SPACE SCIENCE

Ready for Takeoff, Antimatter Experiment Takes Some Flak

The space shuttle Discovery is scheduled to blast into orbit next week, carrying a $33 million experiment to search for primordial antimatter. With its Nobel Prize–winning leadership, its international heritage—including a sophisticated 2-ton magnet from China and detectors from Europe—and its profound scientific goal, the Alpha Magnetic Spectrometer (AMS) has undeniable charisma. Indeed, the shuttle flight is just a test of the device, which is destined to spend 3 years on the International Space Station looking for particles of antimatter left over from the big bang. If anything can give the Space Station some sorely needed scientific credibility, the AMS is it—except that many astrophysicists give the device almost no chance of finding its chief quarry.

"No one believes that there is any chance of seeing primary antimatter," says Greg Tarlé, a physicist at the University of Michigan, Ann Arbor. One reason is that nearly all theorists now believe large domains of antimatter have not survived into the present universe. But Tarlé and others are also critical of the instrument's design. "Even if you take the approach that to look is legitimate, they would not be able to distinguish [antimatter] at the level they claim," he says. He and other critics believe the experiment has received favored treatment from NASA, a charge AMS designers hotly dispute.

The experiment's mastermind, Massachusetts Institute of Technology physicist Samuel Ting, explains that the detector is designed to probe a basic mystery: Where is all the antimatter that must have been made in the big bang? "At the beginning, equal amounts of matter and antimatter were created," says Ting. "Now there seems to be only matter. There have been theoretical speculations about the disappearance of antimatter, but no experimental support."

Balloon-borne detectors have searched without success for antimatter cosmic rays—say, nuclei of anticarbon—that might come from distant antistars. But balloons fly for only a few days. A detector in orbit could search for months, gathering thousands of times more data—information that Ting says might reveal not just antimatter but a signature of the universe's missing "dark matter" as well. In 1993 Ting, who won a Nobel Prize for his work on elementary particles, conceived of an orbiting detector that would sort cosmic rays with a powerful magnet (*Science*, 12 January 1996, p. 142).

Ting organized an international collaboration to build the detector and discussed the project with Roald Sagdeev, former head of the Soviet space program and now a professor at the University of Maryland, College Park. Sagdeev, reportedly impressed, put Ting in touch with Dan Goldin, the head of NASA. Scientists and NASA sources both say that Goldin saw Ting's project as a chance to do some cutting-edge science on the Space Station. International collaborators in Switzerland, Germany, and Italy are footing much of the detector's $20 million construction cost, with the U.S. Department of Energy (DOE) contributing $4 million. The largest U.S. contribution comes from NASA: $13 million to fly the detector aboard the shuttle and the Space Station.

Test flight. The antimatter experiment will ride into space aboard this shuttle mission.

Michael Salamon, a physicist at the University of Utah, Salt Lake City, who is collaborating with Ting, recalls that from the beginning, searching for antimatter was risky. "But the rewards were so great that it was worth looking," he says. Since then, however, physicists Andrew Cohen of Boston University, Alvaro de Rújula of CERN near Geneva, and Sheldon Glashow of Harvard University have analyzed measurements of cosmic gamma rays in search of the flare of energy that would be given off when antimatter encounters matter. They have come up empty. Their results, they say, essentially rule out large domains of antimatter within the visible universe (*Science*, 10 October 1997, p. 226). "The work is extremely compelling," admits Salamon, "and gives me fresh pessimism. It is a big blow to the whole concept."

Is it still worth looking? "Absolutely," says Ting. The new analysis "is a good paper and it stimulates discussion, but without experimental measurement, all other things are just a guess." Is it worth $33 million? "That," says Salamon, "is a political question, which I'd rather not get into."

Some astrophysicists believe, however, that the project itself raises some political questions. Simon Swordy of the University of Chicago puts it delicately: "It was perceived by many scientists that [AMS] circumvented the usual routes of getting an experiment into space." Adds Dietrich Müller of Chicago, "AMS has never been subject to review like other NASA projects." Ting and Salamon bristle at these suggestions. "Some people have gone out of their way to say that there has been no peer review," says Salamon, "when it is simply not true."

AMS was approved by a DOE review panel, which included respected physicists such as the late David Schramm of the University of Chicago, an expert on the creation of nuclei during the big bang. In addition, says Ting, astrophysicists in the European countries contributing to the project reviewed it extensively. In total, he says, it passed more than 200 reviews, one done by the European Space Agency even after the paper by Cohen, de Rújula, and Glashow.

NASA itself did not peer review the project, Ting notes, but there was no reason it should have. NASA is not paying for the experiment's construction; it is simply carrying it as a payload. "AMS is not a NASA experiment," he emphasizes. Adds NASA spokesperson Michael Braukus, "The only slightly unusual thing [about AMS] is that the director knows all about the experiment and is very excited about it."

The questions go beyond politics, however, to the AMS's design. Ting says the device should be able to pick out a single antinucleus from 100 million cosmic ray nuclei. But Tarlé claims that the silicon detectors, which identify particles by mapping their paths through the magnet, won't be able to distinguish matter and antimatter with the needed sensitivity. Müller is also doubtful about AMS's capabilities: "From what I know, some of the measurement claims seem to be inflated."

But Ting notes that the detector's 3-year sojourn in space should allow it to collect unprecedented amounts of data. He adds that primordial antimatter isn't its only goal. It should also be able to identify the antiparticles that might be produced in the decay of dark matter—the invisible stuff thought to account for much of the universe's mass. "The point is that nobody has looked at the charged particle spectrum in space," says Ting. "Who knows what we will find?"

Indeed, Swordy acknowledges that the experiment could do some very useful astrophysics. In the end, of course, it's the data from the AMS that will settle its scientific worth.

–Meher Antia

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