Starlight casts doubt on Big Bang details

Examining the faint light from an elderly Milky Way star, astronomers have detected a far greater abundance of beryllium atoms than the standard Big Bang model predicts. Three somewhat younger stars show a similar anomaly, according to unpublished data from the same team. While the findings do not contradict the premise that the expansion of the universe began with a giant explosion, they do raise questions about certain assumptions of the standard model, such as the notion that the cosmos began as a perfectly smooth mixture.

These landmark beryllium assays – previously considered all but impossible in such ancient stars – demonstrate that "such measurements are indeed possible, and [open] the way to a new investigation of the evolution of the early universe," the researchers write in the Sept. 1 ASTROPHYSICAL JOURNAL.

Because the primordial universe did not contain heavy metals, the surfaces of old stars tend to have very low levels of iron. In ancient stars whose surface composition remains relatively unchanged from primordial times, any beryllium content should reflect levels characteristic of the universe soon after the Big Bang. For this reason, Gerard Gilmore of Cambridge University in England and his colleagues focused on a metal-poor star called HD 140283. This star has only one five-hundredth the iron abundance of the sun, indicating it formed some 15 billion years ago.

Using the Anglo-Australian Telescope in Coonabarabran, Australia, they measured the spectral intensity of two ultraviolet wavelengths characteristic of beryllium – the fourth-lightest element – emanating from the star's surface. Although the standard model holds that the primordial ratio of beryllium to hydrogen should be about 10^{-16} to 1, the researchers measured a value 1,000 times greater.

The team has not ruled out an alternative explanation for the unexpected abundance of beryllium: that cosmic rays striking the star sometime after the Big Bang might have generated extra beryllium. But if cosmic rays did boost beryllium levels, Gilmore says, they should have created 10 times more boron than beryllium. David Lambert of the University of Texas at Austin says measurements by the Hubble Space Telescope hint that HD 140283 does not contain enough boron to validate the cosmic ray scenario, but he says he cannot reject the hypothesis without further data.

If future findings favor a primordial explanation for the beryllium, scientists may have to modify some of their ideas about the Big Bang and its aftermath, says cosmologist David N. Schramm of the University of Chicago. The standard model assumes that the universe initially possessed a uniform density. But a large amount of primordial beryllium, he says, suggests the early universe was much lumpier than generally believed, with regions of high and low density. Schramm notes that neutrons migrating from high-density areas to low-density regions could have sparked a cascade of nuclear reactions that generated the extra beryllium.

Schramm emphasizes that a lumpy universe would still allow for expansion by a Big Bang-type explosion. The lumpiness might, however, offer insight into exactly how the four forces of nature became unified, while constraining theories on how clusters of quarks formed protons and other particles collectively known as hadrons. Gilmore adds that a lumpy universe would contain significantly more ordinary, visible mass than a smooth universe.

Gilmore told SCIENCE NEWS he was heading back to Australia this week to obtain the beryllium spectra of a star with the lowest known metal abundance in the Milky Way. Studies of this star, he says, may further demonstrate beryllium's value in tracing the conditions of the early universe. *– R. Cowen*

Focused attention boosts depressed memory

Severe depression not only produces feelings of despair and helplessness, but also has the capacity to stifle memory. One theory holds that a depressed mood disturbs the ability to use mental strategies for remembering information. A new study, however, points to memory's resilience in the face of depression.

Depressed individuals who use a simple technique to focus their attention perform just as well on a standard memory test as do nondepressed folks, report psychologists Paula T. Hertel of Trinity University in San Antonio, Texas, and Stephanie S. Rude of the University of Texas at Austin.

They say their findings suggest that depressed people get distracted by any thoughts that come to mind – not just by negative ruminations about themselves, as some psychologists believe. Thus, depression sufferers can boost their memory by focusing on external cues that guide attention to a specific task, Hertel and Rude contend in the September JOURNAL OF EXPERIMENTAL PSYCHOLOGY: GENERAL.

Henry C. Ellis, a psychologist at the University of New Mexico in Albuquerque, calls the study "a major achievement," providing the first clear evidence that focused attention can reverse depression-linked memory deficits.

The Texas researchers compared 26 depressed outpatients with 16 formerly depressed individuals and 16 people with no psychiatric problems. Currently depressed volunteers suffered from moderate to severe forms of the mood disorder.

All participants viewed a sequence of 40 common nouns on a computer screen and decided whether each word fit sensibly into a corresponding incomplete sentence. Some sentences required close inspection to decipher whether the noun fit in.

To focus the attention of half the participants, the investigators asked them to repeat aloud each noun and their decision about it before pressing the appropriate computer key and moving on to the next trial. The remaining participants merely keyed their decisions into the computer.

About 20 minutes after completing the test, participants wrote down all the nouns they could remember. The researchers asked them to write at least 20 nouns, guessing if necessary.

In the unfocused condition, depressed individuals remembered substantially fewer nouns than did volunteers in the other two groups. But on the focused trials, no memory differences appeared. Even the most depressed persons remembered as much as healthy controls by following the focused-attention procedure, Hertel and Rude report.

The researchers say they do not know exactly why the technique worked. Depressed people may lack the initiative to use memory-enhancing mental strategies because competing thoughts leave them "in a muddle," Hertel and Rude propose, but when they are forced to focus on the task at hand by relying on external memory cues, such as nouns and sentence decisions, normal memory may rise to the surface.

Ellis says the new findings support a theory of "resource allocation," which he and a colleague developed. The theory holds that irrelevant thoughts increase when a depressed person engages in a memory task, producing greater demands on attention and other mental resources involved in remembering information.

However, a reduced demand on mental resources cannot explain the memory improvement of depressed participants after the focused task, Hertel and Rude say. "The task that eliminated the [memory] deficit was no less demanding than the task that produced it," they note.

Whatever accounts for the memory problems of depressed people, it now seems clear that they remember a great deal when external cues guide their attention, the Texas psychologists conclude. *– B. Bower*