Studies support an accelerating universe

New findings support the bizarre notion that the universe will not only expand forever but will do so at an ever increasing rate.

Early this year, two teams studying the brightness of a collection of distant, exploded stars—called type Ia supernovas—reported preliminary evidence that the expansion of the cosmos is accelerating (SN: 3/21/98, p. 185).

Although his team has only begun analyzing a dozen or so new supernovas, "the additional data set is reinforcing our conclusion that the acceleration [of the universe] appears to be nonzero," says Alex V. Filippenko of the University of California, Berkeley. Filippenko and his colleagues had initially studied 16 other supernovas.

"We have found no systematic errors that could explain why it is that it looks like we have an accelerating universe," notes Saul Perlmutter of the Lawrence Berkeley (Calif.) National Laboratory, a member of the second team, which has analyzed 42 supernovas. Both Filippenko and Perlmutter reported their latest results on Oct. 29 at a meeting at the University of Chicago on type Ia supernovas.

Type Ia supernovas can illuminate the universe's expansion rate because they all have roughly the same luminosity. The astronomers record each supernova's brightness and redshift, the amount by which cosmic expansion has stretched the wavelength of the light it emits. Redshift also indicates how many billions of years ago the light now reaching Earth left a supernova. The most distant supernovas studied by the astronomers come from a time when the universe was half its current age.

If the universe has revved up its rate of expansion, a supernova at a given redshift would lie farther away than expected, and so it would appear dimmer. That's exactly what both teams continue to find. The supernovas examined are about 15 percent fainter than astronomers can account for in a standard model of the universe with no acceleration.

Because gravity always acts to slow expansion, the findings are forcing theorists to grapple with the existence of an antigravity force or some other exotic source of energy in the cosmos (SN: 2/28/98, p. 139).

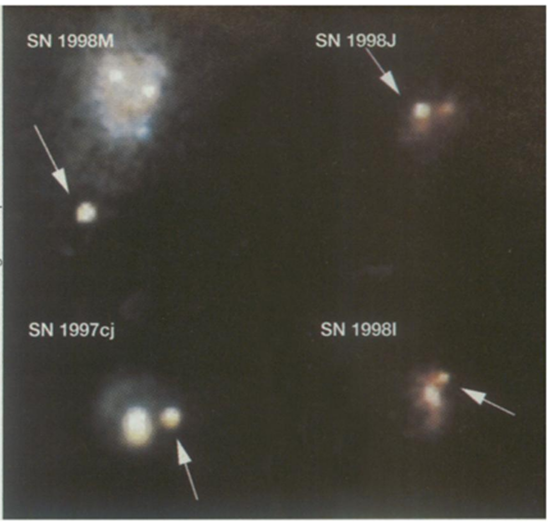
Caveats about the findings abound. Astronomers worry that masking by dust, rather than an accelerating cosmos, may explain the supernova results. Another concern is that supernovas in the distant past may not have been as bright as they are now.

Perlmutter reports that his team did an additional analysis in which they discarded the reddest supernovas. Red coloration can be a signpost of fine dust, which absorbs more blue light than red. The scientists still found evidence of an accelerating universe.

Surprisingly, because dust seems to be ubiquitous, Filippenko's group finds that some of the distant supernovas in their survey are less red than those nearby. This doesn't rule out the possibility that large particles of dust, which absorb all wavelengths of light uniformly, cause some of the dimming, critics say.

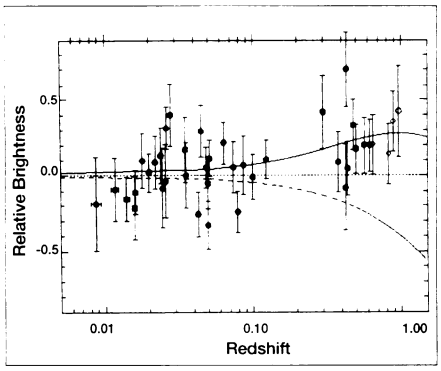
"I'm reaching the point that I'm beginning to believe the two teams," says Jeremiah P. Ostriker of Princeton University. "In another year, we will know much more, but they've come a long way in the last year." —*R. Cowen*

Peter Challis/High-Z Supernova Search Team



Four distant supernovas (arrows).

Adam G. Riess/High-Z Supernova Search Team



Graph indicates that an accelerating cosmos (solid line) best explains the brightness of distant supernovas. Dotted and dashed lines represent other models.

Time proves not reversible at deepest level

Sometimes scientists stir excitement not by discovering something fundamentally new but by unveiling something stunningly fundamental—such as the machinery of time.

New results from two independent physics teams at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Ill., and the European Laboratory for Particle Physics (CERN) near Geneva do just that. They show directly for the first time that "there is a distinction between going forward and backward in time, even at the most fundamental level," says Alan Kostelecky of Indiana University in Bloomington. "The work is truly spectacular."

Until the mid-1950s, physicists thought that, for elementary particles, the physical laws still applied even if three key qualities of the universe were reversed: spatial directions flip-flopping with their mirror images, matter swapping with antimatter, and time running in reverse. Experiments subsequently shattered that notion.

First, scientists found differences in particle behavior when directions are reflected in a mirror. Then, a landmark 1964 experiment found that the asymmetry remains when both the directions and matter and antimatter were exchanged. Because of an overarching theory uniting all three reversals, it follows that time symmetry must also collapse, but that effect has not been observed until now.

In the new experiments, "we have not assumed anything from theory," says Panagiotis Pavlopoulos, spokesman for the experiment at CERN. By allowing antiprotons and liquid hydrogen atoms to annihilate each other in matter-antimatter collisions, the group generated particles known as kaons and antikaons, which can transform into one another. Studying some 1.3 million transformations, they observed a slight variation in the kaon-to-antikaon rate versus the opposite—processes that would be interchanged if the clock were to run backward. A report on the experiment will appear in a future issue of PHYSICS LETTERS B.

Taking a different tack with a high energy beam of kaons, scientists in Fermilab's Kaons-at-the-Tevatron (KTeV) collaboration found a telltale pattern of particle tracks whose shape would vary if time were reversed. The skewed pattern emerged in the trajectories of daughter particles in 1,811 examples of a rare type of kaon decay. "It's really the first time we've had an effect in which we could distinguish an arrow of time," says Brad Cox, a KTeV member from the University of Virginia in Charlottesville. The team announced its findings earlier this month at a Fermilab workshop on heavy quarks.

Although time asymmetry has now shown its face, its origins remain obscure. The reason for it could be as dramatic as a new "superweak" force of nature, Cox says. As for the implications, the studies imply a slight difference in behavior between matter and antimatter that might help explain why the universe today contains virtually no antimatter, although it presumably started with a 50-50 blend of the two types. —*P. Weiss*