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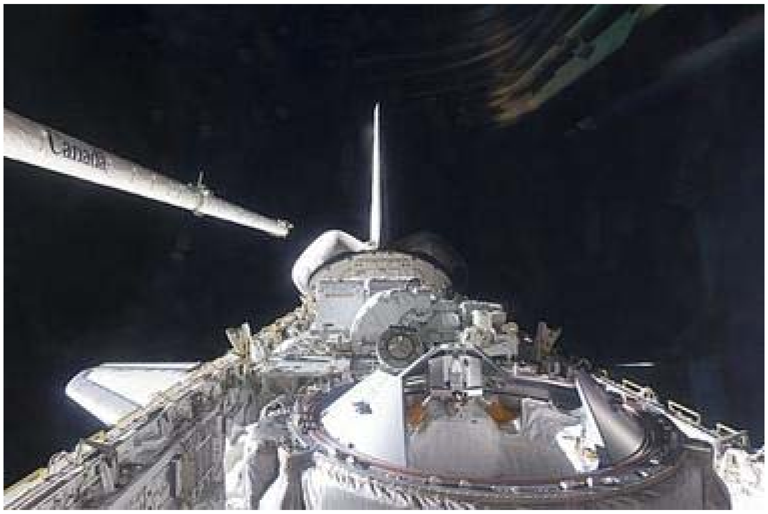
The hunt for antimatter begins at the space station: Will dilithium be next?

A $2 billion particle detector, newly installed on the International Space Station, begins its search for antimatter, dark matter, quarks, and more.



This photo provided by NASA shows a close-up view of the Alpha Magnetic Spectrometer-2 (AMS) in space shuttle Endeavour's payload bay, May 17. On May 19, astronauts used the shuttle's and space station's robotic arms to install the particle detector, which has already sent back reams of data to Earth-bound scientists.
(NASA / Reuters)

By Pete Spotts, Staff writer
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The most complex physics experiment ever launched into space was bolted to the International Space Station on Thursday, marking the start of an exploration into cosmic origins that could last well beyond a decade.

The experiment, the Alpha Magnetic Spectrometer 2, arrived aboard the space shuttle Endeavour on Wednesday.

Its successful activation also marks the first truly national-laboratory-scale physical science experiment at a space station that, so far, has only conducted what on Earth might be considered bench-top experiments in biological and physical sciences.

IN PICTURES: Space photos of the day: Space Shuttle Endeavour

Within a few hours of its installation, the $2 billion particle detector began returning "an enormous amount of data," says the project's lead scientist, Samuel Ting, a Nobel prize-winning physicist from the Massachusetts Institute of Technology.

The research team, which includes 600 physicists in 16 countries, will use the 7.6-ton instrument to study very high-energy, very massive cosmic rays, which only can be directly captured and measured in space.

In addition, they will be hunting for evidence of dark matter, some 90 percent of the matter in the universe. And they will try to help physicists and cosmologists figure out why the universe exists at all.

When it formed from the Big Bang some 13.7 billion years ago, the cosmos is thought to have contained equal amounts of normal matter and its mirror opposite, antimatter.

By all rights, the two should have annihilated each other, leaving nothing behind. But significant amounts of matter survived.

"The question is: Where is the universe made out of antimatter?" asks Dr. Ting. It's "an important question in physics," he adds, with a touch of understatement.

Installing the particle detector: The robot hand-off

During their Thursday workday, four astronauts conducted a carefully choreographed hand-off between shuttle and station.

The orbiter's robotic arm plucked the particle detector from the shuttle's massive cargo bay and gingerly offered it to the space station's robotic arm. The space station's arm just as carefully clasped the detector, and then gently set it into place on one of the station's support trusses.

Once it was locked in place and the power connections automatically made, controllers activated the detector, which began returning its first data.

The hand-off and installation took about three to four hours and went flawlessly, said to Derek Hassmann, the lead space-station flight director for the mission.

Once the device had power, the science team checked out the detector, whose seven individual detector elements are aligned to within 1/10 the width of a human hair. The detectors, along with some 650 microprocessors and some 300,000 data channels, worked perfectly the first time, says Ting.

While the experiment, 17 years in the making, has a specific research agenda, part of its scientific allure is the potential for uncovering things scientists haven't anticipated – a trait common to other high-energy physics experiments.

Instead of manufacturing its own particles, like an Earthbound detector does, the AMS-2 will record collisions between incoming cosmic rays – essentially the cores of atoms representing a wide range of elements – and its detectors. Many of these particles will collide at energies far higher than any terrestrial physics lab could generate.

Like venerable observatories such as the Hubble Space Telescope, the AMS-2 must operate in space to detect these particles, which Earth's atmosphere absorbs.

With the energies and mass ranges available to study, "we're entering a region nobody's entered before," Ting says. "What we're going to see, nobody knows."

Science objectives include:

Getting a better handle on the cosmic-ray environment astronauts face as they live and work in space. The spectrometer will be able to measure the incoming particles over a wider range of masses and energies than any predecessor.

Shedding light on the matter-antimatter mystery. Some researchers have proposed that a process in the early history of the universe tipped the scales in favor of matter – but as researchers have tried to work out the math behind that process, the calculations, in effect, make predictions that don't match astrophysicists' observations.

If the hunt for antimatter – in the form of anti-helium – succeeds, it will yield the first wisp from a smoking gun that anti-matter counterparts to known elements exist outside of a terrestrial laboratory.

A prototype alpha magnetic spectrometer flew aboard a shuttle in 1999. Its results implied that for every million helium nuclei in the universe, there could be no more than one anti-helium nuclei. It's another way of saying: We didn't find any.

The new spectrometer should be able to detect anti-helium at levels of one in a billion helium nuclei.

Hunting for evidence of dark matter. One candidate is a hypothesized particle dubbed a neutralino. Researchers say if these are out there and colliding, among the collision debris will be electrically charged particles, which the the AMS-2 can detect. Sudden peaks in the number of gamma rays, or in the number of antimatter versions of protons and electrons, would signal interactions between dark-matter particles, according to the AMS-2 team.

Looking for strange new forms of matter. Crack open a proton or neutron on Earth, and you'll find quarks inside, Ting explains. Physicists have identified six types of quarks. But the protons and neutrons on Earth only use two types, in different combinations. The other four have appeared – fleetingly – in physicists' labs. Some researchers have proposed that protons and neutrons could have variants that use three different types of quarks, but none has yet been found.

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