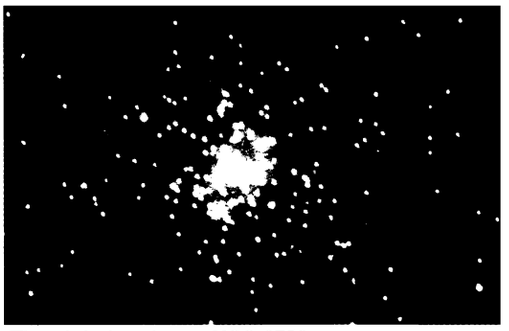
# New thinking about the ages of old stars


T. Stecher et al./ NASA

*The globular cluster NGC 6752.*

Whether it's truly a crisis in cosmology or just a matter of incomplete knowledge, astronomers are up against a conundrum: The universe, according to several observations, appears to be younger than its oldest stars.

To resolve this paradox, researchers must prove that the universe is older than recent estimates of 9 to 11 billion years or that the oldest stars in our galaxy are younger than 12 to 18 billion years.

Two new reports examine the question of stellar age but come down on opposite sides of the issue. One team suggests that researchers may have overestimated the ages of globular clusters, dense groupings of elderly stars scattered around the Milky Way. The other team, which describes a new method of determining the ages of certain mature stars, suggests that at least one star in the galaxy is truly old.

In the Jan. 1 ASTROPHYSICAL JOURNAL LETTERS, Allen V. Sweigart of NASA's Goddard Space Flight Center in Greenbelt, Md., reports that helium's outward movement from the core of a star causes the mature star to burn more brightly than previously calculated. Such migration of interior gases must occur, Sweigart says, because the surfaces of older stars show varying abundances of several other elements—especially aluminum—that are only produced deep inside a star.

Sweigart used computer models to analyze a set of stars known as RR Lyrae. They all have the same intrinsic luminosity, like light bulbs of a single wattage. Astronomers use the brightness of RR Lyrae stars to infer the ages of the globular clusters in which they reside.

If RR Lyrae stars are intrinsically brighter than had been thought, then their globular clusters lie farther from Earth. And if the clusters are more distant, all the stars within them must also be brighter and younger. Sweigart calculates that if an RR Lyrae star were 10 percent brighter—which would require only a small addition of helium to its surface—then the cluster might be as much as 1.5 billion years younger.

Because the extent of helium mixing is not yet known, Sweigart cautions that he cannot determine how much brighter RR Lyrae stars really are. Michael Bolte of the Lick Observatory in Santa Cruz, Calif., agrees that helium mixing affects brightness. He adds, however, that astronomers also use other methods to determine the age of globular clusters and that helium mixing does not influence those estimates. Bolte notes that he's intrigued by another report, which describes a seemingly more straightforward method of determining the ages of elderly stars.

In a study to appear in the May 1 ASTROPHYSICAL JOURNAL, John J. Cowan of the University of Oklahoma in Norman and his colleagues estimate the age of an elderly Milky Way star from the extent to which its abundance of thorium, an extremely long-lived radioactive element, has declined since the star's birth. The team finds that the star is between 13 billion and 21 billion years old. Further studies should narrow that range, Cowan says, but he notes that the age paradox has yet to be resolved.

*—R. Cowen*

# Protein deficiency abets tuberculosis

Claiming more than 2 million lives annually, tuberculosis has reemerged as the world's leading cause of death from infectious disease. Indeed, as much as one-third of the global population may now be infected.

A new study in mice shows that protein deficiency, one of the commonest forms of malnutrition, renders animals especially vulnerable to the disease—even when they receive enough calories. Reported in the Dec. 10 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, the finding offers an explanation for TB's oft-observed link to poverty.

Certain cells of the immune system can destroy the tuberculosis bacterium by zapping it with nitric oxide, a reactive chemical, says immunologist Barry R. Bloom of the Howard Hughes Medical Institute at the Albert Einstein College of Medicine in New York. Bloom showed that immune cells generate nitric oxide through a process that relies on arginine, an amino acid found in many proteins. This led him to speculate that a shortage of protein might explain the vulnerability of malnourished people to TB.

Bloom notes that his new study shows "that basic hypothesis was wrong." Though infected mice given just one-tenth of an adequate protein intake indeed succumbed quickly, their bodies produced as much nitric oxide as uninfected mice or infected mice given full rations of protein.

His team ultimately traced the problem to interferon-gamma and tumor necrosis factor-alpha, compounds that trigger local production of nitric oxide. In protein-malnourished mice, the lungs fail to make enough of either signal for at least 2 weeks after TB infection—which gives the germs time to take hold.

Though the problem eventually corrected itself, the malnourished, TB-infected mice died within 66 days. All infected mice fed sufficient protein survived at least 6 months.

Malnourished mice suffered a second problem. Ordinarily, the body walls off any TB bacteria that survive, imprisoning them within layers of immune cells. But the mice eating the low-protein diet never built effective cages.

Malnourished mice who returned to full rations of protein within 18 days of TB infection, however, "began correcting all the problems," Bloom notes. Those mice survived.

In an accompanying commentary, Ranjit K. Chandra of the Memorial University of Newfoundland in St. John's argues that "the era of nutritional manipulation of the immune system has finally dawned," bringing the promise of fighting lethal infections with improved diet.

*—J. Raloff*

# Rains in the plains less common in past

After weathering a severe drought in 1988 and record floods in the 1990s, residents of the Great Plains believe they are keenly aware of climatic inconstancy. Yet these recent meteorological turns provide only a small taste of what nature can dole out.

Before the year 1200, the northern Great Plains region faced far more frequent and severe droughts than it has in recent history, report scientists who have traced the area's climate patterns for the last 2,300 years. "This shows that the last 100 years are not representative of the kind of climate variability that we potentially can have in this region," says Kathleen R. Laird of Queen's University in Kingston, Ontario.

Laird and her colleagues reconstructed the climatic history of the region by studying fossil diatoms—shells from single-celled algae—preserved in sediments from the bottom of a lake in eastern North Dakota. They identified droughts by looking for particular diatom species that thrive when the water level drops and the lake's dissolved salts and nutrients become concentrated. The scientists describe their work in the Dec. 12 NATURE.

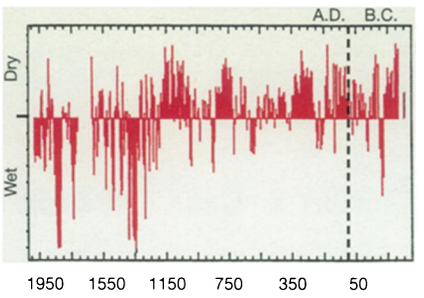
During the last 750 years, droughts have occurred relatively infrequently, a finding that supports previous tree-ring

analysis reaching back 500 years in nearby Alberta. Before 1200, however, the diatoms record a much greater frequency of extreme droughts, many of which exceeded in intensity the Dust Bowl period of the 1930s. The longest dry spells lasted for centuries, from the years 200 to 370, 700 to 850, and 1000 to 1200.

Some of these droughts apparently affected large sections of North America, judging from studies of prehistoric climate in California. Rivers, lakes, and marshes in and adjacent to the Sierra Nevada dried up during the same three intervals recorded in North Dakota, according to Scott Stine of California State University in Hayward.

Before drawing further conclusions about the drought history of North America, climate scientists need to study other lakes in the Great Plains and elsewhere, says Laird. Her study is the only high-resolution climate record of the midcontinent that reaches back more than 500 years.

Because droughts were more common before 1200, when temperatures were warmer, future global warming may increase the frequency of droughts in the Great Plains, says Laird. This scenario draws some support from computer models that forecast how climate will react to greenhouse gas pollution. According to the models, greenhouse warming is likely to make climate more variable and to promote drying in middle North America, says James E. Hansen of NASA's Goddard Institute for Space Studies in New York. — *R. Monastersky*



Laird *et al.*/Nature

*Droughts in North Dakota occurred far more frequently before the year 1200.*

# Stress may weaken the blood-brain barrier

After receiving a drug to protect them against chemical weapons, many Israeli soldiers serving in the Persian Gulf War suffered adverse side effects from the inoculation. These reactions puzzled physicians, who had expected the blood-brain barrier to keep this drug—like many other chemicals circulating in the blood—out of the brain.

Now, an Israeli study suggests that stress may have temporarily opened the blood-brain barrier. "It was surprising—we saw quite large amounts of brain penetration," says Hermona Soreq of the Hebrew University in Jerusalem, a coauthor of the report in the December Nature Medicine.


A. Friedman/Nature Medicine

*Blue dye enters an unstressed mouse's brain (left) less readily than a stressed one's brain (right).*

During the Gulf War, Soreq and her colleagues at Tel Aviv University studied a unit of soldiers given pyridostigmine, a drug that attaches to receptors on nerves outside the central nervous system. When chemical weapons invade the body, they can't bind to the occupied receptors, which limits their ability to cause damage.

Usually, only small amounts of pyridostigmine cross the blood-brain barrier. However, nearly one-quarter of the inoculated soldiers complained of mild neurological side effects, such as headaches and drowsiness. When the researchers inoculated another group of soldiers during peacetime, only 8 percent reported symptoms. "Our suspicion was that the stress associated with war made the difference," says Soreq.

The physicians also injected the drug into mice that had been forced to swim for two 4-minute intervals and into unstressed mice. The researchers found that it took over 100 times more pyridostigmine to penetrate the brains of unstressed mice as the brains of stressed mice. Tests using a larger molecule, a blue dye, showed a similar effect.

"The important thing is finding a drug that should not have crossed the blood-brain barrier and apparently did, under conditions of stress," comments Israel Hanin of Loyola University of Chicago in Maywood, Ill., who advises physicians to consider reducing the drug dosages they prescribe to stressed patients.

Some U.S. forces received pyridostigmine, but the researchers downplay any link between the drug, which the body eliminates within a day, and the long-term symptoms of Gulf War syndrome. "It's very hard to see a direct connection," says Hanin.

More generally, he adds, the discovery of a way to open the blood-brain barrier offers possibilities for delivering drugs to the central nervous system. — *D. Vergano*

# Cushions for drops of levitated helium

Water spilling onto a hot skillet shatters into droplets that skate and bounce across the sizzling surface. The drops ride on layers of water vapor generated by the pan's intense heat.

Researchers have now observed a similar effect at temperatures near absolute zero. As magnetically levitated drops of liquid helium are gradually chilled toward temperatures at which the liquid turns into a superfluid, drops can come into contact with each other yet fail to coalesce because a thin layer of evaporated helium gas separates them.

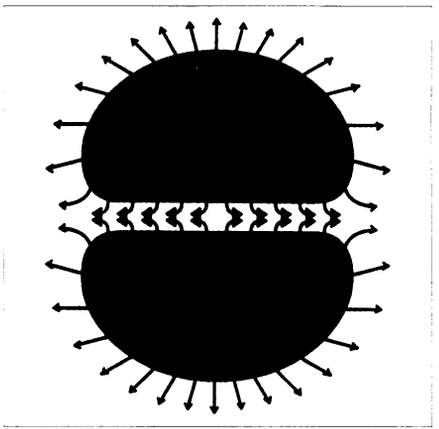
"We didn't expect to see this," says physicist George M. Seidel of Brown University in Providence, R.I. He and his colleagues describe their finding in the Dec. 2 Physical Review Letters.

The researchers discovered the effect in the course of developing a powerful magnetic trap for levitating drops of helium in both its ordinary liquid and its superfluid states. "We were able to maintain drops [as large as 2 centimeters in diameter] in the trap indefinitely," the researchers report.

When two drops of liquid helium were introduced into the trap simultaneously, the Brown team noticed that the drops would appear to come into contact but would not combine into a single drop, as most liquids would. They even observed drops bouncing off each other before coming to rest.

Seidel and his colleagues propose that, as the temperature is lowered, slow evaporation from the drops creates a layer of gas that keeps the liquid surfaces from making direct contact with each other.

The drops coalesce as soon as the helium gets cold enough to turn into a superfluid, a state in which no further evaporation occurs. — *I. Peterson*


Mark A. Weilert *et al.*/Phys. Rev. Lett.

*Evaporated gas (arrows) exerts sufficient pressure to prevent adjacent drops of liquid helium from coalescing. The diagram exaggerates the size of the gap between the drops.*