Astrophysics

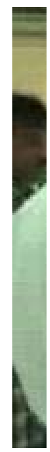
Showtime for Ting

Dennis Overbye

The Alpha Magnetic Spectrometer is designed to sift the high-energy particles flying through space known as cosmic rays. On February 27, the space shuttle Endeavour will ferry the spectrometer to a permanent berth on the space station. The experiment is the brainchild of Sam Ting, the 74-year-old Nobel laureate, writes Dennis Overbye

After 16 years and $1.5 billion of other people's money, it is almost showtime for NASA and Sam Ting. Sitting at the Kennedy Space Centre in preparation for a February launching is an eight-ton assemblage of magnets, wires, iron, aluminum, silicon and electronics that is one of the most ambitious and complicated experiments ever to set out for space.

The experiment could help NASA take a giant step toward answering the question of what the universe is made of. It could also confer scientific glory on both the International Space Station and a celebrated physicist reaching one last time, literally, for the stars. The device, named the Alpha Magnetic Spectrometer, is designed to sift the high-energy particles flying through space known as cosmic rays.



Destination shadow universe

On February 27, the space shuttle Endeavour will ferry the spectrometer to a permanent berth on the space station. But the real destination is the shadow universe. You might think that the universe is made of atoms and molecules, protons and electrons, stars and galaxies.

That notion has been turned on its head over the past few decades as astronomers have concluded that all this is just a scrim overlying a much vaster shadowy realm of invisible "dark matter" whose gravity determines the architecture of the cosmos. If they are lucky, scientists say, the spectrometer could confirm that mysterious signals recorded by other satellites and balloons in recent years are emanations from that dark matter, revealing evidence of particles and forces that have only been theoretical dreams until now.

Einstein’s curved spacetime, equally elusive to the senses, proved crucial to the function of GPS devices that were invented decades after his death. “Real discovery is outside the ring of existing knowledge,” said Samuel Chao Chung Ting, a professor at the Massachusetts Institute of Technology and the leader of the cosmic ray project, in his laboratory at CERN outside Geneva.

Ting, the 74-year-old Nobel laureate and one of science’s great control freaks and worrywarts, has spent his life commanding armies of physicists. In 1974, he discovered a particle that would revolutionise physics, but he took so long checking for errors and looking for more particles that another lab found it and he wound up splitting the Nobel. Gazing at his spectrometer, Ting shrugged off the question of what he had up his sleeve next.

The experiment was born in the early 1990s when Ting failed to land a role on the largest physics machines ever contemplated, the Superconducting Supercollider (cancelled before completion in 1993) or the Large Hadron Collider.

So he turned his eyes to the heavens. According to the laws of physics, equal amounts of matter and its science-fiction-sounding evil twin, antimatter – which annihilates ordinary matter in a flash of energy upon contact – should have been created during the Big Bang. It is one of the abiding mysteries of science why the universe is now all matter.

Or is it? The discovery of a single atomic nucleus heavier than anti-helium could mean there was an anti-star or maybe a whole anti-galaxy somewhere.“If you don’t do the measurement, you will never know,” Ting said.

Prototype of spectrometer

In 1994, Ting told Dan Goldin, then NASA’s administrator, that he could make that measurement with a space-based cosmic ray detector. Goldin was smitten and agreed to put the spectrometer on the International Space Station. In 1998, a prototype of the spectrometer was built and flown successfully on the space shuttle for 10 days on a trip to the Mir space station, although not without some Tingian drama. After the shuttle Columbia disintegrated in 2003, killing its crew of seven astronauts, The Alpha spectrometer was dropped from the flight manifest.

Eventually, the US Congress ordered NASA to provide an extra shuttle flight for the experiment. “Three days after Obama’s inauguration, we were back on the manifest,” Ting said. By then nobody, with the exception of Ting, expected the experiment to find any primordial antimatter. Most theorists have concluded that it disappeared in the first moments after the Big Bang. “The original goal has evaporated,” said Greg Tarle, a cosmic-ray physicist at the University of Michigan and longtime critic of the experiment. Instead, the heavens were crackling with intimations of dark matter.

Two years ago a European satellite named Pamela registered an excess of anti-electrons, or positrons, in space – perhaps from collisions of dark matter particles. But that satellite had no way to tell positrons, which are exotic, from protons, which are humdrum, being the nuclei of hydrogen, and everywhere.

The Alpha spectrometer does. It is a miniature space-going version of the cathedral-size particle detectors that now line the Large Hadron Collider.

At its heart was to be the most powerful magnet ever flown in space, a superconducting electromagnet like the ones in the collider, which would sort high energy particles according to their electrical charges and momenta. According to some physicists, including Ellis and Ting, the positrons from dark matter should have a unique spectral signature that the cosmic ray spectrometer can measure.

Earlier this year, with a fall flight date finally secured, Ting announced he was ripping out the heart of his experiment and replacing his superconducting magnet with a weaker permanent magnet that had flown on the prototype flight. That meant he would miss the deadline for shipping the instrument to Cape Canaveral, Fla. NASA moved the flight to next year.

Ting gave two main reasons for the last-minute change. Vacuum chamber tests in February revealed that the helium needed to keep the magnet cold and superconducting could run out in as little as two years.

Refilling it in space was not an option. In the meantime, he said, the station's lifetime had been extended from 2015 to 2020 or 2028, and it would not be right to occupy space on the station for all those years with a dead experiment.

New York Times News Service

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