large colonies in the presence of Merck's inhibitor, instead growing in a manner similar to that of more normal, untransformed cells. The Genentech-UT collaboration also showed they could reverse cancerous transformation by *ras*, restoring essentially normal growth patterns to cells that express a *ras* oncogene.

Considering the effectiveness of the enzyme inhibitors in test tubes, these results were not wholly unexpected. The crucial question now is whether inhibiting farnesyltransferase action might have too dramatic an impact on cells. To function normally, a cell must keep some level of Ras activity. Moreover, other vital proteins such as nuclear lamins and certain others found in the visual system must also be farnesylated before they become functional.

One encouraging sign, however, is that both groups' compounds do not seem toxic, at least to cells in lab cultures. Normal cells and those transformed with oncogenes other than *ras* seemed to grow as usual when exposed to the farnesyltransferase inhibitors. "In these particular cases, I think we lucked out. It appears we can limit farnesylation without seriously affecting normal cell growth," says Merck's Oliff. This result, as welcome as it may be, creates a lot of future work for puzzled scientists. "How do [these inhibitors] selectively target *ras*-transformed cells without affecting the viability of normal cells?" asks Channing Der of the University of North Carolina at Chapel Hill.

The simple answer is that nobody knows, but there are a number of possible explanations that researchers are exploring. As with many drugs, for example, the effect may simply be a matter of dosage, says Oliff, suggesting that there is a "therapeutic window" in which the compounds inhibit farnesylation just enough to prevent uncontrolled cell division while allowing the enzyme to keep the cell functioning. Still, simply documenting that certain cell lines appear to grow normally does not mean that the farnesyltransferase inhibitors can be used without dangerous side effects in living animals, cautions Genentech peptide chemist James Marsters: "Growth in cell culture and effects on animals are often two very different things."

Whether or not new chemotherapeutic drugs emerge from this work, researchers are also excited at the prospect of using these new inhibitors to understand better the process of farnesylation in general, and the function of Ras in particular. "For us it's going to be extremely useful as an experimental tool," says UT's Goldstein. For those dreaming of cancer treatments and profitable drugs, however, the hope is that farnesyltransferase inhibitors will prove to be much, much more than that.

–John Travis

MEETING BRIEFS

Astronomers Watch the Stars Come Out in Berkeley

New and strange sightings caught the attention of astronomers at this June's American Astronomical Society (AAS) meeting in Berkeley: a supernova that has changed its identity, a clutch of mysterious blue stars, and objects at the edge of the universe, shining brilliantly at the far end of the ultraviolet spectrum. Meanwhile, a more familiar object–one species of supernova–is raising hopes of predicting the ultimate fate of this cosmic zoo.

A Split-Personality Supernova

Three months after its explosion, supernova 1993J has dwindled to nothing more than a wispy smudge, even in the 30-inch telescope at the University of California, Berkeley's Leuschner Observatory. But the great supernova of 1993 is far from forgotten. For one thing, the nearness of its host galaxy M81 made this supernova the brightest to burst into the northern sky since 1937. For another, Berkeley astronomer Alex Filippenko told the AAS meeting, SN1993J just isn't staying true to type. Over the past 2 months, Filippenko and other researchers studying its spectral lines —the fingerprints of its elements—have watched it shift from one established type to another, defying the known supernova categories. In the end, this metamorphosing explosion may force astronomers to redraw their supernova taxonomy.

A. FILIPPENKO

Shape-shifting supernova. Before *(left)* and after images show the explosion.

At first, lines of hydrogen in the supernova's spectrum had marked it as a classic type II, an event scientists believe originates when a massive star, eight or more times the mass of the sun, suddenly runs out of nuclear fuel. The core of the star then collapses into a dense ball of solid nuclear particles, sending out a shock wave that blows away the bulk of the star's mass. Some of the progenitor star's hydrogen, however, lingers around the core.

But, over the past 2 months nearly all of the hydrogen has vanished from the spectrum of SN1993J, while the signature of helium has strengthened. Helium is the trademark of another kind of supernova, type Ib. Along with another subspecies, type Ia, these explosions are thought to originate in white dwarf stars when they siphon enough material from a companion star to trigger a vast thermonuclear explosion. White dwarfs lack hydrogen but may harbor helium.

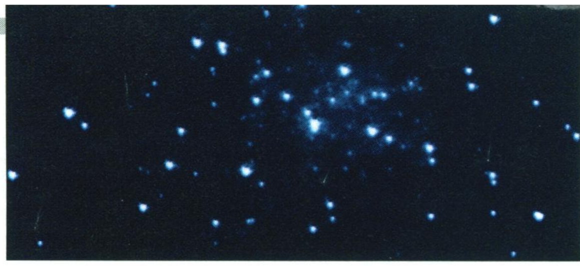
This seeming transformation may actually reflect a problem with the classification scheme, says Filippenko. After all, it has happened before. A 1987 supernova also showed hints of hydrogen at the beginning but later was dominated by helium, Filippenko points out. At the time, he suggested that the 1987 supernova was really "a type II without its clothes on." Like a conventional type II, he proposed, the explosion took place in a collapsing massive star, but a companion star had stripped away most of its hydrogen atmosphere before the explosion, leaving only small traces that could later be swamped by emission from the deeper layers of helium. If all type Ibs originate this way, he suggested, they are really a special case of type II.

Supernova 1993J provides confirmation, says Filippenko, because he and his colleagues had spotted the progenitor star on earlier photographs of the galaxy, and it was a giant star, not a white dwarf. Says Filippenko, "I'm overjoyed. It confirms the idea that I advanced 6 years ago." Agrees astronomer Brian Marsden of Harvard University, "This proves that type IIs and Ibs are related."

The finding may do more than clarify supernova taxonomy, says theorist Stan Woosley of the University of California, Santa Cruz. Studying exceptions like this one may help astrophysicists understand the mechanism of these mega-explosions. Says Woosley, "Because it's an unusual beast, there's a chance to learn a lot from it."

Tough Company in M15

The center of the globular cluster M15 is a rough-and-tumble neighborhood. This dense knot of stars, 30,000 light-years away near the constellation Pegasus, is packed so tight that 100,000 of its stars would fit into the space between the sun and its nearest neighbor. And that crowding leads to violent encounters. Astronomers using the Hubble Space Telescope now think they've spotted some of the casualties: blue, apparently young, stars with a chemical makeup more like that of old, red stars.



G. DE MARCHI AND F. PARESCE

Exposed by Hubble. Naked stellar cores are blue with heat.

These anomalous blue stars, researchers speculate, are really red giants stripped bare, like sheep without their wool. Red giants are stars near the end of their lives, when their outer layers redden and bloat to many times their original volume. But in the crowded center of M15, a red giant is vulnerable to passing stars, which can strip off the diaphanous outer layers, says Francesco Paresce of the Space Telescope Science Institute, who made the observations with colleague Guido De Marchi. The star's hot, blue core is left bare, mimicking a hot young star while retaining the composition of an oldster.

That seems a plausible explanation for the puzzling observations, says astronomer Peter Stetson of the Dominion Astrophysical Observatory, and it would also explain why these cosmic oddities are found only in the densest part of the core of this cluster. But this neighborhood still has some secrets, says Stetson. The "naked stellar cores" lie only at the very center of the cluster, but even away from the core, the cluster still looks strangely blue, perhaps because of a preponderance of massive stars. Says Stetson, "M15 is so bizarre—it still has problems."

Whither the Universe?

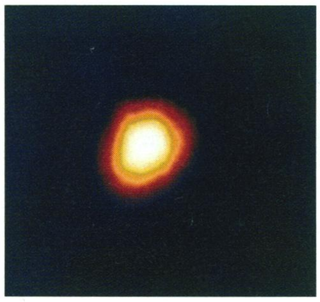
It may be just a case of end-of-the-millennium hubris—or it may be that cosmologists are on the brink of something big. Some say they are within months, or a few years at most, of answering a question that goes back to Aristotle: Does the universe go on forever or is it somehow finite? Or, in the question's modern form, Will the universe expand forever or will it eventually collapse in on itself? Saul Perlmutter of the Lawrence Berkeley Laboratory says he and his colleagues have a method that's likely to give a reliable answer in the near future. And many of his fellow astronomers think he just may be right.

Perlmutter says he's approaching the problem by measuring how fast gravity is slowing the expansion of the universe—a slowing represented by the letter q. If the universe is decelerating fast enough, its expansion will eventually reverse and it will collapse. Besides revealing the ultimate fate of the cosmos, that answer would also confirm something that many theorists now suspect—that some unidentified, invisible form of mass dominates the cosmos, adding to the gravitational pull of the visible mass.

To find the coveted q, Perlmutter is revisiting an old strategy: finding beacons at different distances and comparing the speeds at which they are receding from Earth. (The more distant objects represent earlier times, since their light takes longer to reach us.) Earlier attempts to pin down q relied on galaxies, but their distances are hard to judge. Perlmutter has settled on what astronomers believe may be a more reliable beacon: the exploding stars known as type I supernovae.

Type I supernovae, Perlmutter explains, are believed to explode with exactly the same brightness each time. If so, the relative brightesses of different supernovae should give their relative distances. Meanwhile, the red shift of their light reveals their velocities. If the universe isn't slowing at all, Perlmutter explains, the velocities of the supernovae should increase in proportion to their distances. But if it is decelerating, distant supernovae—representing earlier points in cosmic history—should be moving faster than expected. And the excess should increase as you look farther out.

"I think it's the most promising way I know to get q," says David Branch of the University of Oklahoma. "There's no reason it shouldn't work." The challenge is finding enough supernovae. But recent advances in detectors and high-speed computing have given astronomers the ability automatically to keep track of 2500 galaxies at once, watching for the supernovae that go off about once every 500 years in each one. Perlmutter has already analyzed a number of nearby supernovae and just one distant one, 1992bi. That's not a big enough sample, cautions Perlmutter, but the first hints are of an ever-expanding "open" universe. He now hopes to collect more datapoints from a supernova search at telescopes in the Canary Islands. With luck, he says, he and his colleagues should catch about 30 more—enough for a more confident answer—in a couple of years.



BEHRAM ANTIA/UCB/CEA

Unexpected target. A quasar in the extreme ultraviolet.

That's not long to wait to solve a question this big, he says. "This is the kind of question we asked as children," says Perlmutter. "Is there an infinite amount of space or just a finite amount?" The answer won't make the universe any less mysterious. "Either we will have to try to see the universe as infinite, or try to see space that turns in on itself," he says. "Either way, it's mind boggling."

EUVE Takes the Long View

Observed at the high-energy end of the ultraviolet spectrum, the universe should appear as murky as pea soup: Interstellar hydrogen, astronomers once assumed, simply mops up signals in the extreme ultraviolet. Astronomers expected that detectors aboard the Extreme Ultraviolet Explorer (EUVE) satellite would barely see even as far as the edge of our galaxy. Researchers on this project got a welcome surprise a year after launch, however, when they saw a handful of objects—bright, energetic galaxies and quasars—shining from the very edges of the universe.

"No one in their right mind thought the EUVE would ever see an extragalactic object," says project scientist Tim Carone of the University of California, Berkeley. "It's a surprise that there are lines of sight [through the interstellar gas] that are clear enough to see these objects," adds astronomer Thomas Soiffer of Caltech. The interstellar medium seems to be unexpectedly porous, he says, and the bright objects are shining through the holes. That's a stroke of luck, say investigators, because the extreme ultraviolet may turn out to be a key to understanding these distant galactic powerhouses.

So far, EUVE researchers have spotted five "active galaxies," whose nuclei are brilliant emitters of light and radio waves, as well as four "BL Lac" objects, which are egg-shaped elliptical galaxies shooting out jets of material. The team also observed two quasars—objects that resemble active galaxies but are many times brighter still. Scientists believe all these objects may somehow be powered by material swirling into immense black holes, millions or billions times more massive than the sun. And though quasars and their relatives generate copious radiation at other wavelengths, says Soiffer, these objects shine brightest in the extreme ultraviolet.

As a result, he says, the extreme ultraviolet may be the best place to look for clues to narrowing down the many competing theories of what drives these powerhouses in the sky. Agrees EUVE principal investigator Herman Marshall of Berkeley: "The EUVE is central to the question: What's producing all that light?" It's one of the big unanswered questions in astronomy, he says, "and one of the most fundamental."

–Faye Flam