Air Force pursuing antimatter weapons / Program was touted publicly, then came official gag order

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The U.S. Air Force is quietly spending millions of dollars investigating ways to use a radical power source -- antimatter, the eerie "mirror" of ordinary matter -- in future weapons.

The most powerful potential energy source presently thought to be available to humanity, antimatter is a term normally heard in science-fiction films and TV shows, whose heroes fly "antimatter-powered spaceships" and do battle with "antimatter guns."

But antimatter itself isn't fiction; it actually exists and has been intensively studied by physicists since the 1930s. In a sense, matter and antimatter are the yin and yang of reality: Every type of subatomic particle has its antimatter counterpart. But when matter and antimatter collide, they annihilate each other in an immense burst of energy.

During the Cold War, the Air Force funded numerous scientific studies of the basic physics of antimatter. With the knowledge gained, some Air Force insiders are beginning to think seriously about potential military uses -- for example, antimatter bombs small enough to hold in one's hand, and antimatter engines for 24/7 surveillance aircraft.

More cataclysmic possible uses include a new generation of super weapons -- either pure antimatter bombs or antimatter-triggered nuclear weapons; the former wouldn't emit radioactive fallout. Another possibility is antimatter- powered "electromagnetic pulse" weapons that could fry an enemy's electric power grid and communications networks, leaving him literally in the dark and unable to operate his society and armed forces.

Following an initial inquiry from The Chronicle this summer, the Air Force forbade its employees from publicly discussing the antimatter research program. Still, details on the program appear in numerous Air Force documents distributed over the Internet prior to the ban.

These include an outline of a March 2004 speech by an Air Force official who, in effect, spilled the beans about the Air Force's high hopes for antimatter weapons. On March 24, Kenneth Edwards, director of the "revolutionary munitions" team at the Munitions Directorate at Eglin Air Force Base in Florida was keynote speaker at the NASA Institute for Advanced Concepts (NIAC) conference in Arlington, Va.

In that talk, Edwards discussed the potential uses of a type of antimatter called positrons.

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Physicists have known about positrons or "antielectrons" since the early 1930s, when Caltech scientist Carl Anderson discovered a positron flying through a detector in his laboratory. That discovery, and the later discovery of "antiprotons" by Berkeley scientists in the 1950s, upheld a 1920s theory of antimatter proposed by physicist Paul Dirac.

In 1929, Dirac suggested that the building blocks of atoms -- electrons (negatively charged particles) and protons (positively charged particles) -- have antimatter counterparts: antielectrons and antiprotons. One fundamental difference between matter and antimatter is that their subatomic building blocks carry opposite electric charges. Thus, while an ordinary electron is negatively charged, an antielectron is positively charged (hence the term positrons, which means "positive electrons"); and while an ordinary proton is positively charged, an antiproton is negative.

The real excitement, though, is this: If electrons or protons collide with their antimatter counterparts, they annihilate each other. In so doing, they unleash more energy than any other known energy source, even thermonuclear bombs.

The energy from colliding positrons and antielectrons "is 10 billion times ... that of high explosive," Edwards explained in his March speech. Moreover, 1 gram of antimatter, about 1/25th of an ounce, would equal "23 space shuttle fuel tanks of energy." Thus "positron energy conversion," as he called it, would be a "revolutionary energy source" of interest to those who wage war.

It almost defies belief, the amount of explosive force available in a speck of antimatter -- even a speck that is too small to see. For example: One millionth of a gram of positrons contain as much energy as 37.8 kilograms (83 pounds) of TNT, according to Edwards' March speech. A simple calculation, then, shows that about 50-millionths of a gram could generate a blast equal to the explosion (roughly 4,000 pounds of TNT, according to the FBI) at the Alfred P. Murrah Federal Building in Oklahoma City in 1995.

Unlike regular nuclear bombs, positron bombs wouldn't eject plumes of radioactive debris. When large numbers of positrons and antielectrons collide, the primary product is an invisible but extremely dangerous burst of gamma radiation. Thus, in principle, a positron bomb could be a step toward one of the military's dreams from the early Cold War: a so-called "clean" superbomb that could kill large numbers of soldiers without ejecting radioactive contaminants over the countryside.

A copy of Edwards' speech onNIAC's Web site emphasizes this advantage of positron weapons in bright red letters: "No Nuclear Residue."

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(Page 2 of 2)

But talk of "clean" superbombs worries critics. " 'Clean' nuclear weapons are more dangerous than dirty ones because they are more likely to be used," said an e-mail from science historian George Dyson of the Institute for Advanced Study in Princeton, N.J., author of "Project Orion," a 2002 study on a Cold War-era attempt to design a nuclear spaceship. Still, Dyson adds, antimatter weapons are "a long, long way off."

Why so far off? One reason is that at present, there's no fast way to mass produce large amounts of antimatter from particle accelerators. With present techniques, the price tag for 100-billionths of a gram of antimatter would be $6 billion, according to an estimate by scientists at NASA's Marshall Space Flight Center and elsewhere, who hope to launch antimatter-fueled spaceships.

Another problem is the terribly unruly behavior of positrons whenever physicists try to corral them into a special container. Inside these containers, known as Penning traps, magnetic fields prevent the antiparticles from contacting the material wall of the container -- lest they annihilate on contact. Unfortunately, because like-charged particles repel each other, the positrons push each other apart and quickly squirt out of the trap.

If positrons can't be stored for long periods, they're as useless to the military as an armored personnel carrier without a gas tank. So Edwards is funding investigations of ways to make positrons last longer in storage.

Edwards' point man in that effort is Gerald Smith, former chairman of physics and Antimatter Project leader at Pennsylvania State University. Smith now operates a small firm, Positronics Research LLC, in Santa Fe, N.M. So far, the Air Force has given Smith and his colleagues $3.7 million for positron research, Smith told The Chronicle in August.

Smith is looking to store positrons in a quasi-stable form called positronium. A positronium "atom" (as physicists dub it) consists of an electron and antielectron, orbiting each other. Normally these two particles would quickly collide and self-annihilate within a fraction of a second -- but by manipulating electrical and magnetic fields in their vicinity, Smith hopes to make positronium atoms last much longer.

Smith's storage effort is the "world's first attempt to store large quantities of positronium atoms in a laboratory experiment," Edwards noted in his March speech. "If successful, this approach will open the

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door to storing militarily significant quantities of positronium atoms."

Officials at Eglin Air Force Base initially agreed enthusiastically to try to arrange an interview with Edwards. "We're all very excited about this technology," spokesman Rex Swenson at Eglin's Munitions Directorate told The Chronicle in late July. But Swenson backed out in August after he was overruled by higher officials in the Air Force and Pentagon.

Reached by phone in late September, Edwards repeatedly declined to be interviewed. His superiors gave him "strict instructions not to give any interviews personally. I'm sorry about that -- this (antimatter) project is sort of my grandchild. ...

"(But) I agree with them (that) we're just not at the point where we need to be doing any public interviews."

Air Force spokesman Douglas Karas at the Pentagon also declined to comment last week.

In the meantime, the Air Force has been investigating the possibility of making use of a powerful positron-generating accelerator under development at Washington State University in Pullman, Wash. One goal: to see if positrons generated by the accelerator can be stored for long periods inside a new type of "antimatter trap" proposed by scientists, including Washington State physicist Kelvin Lynn, head of the school's Center for Materials Research.

A new generation of military explosives is worth developing, and antimatter might fill the bill, Lynn told The Chronicle: "If we spend another $10 billion (using ordinary chemical techniques), we're going to get better high explosives, but the gains are incremental because we're getting near the theoretical limits of chemical energy."

Besides, Lynn is enthusiastic about antimatter because he believes it could propel futuristic space rockets.

"I think," he said, "we need to get off this planet, because I'm afraid we're going to destroy it."

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