Have Milky Way MACHOs Been Found?

More than 20 years ago, astronomers came face to face with an unsettling finding: The tug exerted by all the visible material in our galaxy is not nearly enough to keep it intact. To explain why the rapidly rotating stars and gas at the edge of the galaxy don't simply fly away, scientists have been forced to assume that a vast halo of dark matter, extending thousands of light-years beyond the Milky Way's visible outline, envelops the galaxy. The identity of this unseen material has remained under wraps.

Now, two teams of astronomers report that they may have glimpsed some of the veiled stuff, and it might be nothing more than elderly white dwarfs—the dim, compact remains of ordinary stars like the sun. The dwarfs could account for about half the Milky Way's dark matter and may be some of the long-sought MACHOs (massive compact halo objects) that scientists have suggested reside at the outskirts of the galaxy (SN: 4/29/95, p. 261).

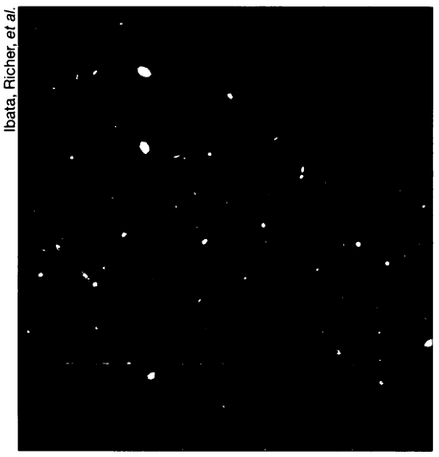
With only 20 objects imaged, the researchers say they must do follow-up observations to verify their conclusions. If the findings hold up, they could revolutionize the way astronomers think about the Milky Way and perhaps the structure of all galaxies.

However, the results won't solve the mystery of dark matter throughout the universe. The Big Bang theory predicts that most dark matter must be of some exotic form not made from protons and neutrons.

Both teams went hunting for MACHOs in postage-stamp patches of sky photographed by the Hubble Space Telescope. Rodrigo A. Ibata of the European Southern Observatory in Garching, Germany, Harvey B. Richer of the University of British Columbia in Vancouver, and their colleagues used Hubble to reexamine the Hubble Deep Field North 2 years after the telescope first imaged this region of sky (SN: 1/20/96, p. 36).

By comparing the two image sets, they picked out five extremely faint objects that had moved slightly. Remote galaxies do not move perceptibly across the sky, so the objects must reside in or near the Milky Way. Their particular motion, brightness, and bluish color suggest they are faint white dwarfs a few thousand light-years from Earth, the international team reports in an article scheduled for publication in the ASTROPHYSICAL JOURNAL LETTERS.

Richer cautions that the findings will remain speculative unless Hubble observations scheduled for December show that the objects continue to move in the same way. "We want to be pretty conservative," he says, "because the objects we're looking at are extremely faint, and the motions . . . are very small."



Ibata, Richer, *et al.*

MACHO images? Located in the Hubble Deep Field North, the central green objects in the five small frames could be white dwarfs in the galaxy's dark-matter halo.

Taking a different approach, René A. Méndez of the Cerro Tololo Inter-American Observatory near La Serena, Chile, and Dante Minniti of the Pontificia Universidad Católica de Chile in Santiago analyzed single images of both the Hubble Deep Fields, North and South. They found 15 point-like sources of light whose bluish color is indicative of old white dwarfs. These objects are likely to lie in the halo less than 6 thousand light-years from Earth, the researchers report in an article to be published in the ASTROPHYSICAL JOURNAL.

The team couldn't determine whether the 15 objects have detectable motion, but tests show that they aren't remote galaxies, Méndez says. A preliminary analysis by Ibata's team suggests that these 15 objects do not include the 5 found by comparing old and new images.

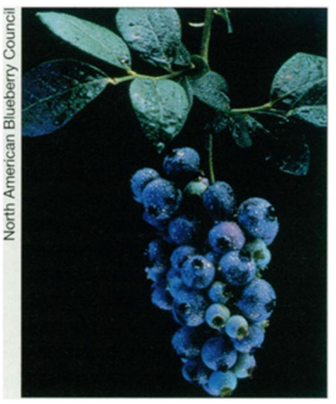
Halo populations of white dwarfs pose serious problems, Richer notes. Formation of such objects would have thrown into interstellar space far more carbon, oxygen, and nitrogen than observations show. In addition, the appearance of galaxies today does not indicate that they once had enough sunlike stars to form a large population of halo white dwarfs.

Theorist Bohdan Paczynski of Princeton University says the findings are intriguing, but he notes that by invoking the white dwarfs, the researchers "are trading one set of difficulties for another that is equally as difficult." —*R. Cowen*

Berry good protection for aging brains

It's depressing to contemplate the memory loss and physical infirmity that so often accompany aging. Federal scientists, however, now report that the blues may constitute a palatable prescription for fighting the ravages of growing old—if, that is, those blues are berries.

The body creates oxidants, chemically reactive molecular fragments, to eliminate old cells, infectious agents, and damaged tissue. When all goes well, natural antioxidants quickly step in to limit the process before it gets out of hand. As animals age, however, their antioxidant production wanes. Indeed, oxidation underlies many degenerative changes that come with aging (SN: 8/10/96, p. 95).



North American Blueberry Council

Anthocyanin pigments give blueberries intense color and antioxidant power.

Last year, chemists at the Agriculture Department's Human Nutrition Research Center on Aging (HNRCA) at Tufts University in Boston found that blueberries are a rich source of pigments, called flavonoids, that show strong antioxidant activity. Their earlier data showed that spinach and strawberries contain copious amounts of other antioxidants.

Colleagues in a neighboring lab have now supplemented the standard rodent food with a powdered form of blueberries, strawberries, or spinach. The researchers added the supplements in amounts having equal antioxidant activity. Ten 19-month-old rats received each type of supplemented rations. In terms of life span, these animals were on par with people in their 60s.

After 8 weeks, the scientists put each animal through a number of tests. These included mazes, walking a narrow plank, and balancing on a spinning rod. Afterward, the researchers removed and examined each animal's brain.

Though all supplemented animals performed better on memory tests than the 10 rats that got undoctored chow, only the blueberry group showed notable im-

provements over the control group in every test of motor coordination. James A. Joseph of HNRCA and his colleagues report their findings in the Sept. 15 JOURNAL OF NEUROSCIENCE.

After eating blueberry-laced chow for 2 months, 21-month-old animals outperformed unsupplemented, younger rats, Joseph says. "So, we got reversals in age-related declines." The blueberries that each animal downed were equivalent, when adjusted for body weight, to 1 cup daily in a person's diet, he notes.

The scientists measured a variety of chemical-signaling characteristics in each rat's striatum, a brain region pivotal to coordination. Each supplement showed a different benefit pattern, Joseph says, suggesting that blueberries' protectiveness may trace to more than oxidant quenching.

"A next important step in the research will be to see if the improvements are long lasting," says Molly Wagster of the National Institute on Aging in Bethesda, Md., which funded the study in part.

The differential benefits seen with the three diets reinforce what many other recent studies have suggested: "All antioxidants aren't alike," observes William A. Pryor of Louisiana State University in Baton Rouge. Some reach different places in the body; others do more than halt oxidation, he says.

It's therefore important, he argues, not to rely on supplements containing a single antioxidant, such as vitamin E. "You've still got to eat plenty of different fruits and vegetables," Pryor says. Since pigments can be very potent antioxidants, he prizes deeply colored foods—especially "anything blue." —*J. Raloff*

Insulin attracts immune wrath in diabetes

In juvenile diabetes, immune cells attack a person's own pancreas. They single out pancreatic cell clusters called the islets of Langerhans and destroy the tiny insulin factories within, called beta cells. How beta cells invite such immune damage is a long-running mystery.

Recently, several discoveries have shed light on the biological mechanism behind this carnage. A study in mice now points to a fragment of the insulin protein itself as the target that draws friendly fire from immune-system warriors called CD8 T cells, researchers report in the September NATURE MEDICINE.

In mice and people prone to juvenile diabetes, these cells become rogues, killing off beta cells as if they were invaders. In neither species do beta cells grow back once destroyed.

Microbes or compounds that initiate immune responses are called antigens. Because part of the insulin protein draws an assault to the body's own tissues, researchers consider it an autoantigen. The immune system programs T cells to destroy anything carrying a specific antigen or autoantigen. Once created, that's all CD8 T cells do.

The new study is the first to finger an autoantigen for CD8 T cells, says study coauthor Charles A. Janeway Jr., an immunobiologist at the Howard Hughes Medical Institute at Yale University. Earlier research had identified the same area of the insulin molecule as an autoantigen for CD4 T cells, which also play a role in the attack on beta cells.

"To find what these [T cells] are actually targeting is very important," says endocrinologist George S. Eisenbarth, director of the Barbara Davis Center for Childhood Diabetes in Denver. "It's coming out that insulin . . . might be a primary or dominant autoantigen" for juvenile, or type 1, diabetes, he says.

Insulin is necessary for the proper metabolism of carbohydrates. In less than 1 percent of the population, beta cells are absent or fail to make enough insulin, resulting in juvenile diabetes. Genetic flaws—many details of which remain hidden—predispose the T cells to incite an immune attack on beta cells, Janeway says.

Mice make a useful, though not perfect, model of human diabetes. The mice used in this experiment came from a strain that frequently gets diabetes after 12 weeks of age. Janeway's group modified CD8 T cells so that they would change color when they come into contact with their activating antigen. The researchers were then able to identify the antigen as a stretch of nine amino acids on the insulin molecule's B chain.

Janeway's team now is looking for means to stimulate immune responses that turn off the rogue T cells. Scientists have been able to flood the bodies of mice with insulin fragments, preventing diabetes, Eisenbarth says. They suspect that T cells lock onto the insulin fragments instead of attacking the pancreas.

Indeed, Eisenbarth and other researchers are giving insulin or its derivatives to children at genetic risk of type 1 diabetes in hopes of inoculating them against beta-cell destruction. —*N. Seppa*

DNA strands connect the quantum dots

Borrowing from biology, chemists have devised a new way to assemble semiconductor bits into potentially useful materials. The specks are quantum dots, sometimes thought of as artificial atoms.

DNA can connect tiny pieces of cadmium selenide into three-dimensional arrays, report Gregory P. Mitchell, Chad A. Mirkin, and Robert L. Letsinger of Northwestern University in Evanston, Ill. The resulting composite of inorganic and organic materials could have applications in biological sensing and electronics.

The researchers create the composite by attaching lengths of single-stranded DNA to cadmium selenide particles suspended in water. Then, they add to the solution double-length DNA sequences that complement the strands bound to the quantum dots. Two DNA strands attached to dots hook to a free strand like "chemical Velcro," bringing the particles together, says Mirkin.

The Northwestern researchers and a separate group at the University of California, Berkeley had connected gold beads in a similar fashion (SN: 8/17/96, p. 100). The current study, however, is the first to extend the technique to quantum dots, which have useful electronic and optical properties, says Mirkin.

Each cadmium selenide dot, 3.2 nanometers in diameter, bears 5 to 10 DNA strands, in contrast to the 220 strands on the 13-nanometer gold beads.

The biggest challenge in attaching the DNA strands to cadmium selenide was getting the semiconductor bits to dissolve in water, says Mirkin. The researchers synthesize the quantum dots in organic solvents, which makes them "very greasy particles," he explains. Mirkin's group bound acid molecules to their surface and then removed protons to give the dots an electric charge.

Mirkin and his colleagues describe their findings in the Sept. 8 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

Because of its adaptability, DNA offers researchers more control over the architecture of a three-dimensional array, says A. Paul Alivisatos of Berkeley. "It would be more difficult to do that with some kind of non–information-bearing self-assembly. DNA contains more information to use to create spatial organization," he says. For example, Mirkin and his colleagues have also created a hybrid material consisting of both gold and semiconductor dots linked by DNA.

Quantum dots have sparked the interest of scientists because the particles fluoresce in a wide range of colors depending on their size. They glow much brighter and for a longer time than conventional organic dyes, making them especially good for marking cells to view with microscopy (SN: 10/24/98, p. 271).

If electrons can travel through the DNA strands (SN: 8/14/99, p. 104), the quantum-dot aggregates might have interesting electronic properties, Mirkin suggests. He and his group are now exploring ways to use DNA-linked quantum dots as photonic materials, catalysts, and biological sensors. —*C. Wu*