If Antimatter Falls in a Black Hole, Does It Make a Sound?

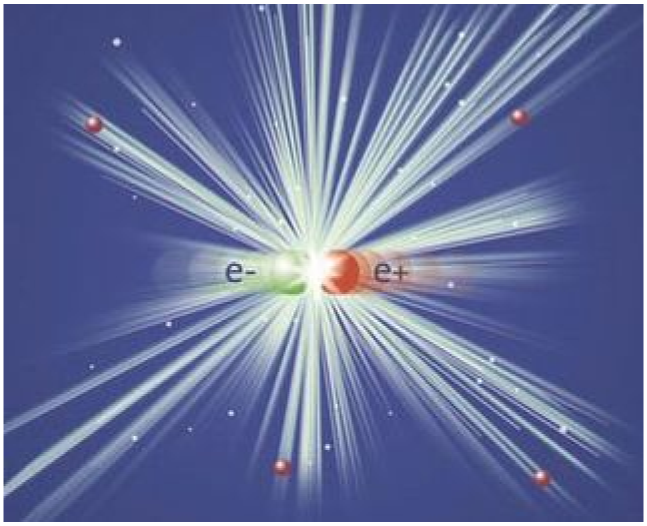
By Jennifer Ouellette | Wed Sep 22, 2010 10:33 AM ET

Antimatter is the stuff science-fiction dreams are made of. This is largely because whenever matter meets antimatter, both particles annihilate and turn their entire mass into energy, fueling, say, the Starship Enterprise -- or an antimatter bomb weighing a mere one-quarter of a gram, but nonetheless packing a punch equivalent to 5000 tons of TNT, as depicted in Dan Brown's bestselling novel (and subsequent film) "*Angels and Demons*."

Oh, don't worry: scientists haven't been able to create anywhere near that much antimatter in fancy research facilities like CERN. We live in a material world -- literally. Matter dominates our universe.

"If you take all the antimatter produced in the history of the world and annihilated it all at once, you wouldn't have enough energy to boil a cup of tea," Harvard physicist Gerald Gabrielse told LiveScience in 2009.

That's good news for those who dread an antimatter bomb capable of wiping out a half-mile city radius, and bad news for anyone who dreams of exploring the final frontier in a ship outfitted with snazzy antimatter engines. And as actor Tom Hanks points out in the Daily Show clip below, the minute you turn the machine off when CERN shuts down for the Christmas holiday, "the antimatter goes away."



But there's still plenty of mystery surrounding antimatter. A new paper has just appeared on the arXiv that attempts to answer one such question: Would gravity still work on antimatter? Or, more accurately, if you dropped a block of the stuff, would it fall to the ground, or be repelled by the Earth's gravitational force (like anti-gravity)?

According to KFC at the arXiv blog: "Nobody knows, and not for lack of trying. Various attempts to drop antimatter and see where it goes have all been inconclusive."

That's a scientist's way of saying the experiment did not go particularly well, but didn't exactly fail outright, either, so technically it's a draw. And they go back to the drawing board for another attempt -- assuming they can still get funding in these tough economic times.

The latest scheme to find out how antimatter falls comes courtesy of CERN physicist Dragan Hajdukovic, who says all you need is a supermassive black hole at the center of a galaxy and an IceCube -- the biggest and most sensitive neutrino detector currently being built deep under the ice sheets at the South Pole.

See, scientists know that "virtual particles" -- extremely short-lived matter/antimatter pairs -- pop in and out of existence all the time, giving rise to the vacuum energy of seemingly empty space. (Space, it turns out, is never completely empty.)

But gravity is the weakest of the fundamental physical forces, and doesn't generate a strong enough field to support this process. So where you can find very strong gravity?

Inside a black hole, of course, just like the supermassive black hole camped out in the center of our own Milky Way galaxy, like a massive black spider lying in wait to gobble any random objects with the misfortune to cross the event horizon and fall to their fate.

In fact, the gravitational field is so strong inside a black hole, that Hajdukovic figures it should generate a constant stream of neutrino-antineutrino particle pairs, and he's done the math to back up that conclusion.

This gives scientists a testable prediction: If gravity attracts both matter and antimatter, the black hole will swallow both particles in a pair. But if gravity attracts matter and repels antimatter, the antineutrinos in the pairs would be ejected violently from the black hole, while the poor normal neutrinos would be trapped within the event horizon.

And that's where IceCube comes in. It's designed to detect neutrinos (and antineutrinos), and the kind of high-energy antineutrinos that would come spewing out of a black hole if such a scenario should show up in IceCube's data quite handily. This would supply some pretty powerful evidence that gravity repels antimatter.

But like many things in science, it wouldn't be 100 percent conclusive, because researchers would then need to rule out other reasons why said black hole would be producing so many neutrino/antineutrino pairs -- say, a previously unsuspected force.

Still, it's nice to know that physicists are on the case -- because the more we understand about antimatter, the closer we get to *Star Trek*'s Enterprise.