The Open University

The Physical World

Relativity: Einstein and Athletics

PRESENTER: Once time got started you might think it just runs along like clockwork, but there's one absolute time we can all agree on. Isaac Newton thought so and in everyday life it's more or less true. But Albert Einstein said something remarkable, revolutionary.
He said speed slows down time.

PAUL DAVIES, VISITING PROFESSOR - IMPERIAL COLLEGE, LONDON: Your time and my time can get out of step in a very simple way. If I were to just get up and wander around this room, for example, then there would be a very slight mismatch in the, if you like, the rate at which my time and your time progressed, so if I carried a clock with me, which was very accurate and we synchronised clocks before I wander about, and then when I sit down again we compare, there'd be a very slight discrepancy between us. So time is something which depends upon your state of motion, and that's something that can be directly demonstrated with experiment.

PRESENTER: Imagine Kris could run at a constant speed, close to the speed of light, then some strange things start happening.

MAN: If, for instance, an athlete were to run at a speed that was close to the speed of light, then they wouldn't experience anything different, but for someone watching them zoom past they would see first of all that if they were carrying a stopwatch with them that that was ticking by more slowly, so time was going by more slowly for the moving athlete.

PRESENTER: This is the key point. If you only remember one thing about Special Relativity, remember this: time actually goes slower for someone who's running at a constant speed relative to someone else. That relative thing is very important. For Kris time is running at a normal rate, but I see his time going slowly. Sounds odd, but time slowing down is a real measurable effect.

In 1971 two scientists flew around the world carrying incredibly accurate atomic clocks. When they returned to earth they found that time really had slowed down for their clocks in comparison with ones left on the ground. But it's such a vanishingly small effect we don't notice it.

MAN: his effect is very small. We're talking about tiny fractions of a second. However if it was possible to travel near the speed of light this effect would be very marked indeed.

PRESENTER: Because Kris is moving relative to me I see his time moving more slowly, but how does Kris see my time?

MAN: The interesting thing is if the person running looked at you they would see your time slowing down as well. This process is completely symmetric and that is why it's called relativity. You would also be moving at high speed according to the athlete, and so all these relativistic effects would occur for you as well.

PRESENTER: Have you got the time? 'Cos I mean its relative you see, your time.

KRIS: My time's relative?

PRESENTER: It's relative to you, it's not, and it's different to me.

KRIS: So we don't have the same time?

PRESENTER: No.

MAN: There's an interesting little story that Einstein developed an irritating habit for a short while of saying "What time does the station leave this train?", and his meaning was that you simply can't tell the difference if the train is moving, or the rest of the world is moving underneath you. It just happens to be easier to get everybody to agree that the train is moving and the world isn't, but there's no basis in physics for doing that.

PRESENTER: That's the thing about relativity – you've got to think about how one thing moves relative to another.

At the moment I'm travelling at about 600 mph relative to the ground, but it really doesn't feel like I'm moving, everything behaves the same as if I was stationary. Well that's because we're travelling at a constant speed. Now the only way I can tell if I'm moving is by looking out of the window, but that would still look the same if the ground was moving and I was sitting still.

MAN: Exactly the same is true with the athlete running down the track, athlete running nearly at the speed of light zooming along says oh look, I'm staying still and all these people are hurtling past me at nearly the speed of the light backwards. So we look at the athlete and say hey, he's moving really quickly, time is different for him. Athlete looks at us and says hey, they're moving really quickly, time is different for me, and it's exactly the same for both of us.

KRIS: Relativity says that who's moving depends on your point of view. So time depends on point of view too. It's relative. Time is different for everyone. Absolute common time doesn't exist.