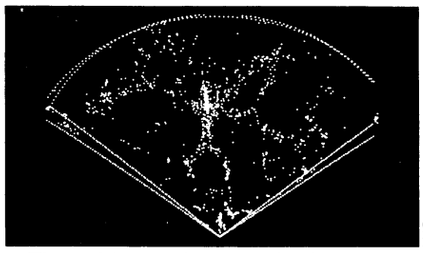
Blown away: Froth of cosmic bubbles

Astronomers used to think the universe was homogeneous. But recent observations of voids in the universe, of clusters of galaxies associated in ultralong superclusters, have seemed to fault the idea. Soon astronomers may have to give it up entirely. The latest, and apparently most extensive, observation, reported at last week's meeting in Houston of the American Astronomical Society, indicates that the universe is a froth of bubbles, large empty volumes with galaxies clustered in their walls.

The distribution of galaxies was observed in what the scientists call a "slice of the universe," a region extending almost halfway around the horizon and 6° thick. In this they have plotted the locations of galaxies according to their velocities of recession from us. The third dimension has to be velocity, says Margaret J. Geller of the Harvard-Smithsonian Center for Astrophysics (CFA) in Cambridge, Mass., because, although astronomers are agreed that a galaxy's recession velocity measures its relative distance, they cannot agree on the value of the Hubble constant, by which they could calculate absolute distance. Along with Geller, the researchers include Valérie de Lapparent (visiting from the Ecole Normale Supérieure de Jeunes Filles and the University of Paris VII in France) and John P. Huchra of the Harvard-Smithsonian CFA.



CFA

The evidence shows up in the pattern in the above illustration: Galaxies appear clustered in long strings with open spaces between them. This is what would appear on a slice taken through a collection of soap bubbles: The lines would be the projections of the walls of the bubbles on the slice. So de Lapparent, Geller and Huchra propose that the universe is structured like soap bubbles. Such a structure could be explained by a theory proposed in 1981 by Jeremiah P. Ostriker of Princeton (N.J.) University and Lennox L. Cowie of the University of Hawaii, which, as Geller says, was generally ignored at the time. According to that theory, a primordial generation of stars, formed before any galaxies, would have exploded. The force of the explosions would have emptied out these bubbles. The formation and expansion of the bubbles is superimposed upon the general (Big Bang) expansion of the universe. Combined observations of both expansions could be one way of pinning down the value of the Hubble constant, Geller says.

The observers plan deeper surveys. "Depth" refers to the faintest galaxies recorded. These may be either the farthest out (and if so their recession velocities will indicate that) or the faintest (intrinsically) that can be recorded at any intermediate distance. A deeper survey should tell whether the bubble pattern extends farther out in the universe. It should also tell whether, as intrinsically fainter galaxies are taken into account, the bubble pattern persists at closer distances. — *D.E. Thomsen*

Was a fifth force felt?

Physicists have divided all the motions in the universe into the domains of four kinds of force: gravity, electromagnetism, the weak subatomic force and the strong subatomic force or color force. Each of these has its source in a different property of material objects — for example, the source of gravity is mass, while that of electromagnetic forces is electric charge. Now, a fifth force is suggested.

Such proposals tend to arise from experimental anomalies that suggest an unknown force may be acting. In the Jan. 6 PHYSICAL REVIEW LETTERS, Ephraim Fischbach (temporarily at the University of Washington in Seattle), Daniel Sudarsky, Aaron Szafer and Carrick Talmadge of Purdue University in West Lafayette, Ind., and S.H. Aronson of Brookhaven National Laboratory in Upton, N.Y., propose that a fifth force was operating in a famous experiment done in Hungary in 1922 by Roland von Eötvös, D. Pekár and E. Fekete. The Eötvös experiment, as it is called, tested the law of gravity by measuring the gravitational attraction between the earth and various materials, including metals, woods and even grease or suet. Fischbach and his co-workers suggest that, unbeknownst to Eötvös and colleagues, slight differences in the responses of different materials indicate that in addition to gravity, a small, *repulsive* force was acting.

Fischbach and his co-workers relate this suggested force to a quality of matter called hypercharge or baryon number. The baryon number is related to the number of neutrons and protons, and therefore to the chemical composition of a material — thus explaining the difference in force for different materials. The researchers propose a formal similarity between this hypercharge force and electromagnetism. Just as electromagnetic forces are carried from object to object by intermediary particles called photons, so this hypercharge force would be carried by "hyperphotons." A number of experiments could test for the existence of the hypercharge force, including a direct search for the hyperphotons themselves.

— *D.E. Thomsen*

Herbal medicine: R_x for chimps?

Dawn breaks on Tanzania's Gombe National Park, and several chimpanzees depart their tree-borne nests in search of an unusual breakfast. They pass up nearby fruit trees and take a 20-minute trek to a patch of grassland where they swallow — without chewing — the leaves of a shrub known as *Aspilia*.

Are the leaves a tasty addition to ape diets on the African savanna? Probably not. It appears that the chimps seek out a recently identified substance on the leaves that kills disease-causing bacteria, fungi and parasites, reports anthropologist Richard Wrangham in the latest ANTHROQUEST, the newsletter of the L.S.B. Leakey Foundation. Last year, Wrangham, of the University of Michigan in Ann Arbor, and two colleagues visited botanical research centers in East Africa and found that several African tribes similarly use the leaves, often swallowing them to ease stomachaches or rubbing them on surface wounds or cuts.

If the chimps are aping humans by intentionally medicating themselves to fight disease or reduce pain, says Wrangham, "we can envision a slowly growing use of [herbal medicines] by human ancestors over millions of years."

Wrangham has observed more than 100 instances of *Aspilia* swallowing at Gombe and at another nearby site, Mahale Mountains National Park. Upon locating the 6- to 10-foot-tall shrubs, a chimp typically puts its lips around a single unplucked leaf, perhaps touching it lightly with its tongue. Several leaves are tried in this way before one is pulled off the stem. The animal rolls the leaf around in its mouth rather than chewing it. Within 15 seconds the leaf is swallowed, occasionally with a grimace. No more than 30 leaves are consumed over the next 10 minutes.

Chimps of all ages engage in this behavior, says Wrangham, but for some reason females use *Aspilia* about once every 10 days, while males use it an average of once a month. There are other mysteries: It is not known, for instance, why Gombe chimps swallow the leaves at dawn while Mahale chimps consume them at any time of day. Also, humans and chimps use the same three species of *Aspilia* and neglect a fourth species. The distinguishing

qualities of the neglected species are unclear, notes Wrangham.

For many years, he says, chimp researcher Jane Goodall noticed that chimp dung at Gombe often contained one type of leaf that was never chewed.

But the function of the leaves, now known to be *Aspilia,* is just beginning to come to light. In April 1984, Eloy Rodriguez of the University of California at Irvine identified a red oil in the leaves, which he dubbed thiarubrine-A. A few weeks earlier, Neil Towers of the University of British Columbia at Vancouver isolated the same chemical from Canadian plants. He found that thiarubrine-A kills common disease-causing bacteria, fungi and nematodes, a type of parasitic worm.

In an electron microscope analysis of leaves retrieved from chimp dung, the two scientists jointly observed that surface cells containing thiarubrine-A were ruptured, probably during passage through the gut.

At that point, Wrangham and the two investigators visited East African research centers, where they found that some African peoples use *Aspilia* to treat a number of medical problems.

Chimps and people may have similar ideas about *Aspilia,* says Wrangham, but it is not clear what the leaves actually do. Perhaps they control worms in the gut. Or, he notes, since chimps sometimes eat more after swallowing *Aspilia,* the plant might be an intoxicant. Animals in many areas of the world "get high" by consuming naturally occurring drugs (SN: 11/5/83, p. 300).

Wrangham and his colleagues plan to monitor in the laboratory the physiological reactions of chimps and other animals to *Aspilia* and thiarubrine-A. They also want to compare physiological measures in chimps who swallow leaves with those of abstaining chimps.

Wrangham's observations add to other recent findings concerning the eating habits of primates, points out anthropologist Randall Susman of the State University of New York at Stony Brook. Several primate species, for example, eat certain plants only when toxins are not present, such as early in the morning before the sun activates dangerous chemical compounds.

"The Gombe chimps appear to be actively seeking out certain plants, not just reacting to them," says Susman. "I would expect similar behaviors to turn up among other apes."

Baboons, which are not apes, do not swallow *Aspilia* leaves in Gombe, says Wrangham, although they occasionally eat foods that are poisonous to many other mammals. "When a baboon eats a fruit that would be toxic to people, it may merely be having a snack, rather than dosing itself with a drug," says Wrangham. "It's exciting to find a case where curious behavior suggests deliberate intake of a powerful drug." — *B. Bower*

Voyager 2: On the threshold of Uranus

The Voyager 2 spacecraft's hurtling flight past Uranus, less than a week away, will be the probe's third planetary encounter since it was launched in 1977. Yet the mood of anticipation surrounding the event's approach is different than it was for either Jupiter or Saturn. Unlike Uranus, of course, those two worlds had been visited before — by Pioneers 10 and 11 and then by Voyager 1. But the extreme remoteness of Uranus, nearly twice Saturn's and four times Jupiter's distance from the sun, has kept its secrets far less accessible even to the limited observations of earth-based and earth-orbiting instruments.

The sunlight reaching Uranus is four times fainter than it is at Saturn, making the planet both darker and colder. Earthbound astronomers have sought for years to detect signs of visible features rotating around the planet as it turns, in hopes of determining the length of a Uranian day. Only Voyager 2 has offered the promise of a clear answer, but it was not until Dec. 27, with less than a month to go before the flyby, that the craft was able to take photos from which even heavy computer processing could pick out identifiable features. And those were only concentric bands, not the sort of irregular details that could be tracked in their motion. By Jan. 13, the question was still open.

Before the spacecraft came, Uranus had only five known moons. Researchers were anticipating the discovery of as many as 18 more, based on a theory that they could be clustered close to the inside and outside of each of the nine rings that earth-based observations had identified around the planet. But it was only last week that Voyager officials announced a sixth moon — and it was not near the rings at all. Measuring about 45 miles in diameter, it follows an orbit about 53,500 miles from the center of the planet, or more than 20,000 miles from the outermost ring (unless, of course, Voyager 2 were to find additional rings).

The spacecraft did not see any of the rings at all until Nov. 28, when it took a series of photos that were then carefully combined to reveal the outermost of the nine (SN: 12/14/85, p. 373). And by the time six more weeks had passed, says Voyager project scientist Edward Stone of Caltech, in Pasadena, photos from the spacecraft were still able to reveal only two other ring-shaped regions, with their individual details too small at that time for the spacecraft cameras to see clearly.

With the flyby drawing nearer, Stephen Synnott of Jet Propulsion Laboratory in Pasadena, the Voyager control center, was combing through the spacecraft's growing bank of photos, evaluating several other possible candidates for new moons. As the Jan. 24 flyby neared, Voyager 2 would enter its "near encounter" phase, with new results from the craft expected by the day, the hour, the minute . . .

JPL

The first photograph to show latitudinal banding in the atmosphere of Uranus, this image was made by "summing" five frames taken by the Voyager 2 spacecraft from about 22 million miles out, less than a month before its flyby of the planet. So low is the contrast of the subtle features that making them visible required computer-dividing the image's brightness by that of a "hypothetical, featureless planet," illuminated by the sun from the same direction. By comparison, the far more conspicuous bands of Jupiter are visible, without enhancement, all the way from earth.

One of the planet's major mysteries seemed to be holding out to the end. Observations from an earth-orbiting satellite as long ago as 1982 had revealed Uranus to have a bright, ultraviolet glow, initially interpreted as an aurora and thus as a sign that the planet seemed to have a magnetic field. Such a field, however, was expected also to produce radio emissions that Voyager's instruments ought to notice. And as late as Jan. 12, Voyager 2 had not heard a thing. "The theorists are coming out of the woodwork," says Michael Kaiser of the NASA Goddard Space Flight Center in Greenbelt, Md. Writes NASA's Alex Dessler, in a piece for the Jan. 16 NATURE, "The impending encounter has made the theoretical community both humble and open-minded. . . . Firmly held views are not in fashion."

Voyager 2 sped on toward its encounter, the mysteries of Uranus looming. "One cannot but smile," says Dessler, "thinking how, in a distant future, a community of, say, pulsar theorists will behave when an interstellar probe is about to fly by a pulsar for the first time. Rotating neutron star indeed!"

— *J. Eberhart*