Support for the theory of a hyperbolic universe

The application of Einstein's theory of general relatively to cosmology raised the possibility that the space of the universe might be curved. The theory does not give an unambiguous guide to the kind of curvature—it might be closed (like a circle or an ellipse in one dimension or the surface of a sphere in two dimensions); or it might be open (like a hyperbola in one dimension or the surface of a saddle in two dimensions). A closed universe is bounded in the sense that an object sent away from one point may eventually return to it without reversing direction (as Magellan's ships did on the earth's surface); an open universe extends on and on endlessly.

Argument and speculation over the question of an open versus closed uniserve have gone on for 50 years. Now, from X-ray observations of the cluster of galaxies in the constellation Coma Berenices, there is a piece of evidence that seems to point toward an open universe, in the opinion of at least two astronomers. The astronomers are J. Richard Gott III of Princeton University and James E. Gunn of the Hale Observatories, and they present their suggestion in the Oct. 1 ASTROPHYSICAL JOURNAL LETTERS.

The open or closed question depends on the so-called deceleration parameter of the expanding universe. The argument goes like this: The universe is expanding according to the most popular interpretation of the observations of distant galaxies. But the mutual gravitational attraction of the matter in the universe generates counterforces that tend to slow the expansion. The deceleration parameter is a measure of this slowing. The size of the deceleration parameter determines whether the curvature is positive or negative.

The deceleration parameter depends on the density of matter and especially of intergalactic gas in the universe. The gas cannot be seen by eye so estimates of its density have varied widely. But the Coma cluster gives off a diffuse flux of X-rays. This, says Gott and Gunn, sets an upper limit on the amount of hot gas in the intergalactic space within the cluster, since it is hot gas that gives off the X-rays.

They then present a theory of how and at what rate gas from the surrounding space could fall into the cluster. This combined with the maximum possible amount of hot gas in the cluster that was determined from observation sets a limit on the total gas density of the universe. It indicates, they say, that most of the matter in the universe is gaseous, and that the deceleration parameter is less than about 0.1. This corresponds to an open or "hyperbolic" universe. □

Gene therapy: Another possibility

The transfer of bacterial genes to human cells, reported by Carl Merrill and his co-workers (SN: 10/23/71, p. 276), has added to the knowledge of cell biology and to the possibility of gene therapy. But their work leaves certain questions unanswered. For instance, what hazards are presented to humans by the bacteria? Where in the cells do the transferred genes reside? What other methods of gene transfer are possible?

Pradman K. Qasba and H. Vasken Aposhian, working along parallel lines at the University of Maryland Medical School in Baltimore, may be on the way to providing some of the answers. They have shown that DNA (and eventually genes) can be delivered to human cells via mammalian viruses rather than via bacteria. And they have shown that part of this DNA is delivered to the nucleus of the cell.

Polyoma pseudovirions (mouse DNA fragments surrounded by a protective protein coat) can infect cultured mouse cells and become uncoated by such cells. In the October PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

Univ. of Maryland

Aposhian: Finding the best way.

Qasba and Aposhian report that the polyoma pseudovirion system can deliver DNA to human cells. Primary human-embryo cells were exposed to radioactively tagged mouse-embryo pseudovirions for 24 hours. Radioactivity was then found in the human cells and seven percent of the radioactive material was found in the cell nucleus. This, the researchers say, suggests that the polyoma pseudovirion system may be useful eventually for human gene therapy experiments if particles containing human DNA and polyoma coats can be produced. Experiments are now in progress to determine the effect of polyoma pseudovirions on whole animals.

"Now we have a means of delivering DNA to the nucleus of a mammalian cell," says Aposhian. But they have not as yet shown that the transferred DNA is being expressed, or utilized, in the human cells. And they do not know which genes are being transferred. Merrill and his group transferred a specific gene to a human cell and proved that it was being expressed. However, Merrill uses bacterial virus as the transfer agent. "We are using animals viruses to deliver animal DNA to animal cells," says Aposhian; "and we don't know which method will prove to be the best." □

U.S. and Soviets to share data on Mars missions

Space exploration may be surmounting some of the traditional barriers to the free flow of scientific information between the United States and the Soviet Union. Last week, the National Aeronautics and Space Administration and the Academy of Sciences of the U.S.S.R. released approved recommendations for joint projects for the study of space and of earth from space. Instead of the vague generalities usually typical of international proposals, the recommendations list specific projects —most to be completed before 1974. For example, in the area of earth resources, specific sensing equipment is recommended for earth and ocean studies over selected sites.

Not only is the detailed nature of the recommendations a shift from the past, but also the openness and sincerity of the scientists from both countries in the three working groups is, says one participant, "encouraging."

"We will know within a few weeks if the system is going to work," he adds.

Two Russian and one United States spacecraft will reach the vicinity of Mars in mid-November. Recognizing the feasibility and mutual benefits of doing complementary work around Mars (the Russians have not stated whether their craft would land or orbit), the agreement recommends "a bilateral exchange of messages on findings of special interest in as near real-time as possible during the execution of the experiments of Mariner 9 and Mars 2 and 3."

"This means," says one space official, "that when the Russian craft go into Mars orbit, they will tell us the orbital parameters, and should the instruments detect an interesting area of Mars, they will let us know so that we can take a look too—and vice versa."

The agreement lists specific international meetings for presenting results of the Mars probes, as well as of lunar exploration. It also suggests meetings "to recommend experiments to be considered by the two sides in planning their respective research programs . . ." and meetings "to propose complementary activity by one party during planetary investigations conducted by the other. . . ." Taken together, these two suggestions, if fulfilled, would eliminate expensive duplications. For example, if both nations sent spacecraft to Jupiter, one craft could carry a spectrometer, the other, a magnetometer; or, both craft could be atmospheric probes, but in different regions.

The Soviet Union says it will send scientists to give papers at the 3rd Annual Lunar Science Conference in Houston next January. A similar conference will be held in the Soviet Union in February or March 1973.

Lunar maps made by each country to a scale of 1:250,000 will be exchanged by the end of December 1971. All lunar photography, past and future, will be exchanged, the first transfer to be completed by March 31, 1972. And finally the two countries will exchange future lunar samples in the same way they did samples from Luna 16 and Apollo 11 and 12.

In the area of earth resources, the agreement is even more specific.

Two sites in the Soviet Union and two in the United States were selected as analogous sites for aerial and spacecraft observations on land. They are: Tsimlanski—a flat steppe plain, cultivated in the main and composed of friable deposits; Ustyurtski—a desert plateau with some grazing land and some below-sea-level depressions; South Dakota—a relatively flat, dry land agricultural area; and Arizona—a desert area with rapidly growing urban centers. Eleven other sites are designated "complementary"—four in the Soviet Union and seven in the United States.

Each nation will make spectrophotometric, photographic, multispectral, thermal and microwave surveys of the sites from space. Each will make geophysical, spectrometric, meteorological, geological, soil and geobotanic observations and measurements from the ground as well. Both ground testing and the similarity of sites will allow accurate calibration of the sensors. At Tsimlanski and in South Dakota, for example, there will be conducted water and snow inventories, agricultural crop inventories and productivity estimates and studies of hydrogeology, structural geology, microclimatology and soil.

Ocean studies will be concerned primarily with sea-surface temperatures, sea-surface roughness, ocean biological productivity and sea-ice conditions. The Soviet Union plans to deploy several research ships in the eastern tropical Atlantic in 1972 primarily for meteorological purposes. It also has meteorological satellites (Meteors) equipped with infrared radiometers. The U.S.S.R. proposes "to send one oceanographic research vessel to one of the two sites in the North Atlantic in 1973 where large horizontal temperature gradients prevail: the Gulf Stream east of Cape Hatteras and the polar front between Iceland and Canada."

The United States programs are similar. The first meteorological exchange will be of "temperature soundings" from satellites by June 1, 1972. Each nation plans to participate in the Global Atmospheric Research Program's Atlantic Tropical Experiment in 1974.

Exchanges of sounding rocket research data will begin in January 1972.

The recommendations are the result of meetings in Moscow Aug. 2 to 6 by joint study groups set up by the January agreement between the two nations (SN: 5/1/71, p. 303). □

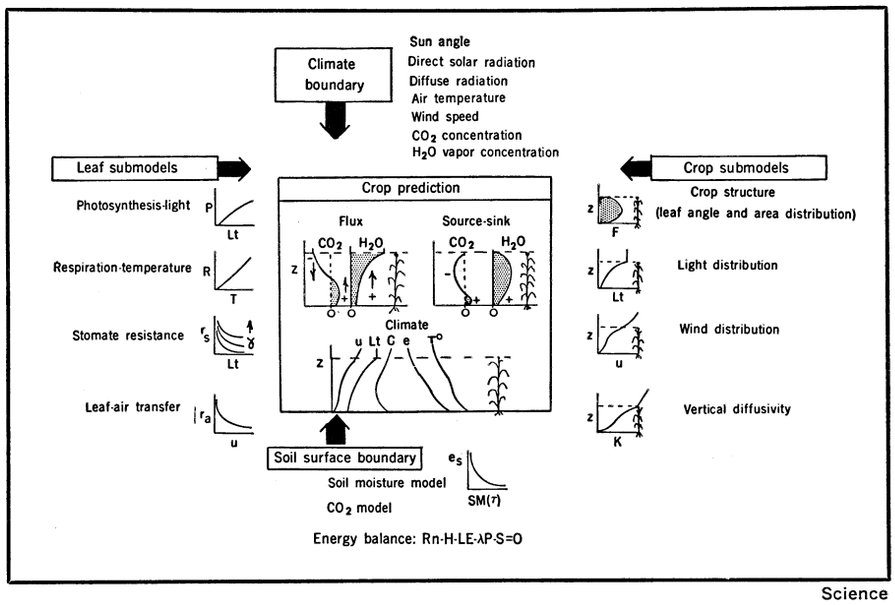
SPAM: A computer views a cornfield

If there is one criticism International Biological Program biome scientists tire of hearing, it is: why haven't the biome studies produced quick tips on crop and land management? To which they testily reply that the biome studies weren't designed to answer such questions (SN: 10/22/71, p. 282). The hope of the critics, however, may now be in sight—a cornfield model that may answer questions not just about cornfields but about other kinds of agricultural environments.

Edgar Lemon and his team at the U.S. Agricultural Research Service in Ithaca, N.Y., have spent a decade carrying out extensive studies in cornfields. They then applied a systems analysis approach to the data they had collected in order to establish various factors in a pecking order of importance within the total ecological picture. What they have come up with is a mathematical model, or computer simulation, of the typical cornfield. They call it SPAM, for soil-plant-atmosphere model. The SPAM effort is reported in the Oct. 22 SCIENCE.

Some of the information that SPAM has pulled together illuminates little-understood plant-soil-air interactions. Most persons, for example, are aware that photosynthesis uses energy from sunlight to fix carbon dioxide into organic materials. When CO_2 and oxygen in both photosynthesis and respiration are transferred across wet surfaces within leaves to the dry external atmosphere, water is unavoidably lost in evaporation. (This process is called transpiration.) SPAM documents what meteorologists and hydrologists have suspected for some time: that transpiration uses most of the energy absorbed by plants from solar radiation. Almost 600 calories are required to evaporate a cubic centimeter of water. Transpiration from leaves and direct evaporation from the soil surface also accounts for a large share of water loss. The tremendous amounts of energy these processes use are directly controlled by plant and soil characteristics.

Essentially SPAM can give answers in two areas. Given the various leaf and plant community traits and the external climate, the model can predict the microclimate in a plant community and at the leaf and soil surfaces. The model can also predict the activity of the leaves and plant community in such processes as photosynthesis, res-



Science

Inputs and predictions of SPAM mathematical soil-plant-atmosphere model.