

ANTIMATTER

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Antimatter: the antiparticles of ordinary matter

Antimatter is matter consisting of elementary particles which are the antiparticles of those making up normal matter.

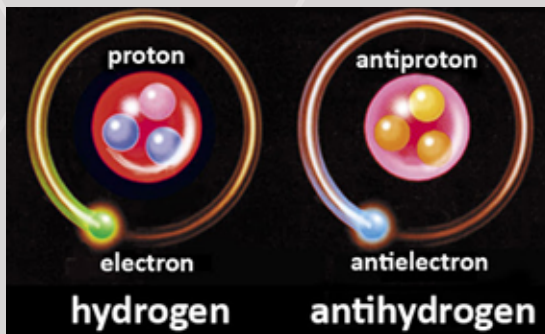


Figure 1. This figure is a Schematic diagram of a hydrogen atom and an antihydrogen atom.
(<https://images.app.goo.gl/yBHYPdKZwzL8kwwK9>)

Did you know that scientists can create antimatter in labs?

In 1995 scientists managed to create anti-atoms for less than a second by destructing the ordinary atoms. In 2011, they trapped antimatter for over 16 minutes. They have recently been working with antihydrogen atoms and the Antiproton Decelerator to discover more about matter and antimatter. In the picture, the Antiproton Decelerator at CERN's ALPHA instrument.



Figure 3. The ALPHA experiment at CERN.
(<https://www.space.com/41648-laser-experiment-helps-unravel-antimatter-mystery.html>)

Who discovered it?

The existence of antimatter was originally predicted by the British physicist Paul Dirac, who won the Nobel Prize in 1933 for his quantum mechanical theory. Dirac was able to sense the existence of antimatter thanks to an equation which described the behaviour of an electron moving at a relativistic speed.



Figure 2. Picture of Paul Dirac.
(https://en.wikipedia.org/wiki/Antimatter#Conceptual_history)

Our sun produces antimatter too

One of the most ambitious ideas to collect antimatter is exploiting the sun: studies show that cosmic rays from the sun produce positrons. The sun could be stimulated through specific devices to generate more of those positrons, yet these proposals are still utopian.



Figure 4. Active Region 1745 produced a M7-class solar flare almost at the western limb of the Sun.
(<https://www.space.com/21889-solar-flares-antimatter-particles.html>)

Antimatter can also be transported

The ALPHA team at CERN is designing a technology that locks antiprotons in a "bottle", keeping the atoms stuck in the centre with powerful magnetic and electric fields. The atoms will be stored in a vacuum and at a temperature slightly above zero. Sadly, development and testing will take about four years before we will be able to transport antimatter.

ANTIMATTER TO GO

To reveal the surface structure of atomic nuclei, physicists send ions of rare isotopes into a bottle 700 millimetres long — where they annihilate with antiprotons stored in the trap.

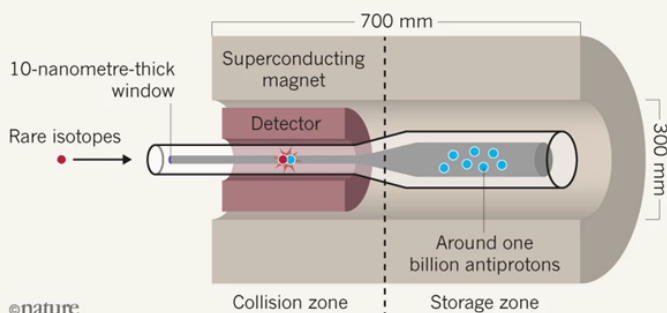


Figure 5. A diagram explaining the PUMA team's antiproton trap.

(<https://newatlas.com/cern-plan-transport-antimatter/53536/>)

Some even think of it as an energy source for the future

Matter and antimatter cannot coexist at a close distance, because in a fraction of a second they collide and annihilate one another. As a consequence, all of their mass is converted to energy (in line with Einstein's theory of relativity $E=mc^2$) in the form of gamma rays or elementary particles. This is a reversible process, which happens because the particles have opposite electric charges.

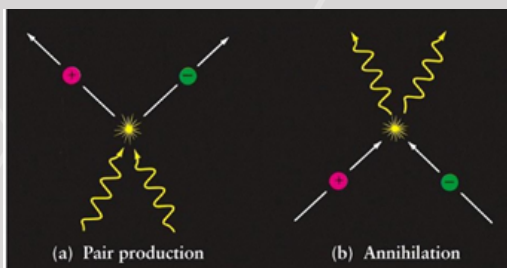


Figure 8. Annihilation between matter and antimatter (<https://www.forbes.com/sites/startwithabang/2018/07/18/what-was-it-like-when-the-universe-first-created-more-matter-than-antimatter/?sh=2ba601a24a53>)

Gravitational interaction of antimatter

Physicists have been wondering about how antimatter would react to gravity. There are several theories, but none of them is proven. That is why there is a growing interest in new experiments.

Are the films right?

Antimatter is a highly intriguing subject for films, but most of the times not used correctly. The well-known film *Angels and Demons* is an example of these scientific inaccuracies.

The three main faults are:

- The energy that is claimed to be produced by the inhibition of antimatter (which is highly exaggerated in the film).
- Transporting antimatter is difficult: it needs to be trapped in a vacuum installation with magnetic fields (not in a bottle).
- With the current techniques, it would take 100 million years to make 1/4 gram antimatter. (completely the opposite of the few minutes it takes in the movie).



Figure 6. Installation in the CERN lab. (<https://www.outsidethebeltway.com/scientists-inching-closer-to-confirming-discovery-of-the-higgs-boson/>)



Figure 7. Container used in the film *Angels and Demons*. (https://danbrown.fandom.com/wiki/Anti-matter_Container)