Physicists Scrutinize Antimatter in Angels & Demons

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There's plenty of antimatter in Angels & Demons - too much, actually.

(PhysOrg.com) -- Could the Vatican really be destroyed by antimatter stolen from a CERN laboratory? The scheme might work in the plot of *Angels & Demons*, the most recent Hollywood thriller based on a book by Dan Brown. However, real physicists are using the movie as an opportunity to talk about antimatter in real life - which has many uses other than mass destruction.

As part of the *Angels & Demons* Lecture Nights series, scientists from more than 30 colleges, universities and national laboratories in the US and Canada are hosting public lectures in order to tell the world about the real science of antimatter, the Large Hadron Collider (LHC) and the excitement of particle physics research. They're showing that the movie, which captures the controversy of the age-old theme of religion vs. science, has a bit of controversial science, as well.

In the movie, an ancient secret brotherhood called the Illuminati manages to steal 1/4 gram of antimatter from a particle physicist's laboratory at the LHC at CERN (the European Organization for Nuclear Research). The group hides the antimatter in the city, and the fate of Rome lies in the hands of Harvard professor Robert Langdon (Tom Hanks), who must prevent the antimatter from colliding with matter and destroying the city.

In real life, as physicists explain, 1/4 gram of antimatter is more than enough to demolish a city the size of Rome. When Hanks says that Vatican City could be "destroyed by light," he is correct: the only difference between a particle and its antiparticle is that they have opposite electric charges, causing them to annihilate into two photons when they meet. According to the formula e=mc^2, 1/4 gram of antimatter contains 45 trillion joules, the energy equivalent of about 10 kilotons of TNT and close to the 14 kilotons from the Hiroshima atomic bomb - but twice the amount of 5 kilotons cited in the movie (apparently the energy from normal matter was not taken into account).

However, creating this seemingly small amount of antimatter is actually a gigantic task. Currently, the largest producer of antimatter is Fermilab, which creates about 2 nanograms of antiprotons per year; at that rate, it would take 100 million years to make 1/4 gram. Antimatter is made by accelerating particles and smashing them into each other, a process which requires a very large amount of energy. For this reason, antimatter poses no realistic threat as a tool of destruction, since it requires much more energy to create than is released upon annihilation (which is also why it can't be used as an energy source). In addition, antimatter is not portable in real life, although in the movie, scientists transport it in a canister.

A few other discrepancies between the movie and real life include the movie's portrayal of CERN. It's not a top-secret science laboratory;

instead, it has 20 member countries and involves 9,000 scientists from around the world. Also, while the fictional CERN laboratory is located inside the high-radiation collider tunnel 100 meters below ground, scientists' offices are actually in safe, above-ground buildings. And while the CERN director in the book is a bald German scientist in a wheelchair, the real CERN's current director, Rolf Heuer, is only German. Another slight difference: while scientists in the book fly a glamorous "X-33 space plane," real scientists fly coach.

The lecture series also notes that antimatter has many useful applications, other than destroying cities. For instance, in PET (positron emission tomography) scans, a patient is injected with sugar through an IV, and the sugar mixes with a radioactive substance. The sugar goes to areas in the body with high metabolism, showing places of high activity. Meanwhile, the radioactive portion decays and releases a positron (an anti-electron), which very quickly finds an electron in surrounding tissue, and they annihilate into two photons. With many such photons, doctors can create a 3D image of areas inside the body.

Antimatter may also help physicists solve some of the biggest mysteries in science, such as the origins of the universe, why particles have mass, and what the universe is made of. For instance, physicists think that our universe contains so little antimatter because most of it disappeared very early on. In the first seconds of the universe, radiation created particles and antiparticles, which in turn annihilated to form radiation, and the process repeated. Possibly, a tiny imbalance between matter and antimatter (about 1 part in 10 billion) may have arisen, though scientists aren't sure why. When the radiation energy eventually decreased and could no longer create particles and antiparticles, the final matter-antimatter annihilations occurred, leaving a tiny excess of matter and a lot of radiation, which today can be seen as the cosmic microwave background.

Another interesting research area involving antimatter is the search for tiny differences between particles and their antiparticles. This symmetry breaking, known as CP violation, was discovered in the decay of particles called kaons, showing that some particles behave slightly differently than their antiparticles - but not enough to explain the asymmetry in the universe.

In short, *Angels & Demons* presents science as one might expect from Hollywood. Although the errors might perturb some physicists, others see it as a way to generate a fresh interest in particle physics by allowing them to speak out about the true nature of antimatter.

More information: http://www.uslhc.us/Angels_Demons/index.html