Buddhist point of view, when we talk about our inability to know the known phenomena it is because of two obscurations, and if these defilements that block our mind are eliminated through mind training, then you reach a certain stretch where you know everything by itself.

Monastic Graduate: When, as a Buddhist, I talk about the limits of knowledge, it's like I'm shooting in the dark with the nearest gun, because I don't really know. Whatever is knowable is knowable through your perceptions, something that has arisen from your awareness. That is how we explain it. Rather than going outside and knowing everything, if you can come face to face with your awareness, you will know everything. If you want to know of something in Buddhism that could be considered outside the limits of knowledge, I think I can give you an example. In Buddhist epistemology, we have a definition for everything that we know, but we cannot give one definition that can define everything in detail. To define everything, every phenomenon, in detail is something that is beyond the Buddhist limits of knowledge.