

Intro

people often say well maybe with a sufficient technicality we could build a Schrodinger cat that was not what Schrodinger point was he was saying this is ridiculous you can't really have a cat which is dead and alive at the same [Music] time you suggested that human consciousness might in some way be the result of quantum effects could you perhaps tell us a bit about how you came

On quantum mechanics and consciousness

to that view and how that view has developed over the years well the story is a bit long and involved in many ways I was when I was a graduate student in Cambridge after having done my undergraduate work in London University College I went to Cambridge and I was working on pure mathematics and I sort of thought well three years from my PhD is quite a long time I can work on other things which might interest me so I went to three courses which were nothing to do with what I should be doing one was of course by Bondi on general relativity which was very influential very influential on what I subsequently did other was of course by Paul der the great physicist which also was extremely influential in what I did later the third course was by a man called Steen who was a mathematical logician and I learned from his course about touring machines which gives a general concept to what you mean by a computation so I learned about that and then he described girdle's theorem I had been worrying a bit about girdle theorem well when I say girdle theorem there are two but you can um put them into one theorem basically it's one one statement which is the important thing um I'd heard about it but I didn't quite like the idea because it seemed to say there were things in mathematics you couldn't prove and I was a little bit worried by that anyway so I went to this course and what I learned was something very different and it's if you have a system of rules which you could use to prove some theorem and if those rules are such that you could put them on a computer and you and it can tell you you try this theorem and you see is it true or not you put it suggest that this set of rules that can be applied and the computer chugs through and says yes it's been correctly applied and therefore the thing is true that's sort of thing and you have to believe that the rules do give you truth that's part of the story I that's the point of them after all so you've looked at them each individually you said does that really do you believe that one yeah that's okay what about that one yep what about that uh oh yeah I see that's okay so that sort of thing yeah yeah yeah and that's the sort of rules you would use to prove these are all statements about infinite numbers of things mhm like if you add two even numbers you get another even number right that's a statement about about an infinite number of things yet you can prove it in a couple of steps and using these rules that would be very easy to prove okay what girdle does as Steen described and it's very clever how you can make a statement which when you look at how it's constructed it really can be interpreted as saying I am not provable by those rules right so then you say well okay maybe it's false in which case it is provable by the rules and since you've built up a trust that these rules really do only give you truths then you know it's it must actually be true that it's not provable by the rules and the statement is true yeah so this is a and it's a statement which is really about numbers ordinary numbers and it's a statement

which you can see by virtue of your that's the thing that I found stunning by virtue of your belief that the rules only give you truth you can see that this is true nevertheless it cannot be proved using the rules right so it tells that there is these rules whatever they are cannot encapsulate one's entire way of proving things in mathematics I found that absolutely amazing because it seemed to me that our understanding transcends any kind of rules and well I won't go into the whole story because it's was complicated I wrote about this in the emperor new mind I had H numbers of complaints from various people I wrote about it again in my books Shadows of mine trying to indicate all these responses and things like that so I won't go into the details of that but it did strike me as rather remarkable that by our understanding of what the rules are saying enables us to transcend the rules and this struck me as completely amazing that somehow the understanding that one has isn't following the rules there's something beyond that and this transcending of these rules is a feature of our understanding right it seems to me that whatever understanding is and I don't know what it is is some quality that we have which enables us to transcend any set of rules that you have for proving things in mathematics yeah and they're not enough yeah but you can see by understanding them you can go beyond them now what does understanding involve well it certainly involves Consciousness in the normal usage of the words yeah because one says you to understand you couldn't imagine something understanding a thing if it wasn't even aware of it yes so being aware of something is a necessary ingredient surely not the whole story because it doesn't say anything about the perception of the color blue for example yeah I mean people complain to me say well you're only talking about a very limited thing of course it is but the point is if what I'm saying has relevance to our understanding it may not be relevance to all features of understanding sure I'm quite happy with that but nevertheless it seems to indicate there's something outside computation in human understanding and then I start talking about Evolution how it can happen and what how this it's a feature of General understanding it's not a very specific thing that mathematicians involve you uh and you can present arguments in that direction too so then I began thinking okay well what kind of I I'm a physicalist so I believe what's going on in our heads is obeying the same laws of physics which is going on around us there's nothing something special injected into our heads which is gives us a quality which is beyond the laws of physics I'm I'm a physicalist I believe it's the same physics in here as Out There and Everywhere yeah maybe different parts of are are emphasized in different ways so I began to think about what are the laws of physics as we know them or knew them at the time I was thinking about this okay well Newtonian mechanics you can put that on a computer there's a little bit of a catch which I always worried about a little but I don't think it's the real answer the catch is that all these laws of physics depend on the Continuum so you're really talking about properties of real numbers ah right and real numbers are not things you quite put on the computer you put approximations to them now is there a catch in the fact that these are only approximations I don't think that's the answer but I'm prepared to admit that there's another route one might try to follow right okay I'm not following that route because I think the computers are impressive enough you can you can get approximation as close as you like and so I don't think that's the answer but I'm prepared to uh look at some suggestion which goes in the other Direction okay then I think about okay newtonium mechanics I think about Maxwell's electrodynamics y you put all those things on the computer I would think about Einstein's general relativity I knew that was pretty hard at the time it had got very far but nowadays y you can talk about ins spiraling black holes and you can it's really very very detailed what

people do yeah yeah yeah so sure then what about quantum mechanics well Shing equation you can put that on a computer it has a problem with how many variables you have to it's sometimes people regard it as a difficult problem for a complicated system but it's not really fundamentally different so the Shing equation also but that's not the whole of quantum mechanics no quantum mechanics involves not just the evolution of the quantum State according to the sh equation or whatever you like to call it unitary Evolution it involves measurement and the measurement problem is violates Shing equation you evolve a state and it says if you made a measurement of such and such a type it would give you a probability of that and a probability of this if you evolve the measuring device as well as the system then you get a contradiction because it says that the answer of the measurement is a superposition of this and that tringo obviously worried about this with his cat I mean that's why he brought the cat into the discussion right really to show that there's something wrong here there's something in the theory I mean people often say well maybe with a sufficient technicality we could build a Schrodinger cat that was not what Schrodinger's point was he was saying this is ridiculous you can't really have a cat which is dead and alive at the same time yeah but it was a m illustration of a wider point right that's right so so Schrodinger I'm well in line with Schrodinger's viewpoint on this Einstein took a rather similar view in fact duraq did too even though he didn't he didn't enunciate that you have to see what his later he didn't say much about what he thought about quantum mechanics but he took a rather similar view you see quantum mechanics is incomplete right right because it doesn't explain the collapse of the wave function the shinger equation is a a smooth continuous evolution of the state but it's not what you get when you make a measurement yeah when you make a measurement which are sort of broadening the system a bit to include the measuring aerators and all that why doesn't it follow the Schrodinger equation and that worried Schrodinger very much MH [Music] and um it seems to me this is the is the gap that's not present in all the other theories see all the other theories right up to the point even including the Shing equation or the evolution unitary evolution in quantum mechanics they are all things you could put on a computer so where is there something that you couldn't maybe put on a computer and the argument I was making here is that it's in the collapse of the wave function right so there is some process and I'm not taking the view as many people did in the early days of quantum mechanics that it's the conscious Observer looking at the system and observing yeah yeah that's the sort of terminology which suggests that yeah observing the system no I don't believe that that you it doesn't really work when you think about it in detail I won't into that but but it certainly doesn't really work so I don't believe it's that however it's a different role for conscious almost the opposite that whatever Consciousness is depends upon what this currently unknown but we know something about it which is to do with seeing how general relativity relates to Quantum Mechanics right but it's the other way around it's not how you quantize general relativity which is what many of my colleagues try and do right it's the opposite how you graviti quantum mechanics you try to put the principle of equivalence these great principles of G into the theory and the Einstein way of resolving these principles of galile into a into an overall Theory and imposing that on quantum mechanics and you can see when you look at this that the arguments tell you that with certain mass displacements that the the superposition of it being one position or another has to go to one or the other in a certain time scale yeah and that time scale you can estimate yeah and so this I claim is what's going on in the brain ah and there and it where in the brain I had no idea I learned a bit of neurophysiology I just couldn't see where in the brain

it could be doing it yeah I rather sort of Pete it off in my the emperor's new mind and without knowing the answer but then uh Stuart Hamov who was an anesthesiologist in Tucson in Arizona yeah and he wrote to me and said more or less evidently you don't know about microtubules he didn't put it quite like that yeah but he said he suggested there's something I mean he was very interested in in general anesthesia and he realized that it's not a chemistry question I mean how you turn it off is a root into what it is and what turns it off is not chemistry because you have many many substances completely unrelated chemically which are General anesthetics one of the most striking being Z Zenon which is an inert gas or more or less inert and so it's not chemical processes it's some physical process and well we develop these ideas together going off on different routes and trying to come back again all the time and uh formulating a scheme which is referred to as the orc o proposal yeah yeah yeah orc means orchestrated it's not the o means objective reduction so the reduction means the collapse of the wave function objective means me it really is a physical process and then there are curious features about when it happens which is another whole story which is another question entirely yes it's got very interesting going back to experiments which I do describe in the emperor new man due to Benjamin Libet and there's some renewed interest in these things you've already mentioned for example that you were taught by Durban who who are the people that you enjoy just personally working with or being taught by the most it's comp well there's one character when it comes to

Personal idols and friends

physics you see I was in Cambridge as a pure mathematician right right but the person I gained a lot of insights from it the physics was Dennis Sharma now Dennis Sharma was a good friend of my brothers my older brother Oliver who had worked in Cambridge doing graduate work there on many body systems um different area from what I worked in but I got to know Dennis through my brother Oliver and we rather hit it off Dennis and I particularly he was interested in cosmology and I'd listened to Fred Hall's radio talks and was puzzled by them right right and this led to and Dennis decided that he was wanting me to switch subjects and work in cosmology I never did that I kept going with my what I was doing yeah but I learned a lot of physics and I learned Dennis was very good at at and knowing physics and knowing the right people to talk to too it's all the skills that he had were very influ very important to me it sort of made me into a physicist basically well I mean maybe that takes us to a question of how it is that you approaches the work that you do so you've said in the past that you're quite a visual thinker what is what is I mean so from everything from pen tiling all the way through to you know CCC you know views on cosmology views you know questions about human consciousness what what is the unifying theme of being a visual thinker how does that feature in the way you do your work it certainly is an important element to my thinking and I remember when I was at school I sort of thought I was better than most of my colleagues at mathematics and then I thought well I feel like a bit of an oddball and when I go to university I will found people who think like me that was not true right what I found was there were more different ways of thinking about mathematics than I'd ever encountered before but the main division clearly was whether you tended to think visually or in terms of equations right and I was clearly one of the fairly small fraction of the class who was definitely a visual person right it actually it didn't do me too well in a sense because in at University College they had this way of doing the mass that to the first two years you actually took the exam the main exam at the end of two years it was a three year

course and the third year was to specialise in your special topics okay now my third year I specialised in the two geometry topics right but when I learned later how well I did my geometry papers were not my best papers the reason was that in algebra it's easy because you can I don't know if it's the real answer but it's something like always you're using one side of the brain rather than crossing over from one to the other I don't know if it's as simple as that but with the doing the geometry papers I can see how to do the problem then I have to translate that into words write it out in words and then do it again so it's all this going from one to the other and one to the other and I was a slow writer and I didn't finish the papers whereas in algebra you can see so you don't have to switch around in that way this is the question this is the answer and you just go like this and so I did much better in my algebra paper than I did in Geometry so you spoke talking about some of the people that you worked with and some of the people who taught you yes um maybe now I could ask if there was anyone from the history of mathematics or physics or science more

If you could meet anyone from the field of science, who would it be?

broadly that you would have liked to have met but never got the opportunity to who would you choose well if we're talking about people from the whole of History I probably well I don't speak Italian but I choose I choose Galileo if it wasn't a and why is that I don't know I always had a feeling people say you know and all that but I mean Maxwell would have been a good person too whether I could have understood his Scottish accent had a very strong brogue I believe but but Galileo I always had a feeling I don't know if it was how much of it was his trouble with the church and all that and try battle the the current views but there were so many things which he understood which people didn't I mean obvious things I think now I what why people one reason why people didn't believe in the capern theory is why don't you feel it swishing through this great speed yeah yeah you hanging on the chair yeah yeah yeah and so Gallow points out no no you don't feel anything yeah g and the principle of equivalence I like the one with the fireworks he imagines the fireworks and they make this beautiful sphere of Sparks and it drops and it remains a sphere as it drops you can cancel out Gravity by Falling freely I mean these beautiful principles Paul said really so fundamental to physics and this coupled with his fight against the authoritarian role of the of the church and and that I think that a lot of that was why he was my particular hero well Roger I'm afraid we're going to have to wrap it up there though I wish we didn't because I have quite a lot more questions than I started with oh dear but thank you very much that was hugely enjoyable