

Our sense of time is our ignorance

Carlo Rovelli reflects on how physics is like art that lifts the veil from reality - and how time may be something we create ourselves

What's the biggest open question in theoretical physics at the moment?

The central frontier is quantum gravity. Einstein understood relativity, which explains gravity, and we have understood quantum mechanics: the problem is in bringing these two things together. We have a broken picture, so it is an exciting time to be a theoretical and experimental physicist.

Recently, there has been great public interest in a range of scientific breakthroughs, from the Higgs boson to gravitational waves. How are such difficult ideas penetrating so deeply?

These things resonate because they are at the core of our knowledge. These are not details; these are the ingredients out of which everything we see is made, and discovering more of these ingredients means we can change our basic picture of reality. It's like when people learned that Earth is round, and that all human beings are actually part of the same family. Science has a way of unravelling mysteries, then things change.

Do you think people relate to abstract physics in the same way they relate to art?

Physics is a lot like the arts. But not just because of its sheer beauty, even if it is beautiful. It's not just because it's hard and you want to do it better, even if that's also true. Physics is like the arts because art has the ability to open our eyes to a different perspective on the world. When you listen to Shakespeare, when you read Dostoevsky, then your vision of humanity is changed. Physics does the same thing - it opens our eyes to something new, more wide and true.

Over the course of your career, has the way people approach your subject changed?

When I was a kid growing up in Italy, science was very much high in everybody's perception. It was even so in the 1950s and 60s: people were fascinated. Many kids wanted to be scientists when they grew up. Then its popularity decreased and there were suspicions because science, like every human activity, has good and bad sides - wonderful gifts and problems that it raises.

Take the atomic bomb, for example, with its ability to cause catastrophe. People questioned if science, because it led to that, was a force for good. Later on, some people blamed science for food perceived as unhealthy, like in the GM debate. But I feel that now the wave is changing: people realise that even with all its defects and limitations, science is the best tool we have, and that it is unbelievably fascinating.

Still, for many people, physics is difficult and intractable - even boring. How can you convince them otherwise?

One should distinguish the actual job of doing physics, solving problems, learning how to do equations, from the sheer beauty of what physics is actually describing. Take music: if you want to learn how to play an instrument, build an instrument, or read or write music, that is a long complicated process that some people may like and some people may not like. But then there is the music itself, which anybody can appreciate.

Science is the same - there's all the process of making it advance, but the results can be appreciated by everybody.

PROFILE

Carlo Rovelli is a theoretical physicist at Aix-Marseille University in France and author of the bestselling book *Seven Brief Lessons on Physics* (Penguin, 2015)



If you had to pick one scientific idea you would like people to know, what would it be?

That, fundamentally, time does not exist. Time exists for us. Up and down exists for us but there's no up and down in the universe. The idea that time is not integral to the structure of reality is not something everybody agrees with, but many people are working on it. It might be true, and this would mean that the universe is something very different from what we think.

What do people misunderstand about the nature of time?

It is uncontroversial that time is different from our intuition – time passes faster on the mountains than by the sea. This can be measured and just happens to be true. Our usual intuition about a single time flowing all over the universe is just wrong.

In trying to understand quantum gravity, we find that there is no time at the fundamental level. As I said, not everybody agrees, but this may mean that instead of time, there is only the change of things with respect to one another. A more speculative idea is that our feeling of passing time depends on us, not on the universe, and is due to our imperfect knowledge of the world. In a sense, time is our ignorance.

What about our grasp of nature more widely? You've said reality may be better understood as a web of interactions...

I think this is true at many levels. If we learn to move from thinking of the world as an ensemble of distinct things to thinking of it as a network of interconnected processes, we will grasp it better. We better understand life as a relation between animals, or cells, or molecules. We better understand particles as interactions between fields. We better understand ourselves as nodes in social interactions, and so on.

You not only tell the stories of physics on vast scales, but also explore where humans fit into those stories. Why is that important to you?

Scientific ideas leave people to wonder – are we just a combination of atoms and nothing else? I don't want to take down science in the name of emotions and on the other hand I don't take down emotions in the name of science.

Nature is so complex; there's no need to deny that we have emotional, psychological and spiritual lives. ■

Interview by Alok Jha