***What is Antimatter?***

**Big Questions – with Oxford Sparks**

**University of Oxford Podcasts**

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**Transcript [2:00 – 6:00]**

**Journalist:** Scientists started to suspect antimatter existed, in the late 1920s, in the height of the jazz era. A young scientist from Bristol named Paul Dirac was not at any underground clubs, no, he was instead harling with his equations.

**Donal Hill:** Dirac was brought up bilingual actually, but ended up not really speaking French or English. He was very, very shy and tended to just speak in equations and Dirac, in Cambridge, in sort of 1928 was worrying about how to combine Einstein’s ideas of special relativity, which is what happens when things move very close to the speed of light, with ideas of quantum physics, so the fuzzy uncertainties of quantum mechanics and the behaviour of tiny particles like electrons. So, the problem he was worried about was how to describe an electron that’s moving very close to the speed of light, and at the time, it bugged a lot of physicists that you got two answers when you tried to figure out how much energy does that electron have ; you got a plus number and you’ve got a minus number, and the plus number was the easy one, that’s just the electron, is was positive energy, but negative energy doesn’t really make sense. There is no such thing as far as we can tell in the world around us, so most physicists just dismissed it, they said: “That’s a meaningless solution”. But because of Dirac’s real respect for mathematics, he was lead by the equations. He didn’t really feel comfortable throwing away one of the answers.

**Journalist:** And then, the 26 years old Dirac goes back to his equations and he has a spark of genius. He decided to take that negative number and make it something physical, something real and even though there is zero experimental evidence for this he asks: “What if there is a hypothetical particle that behaves in the opposite of an electron? What if you are dealing with a Jekyll and Hyde situation in physics?”

**Donal Hill:** What he had done is just predict the existence of the positron in 1928 and he was basically, uniformly marked. No one bought it. So, when he gave talks and conferences and seminars, people were raised their hand and taunt him afterwards and say: “Well, where is this anti-electron that you talk about?” He didn’t really have the answer at the time, but it turned out, once people calmed down to his ideas, they started to look carefully at some photographs of cosmic ray interactions that were taken five years earlier, in 1923 and when they revisited these images, they started noticing weird little tracks that curved the wrong way and by 1932 they realised that these little tracks were actually the signature of positrons. So, all the while, these little antimatter electrons had been leaving their mark in photographs, but just nobody knew what they were until Dirac actually came out with his prediction.

**Journalist:** Donald says what’s amazing is that with just a few equations written on a piece of paper Dirac predicts an entire class of matter, called antimatter. There are these photographs of cosmic rays that prove he’s right and by the age of 31, Dirac wins a Nobel Prize.

**Donal Hill:** And not long after the positron was found in a lab, all of these other antimatter particles started to crop up and surely, we realised that all of the normal matter particles of our universe had these sort of evil twins, and then, the mysteries sort of emerged: “Where did all of that stuff go? Why doesn’t the universe have anti-particles in it as well as particles? Why are we just made of stuff and this stuff only get produced in these high energy collisions and really locked off the case?”

So, that was the next sort of mystery.