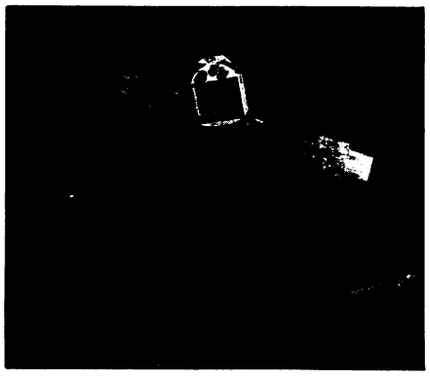
Intergalactic Gas: Toward a Closed Universe

Is the universe open or closed? Will the expansion someday stop and reverse, or will it continue forever? This is perhaps the number one question in cosmology (it is certainly the biggest), and it has been endlessly debated, because the answer depends on things that cannot be seen.

All estimates of the amount of visible matter in the universe agree that it is not enough to close the universe; it is in fact only a small fraction of the amount necessary. The debate over closure continues because of the suspicion of many cosmologists that there is many times as much invisible as visible matter. That view is now supported by the report of a group of X-ray astronomers led by Riccardo Giacconi of the Harvard-Smithsonian Center for Astrophysics. They say they have found evidence for previously unknown matter in the space between galaxies that "could represent a significant percentage of the so-called 'missing mass' needed to close the universe."

While compiling the *Fourth Uhuru Catalog of X-Ray Sources* from observations made by the satellite Uhuru during the early 1970s, the group found evidence for sources associated with clusters or even superclusters of galaxies. Analysis of the data from these sources by Stephen Murray, William Forman, Christine Jones and Giacconi indicates that the radiation comes from extremely hot gas (more than 60 million degrees K). The mass required to produce the recorded intensity is five to ten times all the mass seen at other wavelengths. Giacconi suggests that this gas pervades the space of the clusters and even of the superclusters (it is too much mass to be associated with any single galaxy), and that it is "primordial material," hydrogen and helium that remain from the explosion in which the universe was created. The high temperature of the gas would put most of its radiation beyond the blue end of the visible spectrum and account for the impossibility of seeing it.

Such a huge mass of gas is not only a significant fraction of the amount required to close the universe, it also bears on a subsidiary question: whether the clusters and superclusters of galaxies are gravitationally bound. Galaxies are known to come in clusters, and astronomers who study the statistics of galactic distribution see evidence for associations of clusters into superclusters. The question is whether these associations are bound together by the force of gravity or merely random and momentary associations of galaxies passing in the eternal night of the cosmos. If the clusters are bound, they form an important feature of the structure of the universe. Again, the visible mass of the galaxies in the clusters and superclusters is not enough for the binding. But, if the observations are correct, the newly found intergalactic gas would provide enough.



NASA

Uhuru satellite has found evidence for large amounts of gas in intergalactic space.

Whether enough mass will eventually be found in these all-pervading X-ray clouds to finally settle the debate over universal closure remains to be seen, although the present Uhuru observations suggest that enough may be found as more and more regions are sampled. The Uhuru group suggest that a confirmation of the proposition could come from observations by the soon-to-be-launched High Energy Astronomy Observatory satellite (see p. 38).

U.S.-USSR scientific agreement renewed

The United States and the Soviet Union have renewed for another five years their Agreement on Cooperation in Science and Technology, originally agreed upon during President Nixon's visit to Russia (SN: 6/3/72, p. 356). The renewal was signed July 6 by Frank Press, Director of the U.S. Office of Science and Technology Policy, and by Academician V.A. Kirillin, Chairman of the State Committee of the USSR Council of Ministers for Science and Technology.

No details were announced concerning possible changes in the ongoing program of information exchange and joint research, but Press told reporters after the signing that modifications will closely follow those recommended in a National Academy of Sciences report on the agreement. The only specific research area he would mention as a candidate for increased emphasis was the study of corrosion.

The Academy report, released in May, was based on interviews with many of the 250 U.S. scientists and technologists who have participated directly in the program. They praised the "helpfulness and warmth of the individual Soviet scientific or technical person at the working level," but contrasted this to the "layers of stifling bureaucracy" of the Soviet government. The U.S. government was also criticized for not providing more support to American researchers, including translation and transcription services, procedures for hosting conferences in the United States, briefing scientists before they visit the Soviet Union so they know what to expect and debriefing them on return so their knowledge is disseminated.

Of numerous specific projects covered by the agreement, electrometallurgy was singled out as an example of success, having "stimulated a considerable amount of rethinking of technical approaches in the U.S." A program in the application of computers to management has produced "a better understanding of Soviet views and procedures in planning and management." But in the microbiology project, "the amount of exchange work was practically zero." In physics, "no exchange or substantive interaction has taken place." A source close to the negotiations said the Soviets seem willing to help cut through some of the bureaucratic red tape, while in the United States the "problems are already being remedied." □

Biologists oppose DNA research bills

The turmoil over recombinant DNA research is now four years old. It was at the 1973 Gordon Conference on Nucleic Acids that biologists first called public attention to possible hazards of the gene-splicing research. In the last month at two of the 1977 Gordon conferences, many of the same scientists made an attempt to dam what they see as an impending flood of unjustifiable regulations.

Scientists attending the conference June 13 to 17 in New Hampshire, besides hearing and discussing the latest DNA research results, drafted an open letter to Congress. The authors of the statement are Walter Gilbert of Harvard University, Fred Blattner of the University of Wisconsin, David Botstein of the Massachusetts Institute of Technology and Howard M. Goodman of the University of California Medical Center in San Francisco. Goodman was one of the team who recently inserted rat insulin genes into bacteria.

The letter expresses concern that the legislative measures under consideration would "set up additional regulatory ma-