# The Science of The MANY WORLDS of ALBIE BRIGHT

From radioactive bananas to cats that are both dead and alive at the same time, here's more about the real-life science in *The Many Worlds of Albie Bright*.

**Wait a minute, are bananas really radioactive?**
Here's the info: A single banana contains at least 0.1 microsievert of radiation. That's about the same amount of radiation you'd be exposed to if you lived next door to a nuclear power plant for a year. But don't worry, this level of radiation isn't harmful to you. In fact, if your dentist gives you an X-ray, you're actually exposed to 10 microsieverts of radiation. That's one hundred times the dose you'd get from a single banana.

**But what about Schrödinger's cat? Did that crazy scientist really try to poison poor Tiddles?**
Sadly, we don't know if Erwin Schrödinger had a pet cat called Tiddles. His famous experiment is actually a *thought* experiment—a way of imagining the weird world of quantum physics.

**What exactly is quantum physics?**
Until the end of the nineteenth century, scientists thought

that atoms—the tiny particles that make up all matter—were the smallest things that existed, but then they discovered that atoms were made of *even smaller particles* called protons, neutrons, and electrons. Quantum physics is the theory that scientists have developed to describe and explain how these subatomic particles behave.

**Like a single atom being in more than one place at the same time?**

Exactly! When Albie's dad tells him about the double-slit experiment, he's describing an actual experiment that scientists can perform in real life. If they repeatedly fire electrons at a detector plate with two slits set in front of it, scientists discover something very strange. Over time, a pattern builds up on the detector plate—a pattern that could be produced only if waves of electrons were interfering with each other. This should be impossible, because the scientists only fire a single electron at a time.

And in 1926, Erwin Schrödinger came up with an equation to explain this "*waveform.*"

**An equation for *what*?**

Schrödinger's equation describes how the electron exists as a wave of probability. This means the electron is spread throughout space, all at once, but there is a higher probability of finding it in some places than others. Some scientists say the "interference pattern" on the detector

plate is produced by the electron taking *every* possible path to the detection plate—at the same time!

**But . . . but . . . but—that's crazy!**
Wait a second, it gets even weirder! If a scientist tries to track the path of the electron, the interference pattern disappears and the electron acts like a particle—not a wave—going through either the left- or right-hand slit. To explain this, a Danish physicist named Niels Bohr came up with a theory that became known as the Copenhagen Interpretation.

**The Copenhagen Interpretation—that sounds like the title of a cool sci-fi film!**
It's a sci-fi theory, too! The Copenhagen Interpretation says that watching the electron causes the wave of probabilities to collapse into a definite position. But until you take a look, all the different possibilities exist at the same time.

**That's even crazier! How can an electron know that someone's watching it?**
That's what Schrödinger thought. Writing to his friend Albert Einstein, Schrödinger came up with his "cat in the box" thought experiment to prove how crazy the Copenhagen Interpretation was. As Albie's dad explains in his book:

*A cat is put inside a box with a lump of radioactive uranium that has a 50 percent chance of decaying. This means that at any moment, there is a 50 percent chance of a radioactive particle being emitted. If the Geiger counter detects a radioactive particle, it will trigger the hammer and smash open the bottle of poison. This will kill the cat. However, quantum physics says that until the box is opened and we take a look, the particle will be in both possible states—decayed and undecayed—simultaneously. This means the cat inside the box is dead and alive at the same time!*

In the real world, there's no way something can be dead AND alive at the same time. However, scientists working in a laboratory HAVE managed to film atoms existing in two different states at the same time—just like Schrödinger's cat!

**Okay, so bananas are radioactive, and an atom can be in two different places at once, but parallel universes don't exist—do they?**

We just don't know. According to Hugh Everett's Many-Worlds Interpretation of quantum physics, our universe is constantly splitting into new parallel universes. In his theory, taking a look at the electron being fired in the double-slit experiment doesn't just cause the wave of

probable places the electron could be to collapse into one, it causes the universe to split into different universes for every probable position the electron could be in! In one universe, a scientist will see the electron go through the left-hand slit, and in another universe, a different version of the same scientist will see the electron go through the right-hand slit! As Albie's dad explains, "Everything that can happen *does* happen somewhere."

**So can I jump into a cardboard box like Albie to travel to these parallel worlds and meet a different version of me?**

Not so fast! Albie's cardboard box came with a quantum computer that was hooked up to the Large Hadron Collider at Cern, near Geneva, Switzerland. So far in the real world, scientists have only been able to build simple quantum computers to solve single problems, so you won't be able to use one to help you to hop to a parallel world—yet! However, the atom-smashing experiments that scientists are performing at the Large Hadron Collider might be able to detect mini black holes that could provide evidence for the existence of different dimensions where these parallel universes hide. So maybe one day we'll be able to find many worlds filled with copies of you and me, just like Albie did. . . .