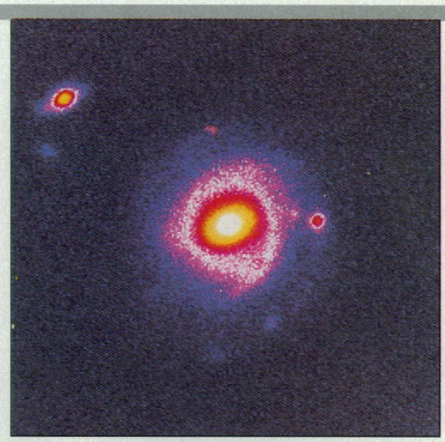
ASTRONOMY

Battle Lines Shift in the Great Cosmic Distance Dispute



ROBERT KIRSHNER

That shrinking feeling. A large universe looks less certain, based on type II supernovae like this one *(small spot at left)*.

On the surface, astronomy may appear a serene and peaceful pursuit, but astronomers have been known to get out their claws when arguing about the distances to faraway galaxies. Take the collection of galaxies known as the Virgo Cluster. Michael Pierce of Kitt Peak Observatory in Arizona and Brent Tully of the University of Hawaii will tell you they think it's 50 million light-years away. Allan Sandage of the Carnegie Institution believes it lies twice as far away. Both sides are respected, both have solid measurements. But at least one has to be wrong.

Over the past 30 years, the impasse over such distances has grown into a rift that divides the field and often erupts in arguments that one astronomer calls "academically mean." Agrees George Jacoby of Kitt Peak, "It's horrible. I can't wait till it's over." He may soon get his wish. He and his colleagues arrived at last month's Aspen Winter Physics Conference, devoted to the distance scale of the universe, expecting the impasse to continue. Many came away surprised by signs of progress.

The battle lines are still sharply drawn between the large universe people and the small universe people. A growing majority of cosmologists side with the small universe camp, citing evidence ranging from the graininess of far-off galaxies to the apparent size of nebulae within them. A persistent minority led by Sandage, however, insists on a universe twice as large. Their strongest evidence comes from observations of the brightness or size of exploding stars—supernovae. But at the meeting, one key supernova adherent, Robert Kirshner of the Harvard-Smithsonian Center for Astrophysics, reexamined his data—and crossed part of the way over to the small-universe camp. In a field as contentious as this, says Princeton cosmologist James Peebles, that's "a remarkable amount of progress."

NOAO

Big gun. Type 1A supernovae like one that exploded in this galaxy still point to a long-distance scale and an old universe.

At issue is an elusive number known as the Hubble constant—the ratio between the speed of other galaxies, which are being swept along by the expansion of the universe, and their distances. The Hubble constant would unlock the cosmic distance scale because it would allow astronomers to calculate the distance to any object in the universe from its velocity, easily measured from the red shift of its light. And because the Hubble constant is also a measure of how fast the universe is expanding, pinning it down would reveal how old the universe is—how long it has been "coasting" since the Big Bang.

To get the constant, astronomers have to find some direct measure of the distance to sample galaxies. Kirshner, for example, watches for the explosions of type II supernovae—the big kind, made famous in 1987 when one exploded in the neighboring Large Magellanic Cloud. To calculate the distance of the galaxy in which a supernova is spotted, Kirshner relies on the same logic that tells us that the moon is much closer to us than the sun or stars. He measures the angular size of a distant supernova—the amount of the sky it takes up—then compares that figure to the supernova's actual size, calculated from its age and rate of expansion.

That strategy has led Kirshner to a Hubble constant of 60. The number implies a universe substantially larger and older than the value of 85 that emerges from most other methods—including the strategy favored by Pierce and Tully, which became a key point of comparison at the meeting. Pierce and Tully attack the distance problem by measuring the rotation rate of galaxies. The faster the rotation, the larger and brighter a galaxy. By comparing the galaxy's intrinsic brightness to its measured brightness, they get an indication of its distance.

Because supernovae are rare, Kirshner has measured only a handful of galaxies, while Pierce and Tully have been able to average results for thousands of galaxies—including some in Kirshner's sample. At the meeting, Pierce suggested that he and Kirshner compare notes on some of the galaxies they had both used. The result surprised everyone. Pierce says when he applied his methods to 12 of the 15 galaxies Kirshner had measured with supernovae, he, too, got a Hubble constant of around 60. The matchup suggests that both methods accurately measure distance. To Pierce and some other cosmologists, it also hints that something about Kirshner's small sample is throwing off his calculation of the Hubble constant.

Pierce thinks Kirshner's figure was skewed by the "peculiar" motions that stir galaxies around in little eddies within the grand cosmic expansion. Since the Hubble constant depends on both distance and velocity, measured from red shift, those random ebbs and flows could "contaminate" the constant even if the distances were measured correctly. The ratio is only really constant over large numbers of galaxies, when these ebbs and flows average out. Pierce believes Kirshner, too, would get 85 if he could apply his method to thousands of galaxies, as Pierce has. Massachusetts Institute of Technology astronomer John Tonry agrees. "The results were devastating for the [big universe] crowd," he says, "and thrilling for the [small universe] people."

Kirshner accepts that his numbers may have been thrown off by peculiar motions, and he says he's increased his error margin to allow for the possibility of a higher constant. Kirshner isn't ready to join Tully and Pierce at a Hubble constant of 85, but his half-step toward a high constant adds to a growing consensus. "If you took a poll 10 years ago, there would have been a 50-50 split," says astronomer John Huchra of Harvard. "Now about 80% or 90% of astronomers adopt a high value."

But there's still a strong argument for the other side, coming from another set of supernova adherents: Sandage and Abhijit Saha of the Space Telescope Science Institute. Sandage and Saha, like Kirshner, use supernova explosions, but of a different, less bright variety, type 1A. And instead of relying on the angular size of the exploding stars to gauge absolute distances, Sandage and Saha take the apparent brightness of each supernova as an indication of its relative distance.

That leaves them in need of some way to

calibrate their distance scale, which they got last year when they spotted a supernova and a variable star known as a Cepheid in the same galaxy. Cepheids brighten and darken with a rhythm that indicates their intrinsic brightness, which enables astronomers to use them as an independent distance scale. By hooking together the supernova and Cepheid scales, Sandage and Saha were able to get an absolute distance to their supernova—and thus to all the other supernovae they had catalogued earlier. The results point to a Hubble constant of 50, and a universe twice as large and old (perhaps 15 billion years) as other methods imply (*Science*, 3 July 1992, p. 34).

"Their arguments sounded good to me," says Kirshner. Theorist Peebles agrees, calling the Sandage-Saha result "dramatic—not to be sneezed at." But the small universe crowd counters that the supernova Sandage and Saha relied on to calibrate his distance scale might be unusually bright, which would make other, dimmer supernovas look farther than they really are. And they stress the number of independent methods that all give the small universe answer. "One would have to have all these methods have a fatal flaw of the same amplitude," says Hawaii's Tully.

"On the surface, it looks like everything is going their way," admits Sandage. But he's not backing down. "I've believed the Hubble constant is 50 since 1974," he says. "I'm convinced the other side is wrong."

Others astronomers think Sandage is emotionally wedded to his large distance scale. Sandage acknowledges the possibility, but thinks the same kind of prejudices are influencing his opponents. In the forward to his *Hubble Catalog of Galaxies* he observes, "Belief is never an entirely rational thing. It comes partly from a logical sifting of all facts, but also from intuition and deep philosophical yearning for a system of ideas." But whatever the role of faith and aesthetic preference in the great cosmic distance debate, Sandage says, the scientific method will settle things in the end.

–Faye Flam

CLINICAL IMMUNOLOGY

MS Study Yields Mixed Results

Over the past several years, immunologists have built a case that the nerve cell degeneration of multiple sclerosis (MS) is the result of the immune system going awry and mistakenly attacking the myelin sheaths that cover many neurons. Attempts to block this abnormal immune attack with broad-spectrum immunosuppressive drugs have been plagued by side effects, however, and several groups have been trying to devise less dangerous, more specific, treatments. On page 1321, a research team from Harvard Medical School and the School of Public Health, led by neuroimmunologists Howard Weiner and David Hafler, now reports the first results from a small clinical trial aimed at testing one possible therapy, known as "antigen feeding," in human multiple sclerosis patients. They found tantalizing signs of improvement in some of the treated patients, but the results were not statistically significant and it's still far too early to say whether the treatment works.

Collaborators. David Hafler *(left)* and Howard Weiner led the antigen feeding study in MS patients.

During the year-long pilot study, 15 individuals in the early stages of multiple sclerosis were fed bovine myelin, a substance containing two of the antigens thought to be the targets of the immune system's attack in multiple sclerosis. Another 15 were treated with placebo. The rationale behind this treatment? Immunologists have known for nearly a century that they could induce animals to become tolerant to an antigen simply by feeding it to them. Then, a few years ago, researchers showed that feeding the antigens that induce experimental autoimmune conditions in animals, including one resembling multiple sclerosis, could prevent symptoms from developing (*Science*, 5 April 1991, p. 27).

In the MS pilot study, fewer members of the group fed bovine myelin had major attacks of their disease than the control group, though the decrease fell shy of statistical significance. In addition, antigen feeding did not seem effective for the study's female patients, all of whom carried a particular histocompatibility protein variant designated HLA-DR2, whose possession is thought to make people more susceptible to the disease.

Those results have led some observers to warn against taking too much encouragement from the study findings. Stephen Reingold, vice-president of Research and Medical Programs at the National Multiple Sclerosis Society calls it "provocative," but says: "there's been no demonstration of benefit. The danger is that conclusions be made from the study that are unsupportable." Larry Steinman, a neuroscientist at Stanford University School of Medicine, who's also working on potential immunotherapies for multiple sclerosis, adds that the lack of success in females is particularly discouraging. Women constitute roughly two-thirds of MS patients.

Weiner and Hafler say, however, that broad conclusions—positive or negative—shouldn't be drawn from the pilot study of only 30 individuals. The researchers suggest that the different responses of men and women in this study could be due to a number of things, from small sample size to requirements for different doses of bovine myelin.

They also note there were other encouraging signs in addition to the improvement seen in some of the men. Individuals treated with the bovine myelin showed a significant decrease in the numbers of immune T cells that react with myelin basic protein. Since the protein is a presumed target of the immune attack in multiple sclerosis, that indicates that the treatment is specifically suppressing immunity to the antigen. Weiner says he's encouraged by the results, given the apparent simplicity of the antigen feeding approach. "In a way," he said, "it's hard to believe that we'd see something by simply feeding a protein." The Harvard team also reports that individuals taking bovine myelin did not seem to suffer any harmful side effects.

Other researchers involved with ongoing antigen feeding trials are also encouraged. David Trentham of Beth Israel Hospital, who's conducting a study in rheumatoid arthritis patients, says the new results are an "exciting beginning." Robert Nussenblatt, of the National Eye Institute in Bethesda, Maryland, who is testing antigen feeding on uveitis, an inflammation of the eye, agrees, saying that the importance of antigen feeding could be far-reaching, potentially even extending to suppressing transplant rejection.

But in the end the multiple sclerosis study may have raised more questions than it answered. As Weiner explains, "The paper should really be viewed as asking the question: 'Should more studies be done?' And I think the answer is clearly 'Yes.'"

–Carol Kaesuk Yoon

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