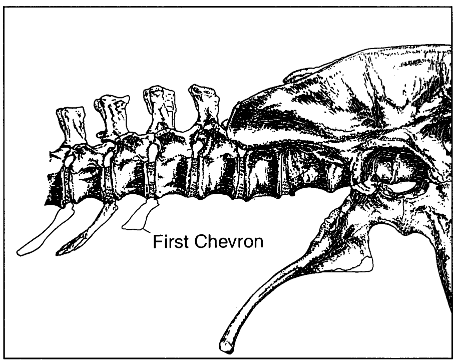
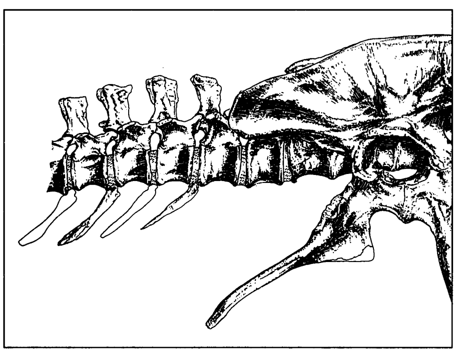
gists announced that 2 tons of rock excavated near the Beardmore glacier, just 650 kilometers from the South Pole, have yielded bones from several species. Among them: a previously unknown carnivorous dinosaur that lived between 200 and 175 million years ago—at least 20 million years earlier than any other large carnivores known so far.

William Hammer and William Hickerson of Augustana College in Rock Island, Illinois, found the fossil-bearing rock in 1991, but it took 2 years for them to chip through enough surrounding stone to get a good look at the bones. When they did, they found partial fossils from small scavenging dinosaurs, the humerus from a pterosaur (a winged dinosaur), as well as something truly remarkable: a 60-centimeter-long skull with a forward-facing bony crest on top. The skull looks a little like that of allosaurus (a theropod, or bipedal carnivore, that lived much later). But the crest is distinctive: Other crests on theropods face to the side, but this one faces forward. "It spreads out like a peacock's feathers," Hammer says. Paleontologists assume such crests, like peacock feathers, serve as signaling displays.



Feminine traits. A female dinosaur's first chevron seems shorter than a male's, and farther away from the pelvis.



Telling tail. The first chevron under the tail of a male *T. rex* may be longer than a female's chevron.

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According to Philip Currie of the Royal Tyrrell Museum in Alberta, Canada, some features of the skull—such as the bones in back of the eyes—resemble theropod fossils from China and South America, but are different in their shape and relative orientation. The next step in sealing the status of the Antarctic dinosaur is to give it a new species name: The Augustana researchers are currently working on just such a christening project.

To Sex a *T. rex*

Peter Larson got interested in dinosaur sex when he pulled a massive *Tyrannosaurus rex* skeleton out of the ground in South Dakota 3 years ago and named it "Sue." The name came from the woman who first noticed the fossil, but Larson, president of the Black Hills Institute of Geological Research, a professional collecting outfit in Hill City, South Dakota, began to wonder whether the name really matched the fossil's gender. Sexing fossil skeletons has long been a thorny problem for paleontologists, but after examining 14 *T. rex* skeletons and making anatomical comparisons to large modern reptiles, Larson thinks the solution lies under the tail.

Larson began by dissecting a series of modern crocodiles, which share several anatomical features with dinosaurs. Male crocs, like many reptiles, have a penis-like sex organ that can be extended or retracted into the body, the muscles involved being attached to one of several bony spines, called chevrons, on the underside of the tail vertebrae. In male crocs, Larson found, the first chevron, which anchors the penis muscles, is the same size as the next chevron down the tail. In females, however, the corresponding chevron is shorter, presumably because it doesn't need to anchor the muscles. It's also positioned farther down the tail, away from the pelvis—perhaps, Larson speculates, to leave more room for eggs to pass.

An examination of the *T. rex* skeletons revealed similar features: Some specimens had a shortened first chevron, positioned farther down the tail. At Larson's request, Philip Currie of the Royal Tyrrell Museum took a look at several specimens of troodontids, close relatives of *T. rex,* and found the pattern again. The individuals with the larger chevrons, Larson concludes, must have been males, each equipped with a retractable penis.

These "male" skeletons were also consistently smaller than the "female" ones, with the shorter chevrons. That size pattern supports Larson's sex scheme, says Sankar Chatterjee, a paleontologist at Texas Tech University: "In many modern reptiles, and in birds of prey, the female is larger than the male."

And that means Larson doesn't have to consider a name change for Sue, whose big bones appear to be a sign of femininity. But he probably wouldn't have rechristened the *T. rex* even if massive dinosaurs appeared to be male. "Then," he says, "we simply would have had a boy named Sue."

–Joshua Fischman

ASTRONOMY

Cosmologists Meet to Face Their Fears

LONDON—The great Russian physicist Lev Landau once said that cosmologists are often wrong but never in doubt. That may have been true once, but after years of having observations refuse to agree with theories, there's no shortage of doubt in the field. Two of its most doubt-ridden issues—the age of the universe, and its composition—brought cosmologists together last month at the Royal Astronomical Society in London to compare their newest results and ideas. "There are quite a lot of new results coming in—new conceptual ideas and new measurements," says Ofer Lahav of the Institute of Astronomy at the University of Cambridge, one of the meeting's organizers.

But that doesn't mean that the conference relieved all the anxieties of cosmologists. While new measurements of the universe's age raised hopes that the cosmos can do without a mysterious antigravitational force—a notion that makes many cosmologists squirm—a new proposal about its makeup holds that that force may be an integral component of the cosmos.

The universe ages gracefully

One of cosmology's oldest problems has been squaring the seeming youth of the universe with the extreme old age of its oldest stars. At the conference, however, two groups presented data pointing to a far older universe—old enough to dispel the contradiction.

If the results hold up, they could also put to rest a specter that has long haunted cosmologists: the cosmological constant. Added to the gravitational equations of general relativity, the constant implies a mysterious force apparently generated by empty space that gently pushes galaxies apart. Einstein, who first invoked it, later dismissed the constant as a blunder, and many astronomers would agree with Tom Shanks of Durham University, co-organizer of the RAS meeting, who calls the constant "inelegant." But in recent years, some astronomers have called for its reinstatement, primarily to solve the apparent mismatch between stellar and cosmic ages.

Astronomers can't calculate the age of the universe directly; instead, they infer it from the rate of expansion of the universe, as measured by the so-called Hubble constant. A larger Hubble constant (faster expansion) implies that gravity has had less time to slow down the universe since the Big Bang, thus implying a younger cosmos. But measuring the Hubble constant itself is no easy matter, because it demands a knowledge of both the rate at which a far-off galaxy is moving away from Earth and the galaxy's absolute distance.

A galaxy's speed is easy to determine from the red shift in its spectrum, but actual distances are tough to gauge. The results so far have been troublesome, as well. In recent years, evidence from a range of different techniques has led many astronomers to conclude that the constant may be relatively high, around 80-100 in standard units of kilometers per second per megaparsec.

A Hubble constant that high would imply a cosmic age of 8 billion years, and that's hard for many cosmologists to swallow, because it would make the universe at least 5 billion years younger than the oldest known stars. This is where the "inelegant" cosmological constant can help. By continuously supplying an extra push to the expanding universe, the mystery force would keep the universe from slowing down as much as expected, and thus allow it to be older than it looks.

But those looking for ways to avoid the cosmological constant point out that the high Hubble constant values are primarily based on extrapolations of observations made on local galaxies. Slow changes in galaxy behavior over time and local variations in the flow of galaxies—eddies and calm spots—could confound such attempts to measure the Hubble constant. As a result, astronomers have worked to develop new, truly "deep space" ways of estimating the Hubble constant, methods that do not have to be calibrated with local galaxies.

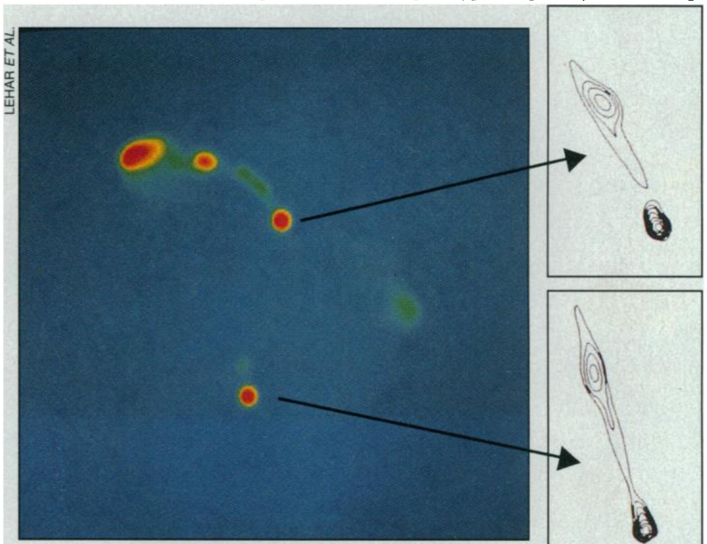
One such technique, known as Sunyaev-Zel'dovich effect, exploits the fact that the very hot gas trapped inside clusters of galaxies interacts with the background of cosmic microwave radiation that washes through the universe, and makes it appear cooler. Theory shows that by combining the size of this apparent temperature drop with measurements of the flux and temperature of x-rays given off by gas in the cluster, observers can estimate the cluster's actual size. Then, simply by comparing this absolute size to the cluster's apparent size in the sky, astronomers can work out how far away it is, and so estimate the Hubble constant.

A few weeks ago, a team led by Michael Jones at the Mullard Radio Astronomy Observatory in Cambridge presented the results of the most comprehensive effort so far to measure the Hubble constant using the Sunyaev-Zel'dovich effect. The results, published in *Nature*, favored a low value for the Hubble constant, around 50. At the London conference, Jones announced improved results, based on better x-ray flux data and more observing time. The value has now dropped to around 38.

A very different technique recently yielded much the same result. A team led by Joseph Lehar of the Institute of Astronomy at Cambridge has been pursuing the Hubble constant by observing distant quasars whose light has been bent by the gravity of an intervening galaxy, creating multiple images. Changes in the quasar's energy output appear in the different images at different times; the time variations allow astronomers to calculate the absolute distance of the intervening galactic lens, and thus get a handle on the Hubble constant. Based on observations of quasar 0957+561, Lehar told the conference, he found a best estimate for the Hubble constant of around 37—very close to Jones' result.

New spices in a cosmic recipe

These two new measurements of cosmic expansion, by implying a comfortably old universe, may eliminate one rationale for Einstein's mysterious cosmological constant. But another may be on the horizon: a new recipe for the constituents of the universe, presented by Oxford cosmologist George Efstathiou.



LEHAR ET AL.

Surveyor's mark. The "double quasar" 0957+561 provides a clue to the cosmic expansion rate.

The makeup of the universe is a puzzle because of another of cosmology's great contradictions. Currently favored models of the very early universe predict that it was endowed with just enough matter to expand forever; any more and gravity would eventually stop the expansion and cause it to collapse. In cosmologists' shorthand, the "omega" of the universe is exactly 1. The trouble is that an omega of 1 requires about 100 times more matter than is visible through telescopes.

Undoubtedly, some fraction of the invisible, or dark, component of omega is just dust, gas, and other "baryonic" matter such as the tiny failed stars known as "massive compact halo objects" (MACHOs), which may have been identified in the past few months (*Science*, 1 October, p. 30). But according to the theory of how chemical elements were created during the Big Bang, baryonic matter cannot account for more than about 5% of omega. The rest takes the form of exotic particles, which cosmologists divide into two types: hot (fast-moving) dark matter, such as neutrinos, and cold (slow-moving) dark matter, which would consist of esoteric—and so far hypothetical—particles such as axions or neutralinos. Because cold and hot dark particles would have different effects on how the matter in the early universe curdled to form galaxies and clusters of galaxies, some cosmologists now favor a mixture of hot and cold.

But even hot and cold dark matter may not be enough to pump up omega all the way to 1, according to Efstathiou. A new analysis of x-rays from gas surrounding galaxy clusters shows that the total mass anchoring the gas —a measure of both ordinary matter and any exotic particles—is relatively low, implying an omega of around 0.2. This is far less than the value of 1 predicted by the simple theory of the early universe. Again, the cosmological constant offers an out: It could account for the missing 0.8. (For quantum mechanical reasons, the cosmological constant contributes a positive mass density even though it gives an antigravitational effect.)

According to Efstathiou, as well as rounding up the omega value, a mix of one-fifth cold dark matter, four-fifths cosmological constant and a dash of baryonic matter also gives just the right type of galaxy clustering. "I'm extremely happy, because our model seems to explain everything," he says.

Many of his colleagues are less pleased with his solution, though. Shanks of Durham argues that so large a cosmological constant raises as many questions as it answers. And Efstathiou himself admits that his proposal does have some problems. For example, why does the cosmological constant have just this particular value? "Understanding the size of the cosmological constant is one of the major problems facing physics today," he says.

Many cosmologists hope the new deep space techniques for probing the behavior of matter in the universe may yet prove that Einstein was right when he dismissed the cosmological constant as a blunder. But according to Efstathiou, the cosmological constant may be a blunder whose time has come.

–Robert Matthews

Robert Matthews writes for The Sunday Telegraph *in London*.