

The Man Who Fell to Earth

Mathematician Roger Penrose explores the mysterious continent where truth, beauty and triangles really live

by *Karl Giberson*

I first encountered the physicist Roger Penrose when I was a graduate student in physics at Rice University. He gave a seminar on his theory of twistors, strange mathematical things that just might be the building blocks out of which the universe was constructed. He filled the blackboards with remarkable shapes that looked vaguely like doughnuts and French horns wrapped in graph paper; he wrote equations that none of us could understand. He passed on the sort of secrets that that Einstein liked to call the “thoughts of God.” I sat silently in a row with other students from the experimental atomic physics lab, awestruck and uncomprehending.

Two decades later I ran into Penrose again during a summer program at Oxford University. By that time he was Sir Roger Penrose, one of the few scholars ever to be knighted for contributions to mathematics. In 1988, he’d shared the Wolf Prize for Physics with Stephen Hawking. Penrose had developed the mathematical foundations for some of Stephen Hawking’s most important ideas. He had also contributed to an odd branch of geometry called tessellation, which studies how to completely cover surfaces with tiles of prescribed shapes. One particularly remarkable pattern now goes by the name of Penrose Tiles, and is the basis for a board game. With help from his father, he also created the famous Penrose staircase, which ended up inspiring M. C. Escher’s famous drawing of a waterfall flowing uphill.

By the time I encountered him at Oxford, he had developed an interest in the mechanics of the mind and had become convinced

that human thinking was absolutely and utterly different from what artificially intelligent computers were doing. He had outlined these ideas in two books that enraged many in the artificial intelligence community, *The Emperor's New Mind* and *Shadows of the Mind* (both Oxford University Press). He was also fully convinced that a coherent explanation of reality required the existence of a timeless realm of eternal thoughts — entailed the very real discovery of truths from this other world. Heady stuff. In short Roger Penrose was a twenty-first-century follower of Plato.

Intellectual exploration gets no richer than the conversation I had with Penrose about his Platonism. Here was a man, in many ways intellectually alone, for there were few who had any idea where he was going, and fewer still who could accompany him on his explorations. His questions were as deep as any that have ever been pondered by any philosopher or scientist. As we talked, his penetrating eyes stared past the superficial reality of the classroom at Oxford's Wycliffe Hall. His tentative tone revealed his own deep awareness of just how hard he was thinking about how it can be possible to think.

We may never know if Penrose is on the right track for his questions are deep and his explorations are very difficult. But I have to confess that, of all the great minds that I have been privileged to know, there are none that seem to be any closer to the ultimate wellspring of truth than Roger Penrose.

S&S: Why do you call yourself a Platonist? **_RP:** Usually it's other people who call me a Platonist! I view the mathematical world as having an existence of its own, independent of us. It is timeless. I think, to be a working mathematician, it's difficult to hold any other view.

It's not so much that the Platonic world has its own existence, but that the physical world accords with such precision, subtlety, and sophistication with aspects of the Platonic mathematical world. And this, of course, does go back to Plato, who was clear in distinguishing between notions of precise mathematics and the usually inexact ways in which one applies this mathematics to the physical world. It is the shadow of the pure mathematical world

that you see in the physical world. This idea is central to the way we do science. Science is always exploring the way the world works in relation to certain proposed models, and these models are mathematical constructions.

We try to see whether our model fits the way physical behavior seems to work. And if you get that model right then the fit is extraordinary. Some people might argue that you can choose this model or that model and if you happen to find a pretty good one, well, it will be pretty good but so what. But that doesn't face up to the quite extraordinary precision that one sees. And it's not just precision. The mathematics one uses has a kind of life of its own; it's a beautiful structure as well. You can see that this is really sophisticated mathematics; it has ideas which have a profundity of their own. The deeper we probe into the workings of the world, the more we see this. And I feel that that just can't be an accident.

S&S: Is this Platonic world larger than just mathematics? **_RP:** Plato speaks of truth, beauty and morality, but in my view, truth in its purest form tends to be mathematical truth. However, I'm somewhat sympathetic towards a broader Platonism in which morality and beauty have fundamental elements which are also absolute and independent of individuals or cultures.

S&S: If you were going to have a public debate with a staunch anti-Platonist, what would be the most compelling arguments you'd bring to the table? **_RP:** I'd think I'd have to know whether this person was a mathematician.

S&S: Assuming that they were. **_RP:** Mathematics to me is completely clear-cut; the statements are either true or false. Whether we can see that they are true or false is a subtle difference, but the truth or falsity is absolute and independent of any formal standpoint you take.

I would also argue that the Mandelbrot set—this incredible structure that people now produce on computers with great ease—indicates that math is absolute. These sets have elaborate mathematical structures that are produced by a simple mathematical rule. That simple mathematical rule has been known

for a long time but the fact that there were these extraordinarily elaborate structures hidden in it has only recently been found with the type of new computers we've got. These structures are there no matter who does it, who puts it on their computer, no matter what computer you use.

The further you go the more detail you find. No actual computer, of course, can find the whole thing; it goes only to a certain level. But it's very hard to see how that structure doesn't have its own independent existence. How can it be that we're all just recreating this pattern? If we're recreating it each time, why does it come up the same each time? It's telling me that there's something there which we're exploring. I don't see any other way of really understanding what the Mandelbrot set is about other than that there is something out there, a Platonic notion, which we can explore through greater degrees with the greatest skills we have.

S&S: What is the role of our mind? Is it simply a conduit between the Platonic and the physical world? **_RP:** I like to say that one sees three worlds. There's the Platonic world that has this absolute existence and which would be there even if there were no physical world. In a sense, it just conjures itself into existence. And then there's the physical world that we talk about, filled with objects that we don't understand that well, but which often have a relation to the mathematical world. And then there's the mental world, which we don't understand either!

I am interested in the mysteries of connection between these worlds. When one has physical structures of the right kind— I'm talking about wakeful, living, healthy human brains—how do they create mental worlds? That's a profound mystery. We don't understand it in terms of our present-day physical pictures. I'm not saying we won't ever discover what's going on, but we don't at the moment.

The third mystery is how our rather inaccurate, sloppy, and funny ways of thinking can have access to this pure Platonic realm. Goedel, the famous mathematician, calls it mathematical intuition, but what is that? How can one understand that in terms of other things that we can appreciate in the universe?

S&S: You mentioned that we create mathematical symbols with our minds and then they take on a life of their own. One aspect of that life is their ability to make dramatic predictions about the world that are sometimes quite surprising. How did general relativity, for example, know all the things that it knew to predict? Einstein didn't know those things, and yet he was the creator of the theory. **_RP:** That's a good argument, a "Platonic would-be" proof. As you say, sometimes the implications of the mathematics can be very difficult and not at all obvious. I find that highly remarkable. I think you have to face up to the fact that philosophers on the whole tend not to address the first mystery—the relationship between the physical world and the Platonic world. They're more concerned with the third one—how is mathematics absolute?

S&S: Actually that wasn't a fair question to ask you but I've asked that question of people who feel science is a social construction, and I always get the impression that they don't understand enough of the science to appreciate the question. **_RP:** People who take this relativist view think that, well, Einstein's relativity comes along and it completely overturns what we had before that we thought was true; it's all a matter of opinion and a social construct. I would say that, although there is an important influence from society, and although a lot of cutting-edge physical theories are tremendously fashion-driven, there is still a truth out there and we're trying to find that truth, and we need sophisticated mathematics to get at that truth.

S&S: Your view of consciousness seems far richer and subtler than the prevailing view among many scientists, especially those working in artificial intelligence or evolutionary psychology. **_RP:** My position demands a major revolution in physics. Because of my background in physics, as well as mathematics and mathematical logic, I've come to believe that there is something very fundamental missing from current science. I'm saying that, out in the world, there's something going on which you couldn't properly simulate on a computer. Our understanding at this time is not adequate and we're going to have to move to new regions of science in which noncomputational things actually happen.

This new region is a place which is currently hidden from us. There is such a place at the borderline between the quantum level of activity and the classical level, the sort of fuzzy borderline between what we understand of the physics of the small and the physics of the large. That borderline is there. My critics don't go along with me because I'm saying we need a revolution in physics and they think I'm just flailing around somewhere looking for a revolution. But from my physical understanding of math I'm quite convinced that this revolution is needed.

S&S: Are you optimistic that it will occur? **_RP:** I am. Certain colleagues and I have proposed an experiment. I'm not an experimentalist but my colleagues are, and they think this experiment, although very difficult, is doable. For theoretical reasons that have to do with the interplay between quantum mechanics and Einstein's general theory of relativity, there are certain conflicts between the basic principles of these two theories, and these conflicts show up at a certain level. I want to know if you can actually see anything new happen at this level. I am asserting that certain very specific new things happen at this level.

S&S: And what if nothing interesting happens at that level? **_RP:** Then I am at sea! I don't know what to do. But if it does, and you see these new things come in here, it opens up a big area. Quantum mechanics came about because of brute facts of the world, experiments that didn't fit with the previous pictures; people were driven to this very odd theory, which became a beautiful piece of mathematics. But it's not something anybody would have thought of without the brute facts of physics. On the other hand we have Einstein's general relativity, a beautiful theory which is a product of one mind.

S&S: If the experiments turn out as you hope, what is your intuition about which theory will have to be modified—quantum mechanics or general relativity? **_RP:** Some of each. But we are going to have to have a quite new way of looking at quantum mechanics. I think that's going to be necessary.

S&S: Are there no phenomena that we're aware of currently that fall in this sort of borderland between the worlds of the quantum

and relativity that you're talking about? We have well-studied phenomena at just about every scale; there must be something that occurs in nature at that level. **_RP:** You're asking about the level where you can start to see deviations from quantum mechanics. And it's very difficult to probe that level. Certainly none of the quantum mechanical experiments that I'm aware of get anywhere close.

S&S: They're all too small? **_RP:** Well, there's beauty in being too small. Take the beautiful experiments using Bucky-balls, or C-60 molecules, putting them through two slits and seeing them in two places at the same time. These results agree with quantum mechanics perfectly. But I would expect that, because Bucky-balls are too small.

You won't see the effects I am looking for in this case. If you could do this experiment, not with Bucky-balls but with little crystals the size of dust specks, then you'd start to see differences.

S&S: Who are the other thinkers in this field that you think are going about this in the right way, producing arguments that cause you to take notice? **_RP:** I've collaborated with Stuart Hameroff, who heads the consciousness studies program at the University of Arizona at Tucson. He had ideas about quantum mechanics and the brain and consciousness. He said that you can't look at just the cell level, you've got to look at microtubules, these little tiny tubes which are part of what is called the cytoskeleton, which are present in other cells too. But the microtubules in neurons seem to have a particular organizational structure, different from other cells, and he's claiming that this is important in consciousness. I think this is the best yet of anything I've seen which suggests a place where these quantum effects could be playing a proper role in conscious perception. It doesn't mean it's right. There may be something else going on; maybe it's only part of the story and there are other structures involved as well. There are great difficulties with this idea, but it's better than anything else I see.

S&S: There have been some strong critics of this theory: Is there evidence that the microtubules in neurons are different than those in other cells? **_RP:** Yes, in fact. They are stable and don't come to

pieces like most microtubules; they shrink and grow mostly, and the suggestion is that they have a different kind of lattice structure.

One of my responses to this is: “Well, we think we know what noses do don’t we: We breathe through them and they filter the air.” Then you see an elephant. In nature you see structures that can play different roles in different environments.

Biological systems are very, very elaborate and involve extraordinary ingenuity—the ingenuity of nature. But I would like to see more positive evidence for microtubules and quantum effects.

S&S: Let me give you a sort of free-ranging speculative question here. The Platonic world has been connected to all kinds of larger ideas over time. Religious thinkers have called it the mind of God. Paul Davies uses that metaphor as well. Is there any sense in which you could see this Platonic world as embodying some kind of consciousness? I’m thinking of notions like Freeman Dyson’s. He has proposed a nontheistic universal mind. **_RP:** I have to be cautious. I think if one is going to use the word God, which sometimes people would in this connection, the suggestion seems to be that God— whatever that is—is sentient. Somehow it’s possible to be God, in a sense. Einstein talks about that. He thinks about physics by kind of imagining himself to be in the mind of God. But would Einstein ever have meant that his God was a sentient being? I don’t know but probably not.

S&S: I’m thinking primarily of the mental world. Is it too much of a leap to impute some level of mentality to the Platonic world so it’s not in some sense just sitting there but maybe is active and a part of insight? Could you have the Platonic world without the physical world or without the mental world? **_RP:** Let’s go to the physical world. Would you call a dead world with no minds in it a real universe? Somehow the way the universe is made known is through mentality. But you could argue, perhaps, that there are many universes with different parameters and maybe some of them are totally dead. But would it be unreasonable to say they exist if they’re totally dead? I’m not sure what position I take on that.

This relates also to the mathematical Platonic world. Does it really depend on the world being able to perceive these things? Will it evaporate in a certain sense without that? I don't think I'm the one to answer these questions. I'm inclined to think that there are deep connections between these worlds.

But there are other aspects of the Platonic, if one is allowed to broaden the idea to beauty and morality. Particularly morality. Morality seems to me to be absolutely fundamentally connected to this concept. If you're talking about somebody in his lab who has produced this machine and you say "Look, it's conscious! I've decided that this thing I've produced is conscious, but now I'm going to switch it off." Is he allowed to do that? If he's right that it really is conscious, then you can't switch it off because it's got its own being; it's a living thing with a mind of its own.

You've no right to switch it off, if it's got a mind of its own. So these issues of morality seem to me so fundamentally intertwined with the issue of consciousness. Since morality and beauty and truth are all interconnected it seems to me one can't ultimately separate the Platonic world from the mental world. I think ultimately I would say all these worlds have to be there.