Antimatter

Summary

http://quantumspotacademy.org/videos/antimatter/

When an English physicist and mathematician named Paul Dirac was developing a mathematical model of the electron, his calculations required taking the square root of energy squared. This step resulted in both positive and negative solutions. Dirac interpreted the negative solution as a clue to a new symmetry in the laws of physics, and in 1931 he predicted a “mirror” twin of the electron called the “anti-electron,” which would have the same mass, but the opposite charge as the electron.

In 1932, American physicist Carl Anderson found a particle exactly like the electron, but with the opposite charge; the term “positron” was coined to describe it. Anderson’s positron was precisely the anti-electron that Dirac had predicted.

For every particle of matter there is a corresponding particle of antimatter with the opposite charge (neutral particles still have distinct antiparticles). Some particles are indistinct from their antiparticles, much as a symmetric object is identical to its mirror image. Understanding symmetries of this kind play a critical role in particle physics.

Matter and antimatter particles can annihilate with each other, producing a pair of high energy photons. The energy produced by 1 gram of matter annihilating with 1 gram of antimatter is 180 trillion joules of energy, which is greater than the combined explosive energy of both atomic bombs dropped during WWII. With this much energy, the electricity for the average American home could be provided for four and a half thousand years. Energy can also be converted back into matter and antimatter.

Antimatter isn’t an energy source because we can’t get more energy out of it than we put in. Antimatter is used in physics experiments and medical imaging technologies. Perhaps someday it may be used as a rocket fuel, but the rate of antimatter production is currently insufficient for this to be feasible.

A great mystery in physics is why the contents of the universe are primarily made of matter, despite the symmetry between matter and antimatter. A slight asymmetry has been observed in the behavior of neutral kaons. The kaon can oscillate between its matter and antimatter forms and seems to prefer its matter form slightly. However this asymmetry is insufficient to explain the overwhelming majority of matter in the universe.