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Experiments at Stanford Shake Dark-Matter Claim

Findings Cast Doubt on Particle Detection

By JAMES GLANZ

MARINA DEL REY, Calif., Feb. 25 — A team of physicists announced today that a highly sensitive experiment at Stanford University to detect the so-called dark matter particles that could account for most of the mass in the universe had contradicted a stunning and controversial announcement by a team of Italian and Chinese physicists last week that they had detected the elusive particles.

After a year's worth of observations, the scientists said, it was highly unlikely that their detector had recorded any mysterious particles in the numbers suggested by the Italian experiment.

The new results were presented here today by Dr. Richard Gaitskell, a physicist at the University of California at Berkeley, for a team of scientists at 10 American institutions who built the Stanford detector. The findings were reported at the Fourth International Symposium on Sources and Detection of Dark Matter in the Universe.

Dr. Gaitskell's interpretation was immediately challenged by a representative from the Italian group, which had reported a slight seasonal variation in the counts in its own detector. The group had attributed its findings to variations in Earth's speed through a dark matter cloud surrounding the Milky Way galaxy. Few physicists, however, have endorsed the Italian results.

While physicists who were present at the often contentious session found the Stanford experiment persuasive, they say it does not definitively rule out the possibility that the competing group, based at the University of Rome, has made what would rank among the most important of all discoveries in cosmology and physics if true.

The doubts about today's announcement arose partly because the Stanford experiment actually registered about the number of counts, or particle detections, that would be expected if the Rome group was right and had discovered the so-called weakly interacting massive particles, or WIMP's, predicted by several prevailing theories. But Dr. Gaitskell said those 13 counts, found in experiments undertaken over parts of two years, were caused by ordinary particles called neutrons that occasionally escape from atomic nuclei and are detected.

A crucial aspect of the new data, Dr. Gaitskell said, "is simply not consistent with a WIMP hypothesis." But he added that it was "extremely consistent" with the hypothesis that the scientists were seeing neutrons.

At the same session, Dr. Pierluigi Belli of the University of Rome reiterated his group's findings and, like Dr. Gaitskell, submitted to lengthy questioning by other scientists in attendance. Dr. Belli said the 13 counts registered by the Stanford detector "are more or less the same number that are expected from our results; in my opinion, this is a question mark."

Dr. Douglas Michael, a physicist at member of the Rome group. "By no means is this a final statement."

To add to the intrigue, members of the American team were careful to say that while they had found no positive evidence for WIMP's, they could not rule out the possibility that their own detector had seen a small number of them, hidden among the neutron counts. The team's analysis, said Dr. Blas Cabrera of Stanford, "is basically saying that of those 13 candidates, maybe 2 or 3 could be WIMP's, at most."

That hedge emphasized the sky-high scientific stakes involved as well as the statistical uncertainties. In fact, since both groups are planning improvements to their detectors in hope of capturing WIMP's, the chase is certain not to end here, no matter what the immediate outcome.

WIMP's are predicted by advanced theories of physics and could account for the mysterious "dark matter" whose gravity is believed to keep galaxies like the Milky Way from breaking apart, and that probably allowed them to form in the first place.

Even though astronomers believe that dark matter makes up some 80 percent of the mass of the universe, WIMP's generally pass through ordinary matter without a trace because they interact so rarely with it. But occasionally they should collide with ordinary atomic nuclei, and the Rome team reported that their own detector had found evidence that Earth is moving through a swarm of WIMP's, as expected if they are the dark matter.

Are scientists' sightings elusive particles or merely errant neutrons?

Because the Sun is orbiting the center of the galaxy at about 140 miles per second, detectors on Earth should encounter the WIMP's as a kind of "wind." But because Earth is also revolving around the Sun, the speed of that wind should vary from season to season, changing the detection rate — the signal the Rome group believes it has seen.

That approach requires the subtraction of a much larger, steady background signal that presumably includes both WIMP's and ordinary particles. Skeptical scientists questioned Dr. Belli closely on whether his team might be seeing a spurious variation caused by an incorrect subtraction or a background that varies with the season for unrelated reasons, such as changing levels of natural radioactivity. Although language barriers sometimes inhibited the discussion, Dr. Belli replied that all such sources had been carefully anain my opinion, this is a question mark."

Dr. Douglas Michael, a physicist at the California Institute of Technology, said that because neutrons were extremely difficult to account for in such experiments, "it looks to me like there is a little bit of room" for the Rome results to be correct, even if he favored Dr. Gaitskell's interpretation.

"I'm going to have to take a little bit of a wait-and-see attitude," said Dr. Katherine Freese, a physicist at the University of Michigan who was also present during the sometimes heated exchanges. But she added that "if I had to put money on it, I would put money on C.D.M.S.," or the Cryogenic Dark Matter Search, as the collaboration using the ultracold detector in Stanford is known.

Several scientists said that substantial differences in the two experiments, combined with poor knowledge of the properties of WIMP's, if they indeed exist, meant that both results could eventually turn out to be correct. "You cannot say that one experiment is ruling out another experiment," said Dr. Alessandro Bottino, a physicists at the University of Turin and the National Institute of Nuclear Physics in Italy who is not a

barriers sometimes inhibited the discussion, Dr. Belli replied that all such sources had been carefully analyzed. "The cumulative analysis favors the presence of annual modulation," he said, referring to the seasonal effect.

The American collaboration took an entirely different approach, concentrating only on identifying interactions caused by the main WIMP "wind," if it exists. The collaboration built heavily shielded, ultracold detectors that can specifically identify and reject many types of spurious interactions caused by natural radioactivity and the high-energy particles arriving from space called cosmic rays.

The collaboration, led by Dr. Cabrera, Dr. Bernard Sadoulet of Berkeley and Dr. David O. Caldwell of the University of California at Santa Barbara, placed the detector in a tunnel about 30 feet beneath the surface to provide further shielding from cosmic rays.

Even after those precautions, some neutrons jarred loose from the surrounding rock are expected to slip into the detector and interact "just like a WIMP," said Dr. Richard Schnee, a team member at Case Western Reserve University.

But he added that several checks had determined that most of the 13 counts were caused by neutrons, not WIMP's.

"All of our events are consistent with being caused by neutrons," Dr. Schnee said, although he agreed that the team could not rule out the possibility that a few of them might indeed have been caused by WIMP's. Most physicists and cosmologists saw the developments in a positive light, since expected improvements in both detectors should allow ever more sensitive searches for the mysterious particles, and — perhaps — solve a problem that astronomers have grappled with since gathering the first indirect evidence for the existence of dark matter nearly 70 years ago.

"What's really exciting is that we now have detectors sensitive enough to detect the dark matter particles," said Dr. Michael Turner, a cosmologist at the University of Chicago. "These are the first two experiments to touch the promised land."