Dating the cosmos: Hubble eyes aging stars

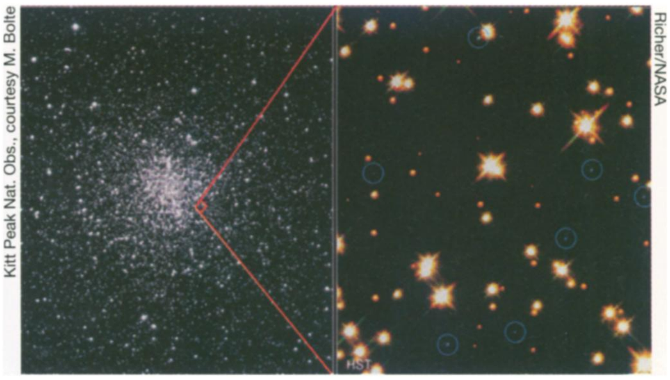
Everyone knows you can't be older than your mother. But over the past year, observations with the Hubble Space Telescope and several other instruments seem to have contradicted this cardinal rule. On the one hand, measurements of the speed at which the most distant galaxies are moving from Earth suggest that the universe may be no older than 8 billion to 12 billion years (SN: 10/8/94, p.232). On the other hand, astronomers estimate the ages of our galaxy's oldest stars at 13 billion to 16 billion years.

Now, new findings from Hubble may provide a step toward resolving this cosmic conundrum.

In viewing the globular cluster M4, the dense grouping of elderly stars nearest to Earth, Hubble has detected more than 200 white dwarfs—the largest community of these old, shrunken stars ever identified. Because they all reside at the same distance and were spawned from stars that formed at the same time, dwarfs in a cluster provide a unique opportunity to compare theoretical predictions with the actual evolution of these geriatric objects.

In particular, notes Hubble investigator Harvey B. Richer of the University of British Columbia in Vancouver, the dwarfs discovered in M4 should help fine-tune predictions about how rapidly these objects cool—a critical factor in attempts to infer the age of the universe from the temperature of white dwarfs. Richer and a team of U.S. and Canadian colleagues detail their work in the Sept. 20 ASTROPHYSICAL JOURNAL LETTERS.

Formed by the gravitational collapse of old, sun-like stars that have run out of nuclear fuel, white dwarfs represent the last and by far the longest phase in the life cycle of these stars. Dwarfs start out hot but gradually cool and fade in a highly predictable manner. Indeed, a dwarf cools at such a predictable rate that its surface temperature indicates its age. The coolest, dimmest dwarfs—those that have lived the longest—thus provide an estimate of the age of the cosmos, independent of such parameters as the expansion rate of the universe and the distance to far-off galaxies.



Kitt Peak Nat. Obs., courtesy M. Bolte

Richer/NASA

Left: A view of the globular cluster M4 taken with a ground-based telescope. The red box indicates one of three small areas probed by Hubble. Right: False-color view of one of the tiny regions of M4 seen by Hubble's wide-field and planetary camera. The image reveals seven white dwarfs (blue circles).

Richer emphasizes that none of the M4 dwarfs detected by Hubble are faint enough, or old enough, to serve as cosmic clocks. But, he adds, "we can use these dwarfs to refine our theories and make sure we understand in exquisite detail white dwarf cooling." Richer estimates that the oldest objects detected during Hubble's 30-hour survey have been white dwarfs for about 5 billion years.

The team's ultimate goal—to detect a large group of white dwarfs old enough to date the universe—looms ahead. However, notes study coauthor Roger A. Bell of the University of Maryland in College Park, Hubble will have to detect dwarfs with one-fortieth the brightness of those seen in M4 in order to find the oldest stars.

To pick out such faint stars, Richer recently proposed that Hubble take a much longer exposure—about 100 hours—of a single region in another globular cluster, NGC 6752. This cluster, about 12,000 light-years from Earth, lies nearly twice as far away as M4. However, its position in the sky enables Hubble to stare at the cluster almost continuously as the telescope orbits Earth. In contrast, Earth often blocks the telescope's view of M4.

If administrators at the Space Telescope Science Institute in Baltimore approve the 100-hour survey, Hubble might make the observations a year from now, Richer says, perhaps yielding results by early 1997. —*R. Cowen*

Viral legacy may make pregnancy possible

Millions of years ago, a retrovirus infected our primate ancestors, leaving a legacy of its DNA in their genes. That DNA has been passed down to humans. A study now finds that the protein encoded by this DNA abounds in placental cells—suggesting that the protein may play a useful role today by helping prevent a pregnant woman's immune system from rejecting her fetus.

Up to 0.5 percent of the DNA in the human genome may derive from ancient retroviruses, says Mark Boyd of Hahneman University in Philadelphia, but most of this retroviral DNA produces no useful proteins.

However, at least 0.1 percent of the protein in the layer of placental cells that separate the fetus from the mother comes from a known retroviral sequence designated ERV-3. Or so report Boyd and his colleagues at the Kennedy Institute of Rheumatology and Chester Beatty Laboratories, both in London, in the Aug. 20 VIROLOGY. That's a significant amount, notes Boyd, since elsewhere in the body, this protein "is barely detectable."

A pregnant woman's body regards the fetus as an interloper in some ways, so its natural reaction is to reject it. One reason for this immune response lies in the structure of the placenta, Boyd says.

In primates, the placenta looks "kind of like a tree stuck into the side of the maternal tissue" as opposed to a flat plate in other mammals. The large surface area of its branching network of blood vessels results in an unusually high degree of contact between the mother and this "foreign" tissue. "It really invades," Boyd says.

In order for the mother's body to retain the placenta, something has to suppress her immune response to it.

"There's no way ERV-3 is the only immunosuppressive thing in the placenta," Boyd says. But he adds that the ERV-3 protein's abundance in placental cells suggests it's an important factor.

Maurice Cohen of Abbott Laboratories in North Chicago, Ill., helped determine the DNA sequence of ERV-3 in 1985, while he was at the National Cancer Institute in Frederick, Md. It resembled sequences in other retroviruses known to suppress immunity, leading Cohen and his group to argue that it might perform some immunosuppressive function. But Boyd's group has "gone a step further and identified a protein."

Boyd and his colleagues plan to test for the protein's suppression of immunity in two ways: first, by trying to block any suppression using antibodies to ERV-3, and then by turning on the ERV-3 DNA in cells that do not normally suppress immunity.

"Even if [ERV-3] isn't immunosuppressive, the evidence that it's doing something useful is just impossible to ignore now," Boyd says. "I quite like the idea that the cell has hijacked the virus and not vice versa." —*C. Wu*