

UC SANTA BARBARA

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## **UCSB REPORTS RESULTS IN INTERNATIONAL RACE TO FIND DARK MATTER**

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Physicists at the University of California, Santa Barbara, part of a team of researchers from 10 institutions who are among a handful of the world's leaders in the race to discover the elusive particles called 'dark matter,' reported results that dispute the breakthrough announced last week by their main competitors, a research group based in Italy.

"There is a great deal of interest in the Italian results, because if it were true that they had discovered most of the material of the universe, it would be extremely important," said David Caldwell, professor emeritus of physics at UC Santa Barbara, and a founder of the team of scientists from U.S. institutions, called CDMS for Cryogenic Dark Matter Search. "However, our results do not confirm their observation."

The Italian-Chinese results were reported in a front page New York Times story on February 19th.

The CDMS team will present its own results at a major conference on Friday, the Fourth International Symposium on Sources and Detection of Dark Matter in the

Universe, held at the Marriott Hotel in Marina del Rey, Calif. Of all the experiments worldwide, those by the CDMS team and the Italian-Chinese team are considered to be neck-in-neck, in front of the pack. The CDMS experiment is better than any other experiment in distinguishing dark matter particles from known particles, according to Caldwell.

The search for dark matter is a heated one, because scientists generally agree that dark matter comprises an estimated 90 percent of the mass of the universe.

Finding dark matter -- also called WIMPs for weakly interacting massive particles -- would confirm 70 years of combined astrophysics and particle physics research which suggests that most of the matter of the universe is dark and is not made of ordinary atoms, which emit light.

The discovery would be a profound extension of the Copernican revolution which revealed that the Earth was not the center of the solar system; the discovery of dark matter will mean that we are not even made of the most dominant form of matter in the universe.

Scientists postulate that about a million dark matter particles pass through the area the size of a person's thumbnail every second, but they move through like ghosts, with very few particles actually touching the person.

The dark matter is inferred from the gravitational pull that it exerts on the matter that does emit light.

For example, the atoms that orbit many spiral galaxies move at speeds that are much faster than the gravitational pull that the light-emitting matter alone in those galaxies can explain.

And yet, a straightforward explanation - that the dark matter consists of ordinary atoms that somehow fail to emit light - is inconsistent with the big-bang theory.

Consistent explanations usually involve some sort of 'new' physics, such as new types of fundamental, massive particles. Very general considerations about the big bang imply that those new particles must interact with protons and other nuclei, in addition to the gravitational pull, via a very weak force.

The CDMS group is working to detect the dark matter by exploiting the implied force.

Should a dark matter particle pass close to an atomic nucleus, this force would cause the atomic nucleus to feel a push, and then recoil with an appreciable velocity. The magnitude of that velocity should be approximately

200,000 meters per second, which would give the nucleus a kinetic energy that would be a bit less than the energy of a medical X-ray. Unlike an X-ray, however, most of the energy of a recoiling nucleus creates sound and heat, while an X-ray creates mostly free charge or ionization.

The apparatus currently being used by the CDMS research group -- housed in a tunnel at Stanford University - was designed, fabricated, and operated by a tightly-knit team of physicists from 10 U.S. institutions.

"We benefit from a strong, all-for-one team spirit," said Harry Nelson, physics professor at UC, Santa Barbara.

Comparing the CDMS equipment to that of the Italian-Chinese group (called DAMA for DArk MATter Experiment), Nelson said, "Our experiment is smaller, but better able to distinguish the dark matter from garden varieties of radioactivity."

According to the CDMS statement, "This powerful technology derives its advantage from being able to distinguish background 'events' which result from many of the known particles interacting in the crystals from those that are likely to be dark matter interactions.

This allows an unambiguous identification of events in the crystals caused by any new form of matter."

Nelson explained the difference between DAMA and CDMS by comparing it to television reception.

"It's as if they see a lot of 'snow' and a faint image on their TV," said Nelson.

"On our TV, there is no snow, as though our electronics are better, but there is no image either.

But they have a much bigger antenna. When you put together all the factors, we have similar sensitivities, yet they see a faint signal, and we don't."

However, Nelson said that just reading about DAMA's research isn't enough. He is looking forward to asking the hard questions in person at the conference to clarify the interpretation of the results. Nelson spent several years as one of the few Americans on the staff of CERN in Switzerland, the European Laboratory of Particle Physics.

DAMA he said, is an impressive competitor. "We have different techniques," he said.

"Discovery is like a roulette wheel. You've got to place a bet,

by choosing an experimental technique; we hope our choice will be superior in the end."

The CDMS collaboration uses a new technology where crystals are cooled to within one-tenth of a degree Centigrade of absolute zero. In crystals that are so cold, it becomes possible to distinguish the heat and sound from events initiated by WIMPs from events initiated by known particles, such as photons, electrons, and alpha particles.

More refined experiments are planned by both groups.

In 2001, the CDMS experiment will expand its detectors from the current mass of 0.6 kilograms to 10 kilograms, and it will move from the tunnel, which is only 10.5 meters underground to a deep mine in Minnesota.

The rock in the mine will protect the experiment from cosmic rays that constantly bombard the Earth from outer space, which can possibly cause a spurious dark matter signal.

The CDMS collaboration consists of 55 scientists from UC Berkeley, Stanford, UC Santa Barbara, Lawrence Berkeley National Lab, Fermi National Accelerator Laboratory (Fermilab), Case Western Reserve University, Santa Clara University, National Institute of Standards and Technology (Boulder),

the University of Colorado at Denver and Princeton University. Their findings have been submitted to Physical Review Letters. The research is supported jointly by the Department of Energy and by the National Science Foundation.

The UC Santa Barbara team includes: David Caldwell and Harry Nelson, previously mentioned faculty; Steve Yellin and Dan Bauer, senior scientists; Dave Hale, Susanne Kyre and Dan Callahan, engineers; Andrew Sonnenshein who completed his Ph.D. at UC Santa Barbara and is now at Princeton University; Ray Bunker, Craig Maloney, Tim Bouck and Joel Sander, current graduate students.

For more information see

<http://hep.ucsb.edu/dept/CDMS.html>

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## **About UC Santa Barbara**

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.