New thinking about the ages of old stars

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.

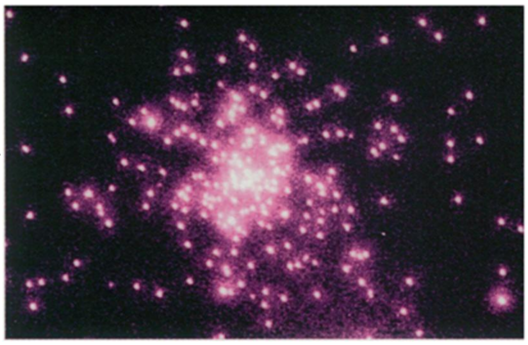
In the Jan. 1 ASTROPHYSICAL JOURNAL LETTERS, Allen V. Sweigart of NASA's Goddard Space Flight Center in Greenbelt, Md., reports that helium's outward movement from the core of a star causes the mature star to burn more brightly than previously calculated. Such migration of interior gases must occur, 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.

T. Stecher et al./ NASA



The globular cluster NGC 6752.

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