Clouds of Matter Between the Galaxies

The most fundamental open question in cosmology is whether the universe is open—or whether it is closed. If there is enough matter in the universe, the mutual gravitational attraction of it all will eventually stop the present expansion and start a recollapse. If there is not enough matter, the expansion will continue forever, and there is no limit on the universe's size.

The visible matter is not enough to close the universe. Even if one adds the invisible matter now known, such as the interstellar gas clouds, there is not enough. So astronomers now ask whether the space between galaxies is totally empty or whether there are invisible gas clouds in intergalactic space. The discovery of X-ray sources in some clusters of galaxies, sources too extended and amorphous to be satisfactorily identified with individual galaxies in the clusters, has led some astrophysicists to the conclusion that intergalactic clouds exist.

Now, a study of quasar spectra, reported to the National Science Foundation by Robert E. Williams and Ray J. Weymann of the University of Arizona, nominates a particular cloud for the status of intergalactic cloud and gives a dynamical and numerical argument why it should be.

The finding, NSF says, is believed to represent the most solid evidence yet for the existence of substantial amounts of matter between the galaxies.

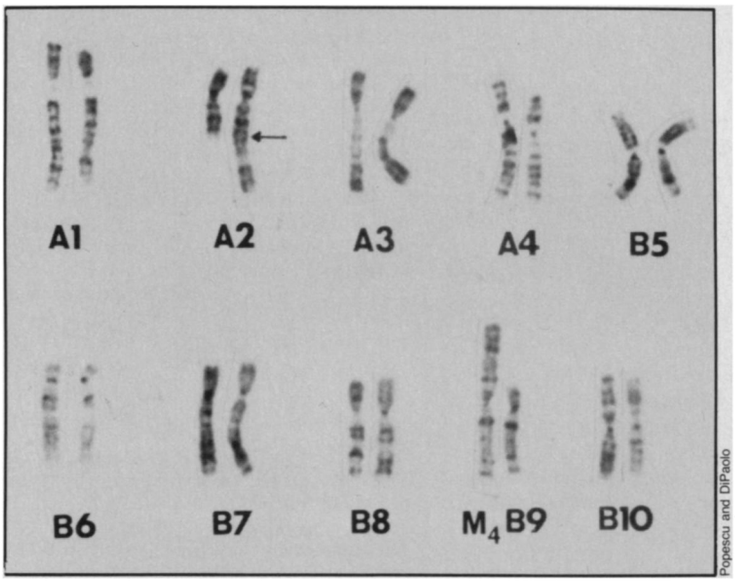
Quasars are compact bodies that give off extremely large amounts of energy. Whatever their relationship to normal galaxies may be, quasars are not part of galaxies in the view of most cosmologists but stand outside them as extragalactic objects. The spectra of quasars exhibit both bright lines that result from emission of particular wavelengths by various hot substances and dark lines that result from absorption of particular wavelengths by cool substances.

It happens in the cases of many other astronomical bodies that emission and absorption lines are produced in different parts of the same object that happen to be warmer or cooler. But in the quasar cases this does not seem to be so. The absorption lines generally show different amounts of redshift from the emission lines. This means that emitter and absorber(s) are moving at different speeds and thus cannot be simply parts of the same object. Several astrophysicists have suggested that the absorptions are done by clouds of gas emitted by the quasar that are either moving away from it or have become satellites of it. But now Williams and Weymann have found at least one instance where the dynamics do not seem to support such an interpretation.

It is one of the clouds that absorb light from the quasar PHL 1222. The redshift relation indicates that this particular cloud is traveling toward the quasar at a speed of 1,500 miles per second, extremely fast. Yet the evidence is that this cloud is also quite far from the quasar. Matter near a quasar ought to be highly ionized because of the intense radiation it receives, but this cloud, by the evidence of the wavelengths it absorbs, has quite a low degree of ionization. Williams says it must be at least a million light-years from the quasar.

It seems hardly likely that a single quasar could exert a gravitational force strong enough to produce such a speed at such a distance. It seems much more likely that the cloud is responding to the gravity of the whole cluster of galaxies in which the quasar is located. The cloud is therefore not particularly attracted to PHL 1222 nor associated with it, but a free intergalactic cloud responding to the dynamics of the whole galaxy cluster. "Since the cloud seems to be one typical of many quasars, the inference is that many other quasars' clouds can be explained in the same way," Williams concludes. Thus there would be a lot of intergalactic clouds. □

Chemical carcinogens: Cause probed



Chromosomes taken from a cell turned cancerous by a chemical carcinogen, show how chemical carcinogens can alter chromosomes. A portion of chromosome number A2 has been translocated to the short arm of chromosome number B9 to form a new chromosome, number M4.

Cancer, regardless of the tissues or organs it afflicts, consists of one or several cells gone haywire. These cells then multiply like wildfire, taking over the body and usually killing the victim. Environmental chemicals, along with viruses and radiation, have been well established as triggers of cancers in animals and tissue cultures and hence are believed to set off human cancers also. Some cancer researchers, in fact, believe that most human cancer is caused by chemicals in the environment.

Although scientists have known for 40 years that chemicals trigger cancer, at least in tissue culture, precisely how they might do so has eluded discovery. Nonetheless, investigators are learning more and more about it, as revealed at the recent annual meeting of the Federation of American Societies for Experimental Biology and by an article in the latest issue of the PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The body's first line of defense against foreign chemicals, including carcinogens, are enzymes in the liver. In their zeal to rid the body of carcinogens, however, the enzymes may make them more carcinogenic than the parent compounds, Charles Heidelberger of the University of Wisconsin reports. Precisely how long carcinogens must remain in the body, and in what form, to do their dirty work is not known. But if they do stay long enough to cause trouble, their next stop is presumably target cells.

As far as Heidelberger can tell, carcinogens "can do their own thing without switching on RNA tumor viruses." In other words, it looks as if they can turn cells into cancer cells without an RNA tumor virus or its reverse transcriptase enzyme being present. Heidelberger admits, though, that he doesn't know whether some unknown virus might switch carcinogens on.

Once carcinogens get inside cells, they attach to chromosomes. This attachment may or may not damage the chromo-

somes, J. A. DiPaolo of the National Institutes of Health in Bethesda, Md., has found. "There may be two kinds of cancer," he says, "one which includes chromosomes and one which does not." In any event, the chromosomal damage that is exerted may consist of a breakage or rearrangement of preexisting chromosomes or the addition of new chromosomes. Such action, however, may not necessarily be as crucial as other actions of carcinogens in cells, notably their interaction with DNA (genes) that reside on the chromosomes.

There is no doubt that carcinogens attach to DNA, Michael Lieberman of the National Institute of Environmental Health Sciences in Research Triangle Park, N.C., reports. Both he and other researchers have found this. Lieberman and his co-workers have also noted that mammalian cells are able to shuck carcinogens off their DNA, at least to a certain degree. But is this action sufficient to protect the cell from the carcinogen? If not, then the chemical residue left on the DNA may be able to damage the DNA.

Such damage, in fact, has been documented, as gene mutations, by several research groups—by H. V. Malling and F. J. DeFerres of NIEHS in 1969, by Heidelberger, T. H. Corbett and W. S. Dove of the University of Wisconsin in 1970 and by Bruce Ames and his team at the University of California at Berkeley last year. Ames and his team, for example, found that of 300 carcinogens and noncarcinogens they tested, there was a correlation (90 percent) between carcinogens and mutagenicity and few noncarcinogens showed any degree of mutagenicity.

As a result, Ames concluded at the FASEB meeting that ". . . almost all chemical carcinogens cause cancer by mutation. A mutation damaging a normal regulatory mechanism in a cell can result in uncontrolled growth in that cell and in its descendants, thus giving rise to a tumor." Ames and co-worker Joyce McCann reiterate their conclusion in the March issue of the PROCEEDINGS and discuss its implications.

Not all scientists are convinced that mutations are the means by which carcinogens alter gene expression and turn a cell into a cancer cell, though. In Lieberman's view, for example, "A mutation may be one mechanism whereby you get an alteration in gene expression, but I don't think it is the only one." Still other researchers contend that carcinogens may turn cells into cancer cells not only through gene expression but through altering other aspects of the cell, since carcinogens are known to change not only the cell's genetic machinery (chromosomes and DNA), but its proteins, RNA, membrane molecules and small molecules, not to mention the surface of the cell and the immune system in the whole organism. Another possibility is that carcinogens trigger cancer through one of these routes exclusively. □

Chinese meteorite yields record chunk

A 3,894-pound meteorite, believed to be the heaviest observed fall on record, struck the earth in Kirin Province of northeastern China on March 8, according to the official Chinese news agency Hsinhua. (Much heavier stones have been recovered from unobserved falls.) The object was one of more than 100 fragments of a much larger meteorite that exploded overhead near Kirin City, scattering rocky chunks over nearly 200 square miles. Analysis of the chunks reportedly showed silicon, magnesium, iron, sulfur, calcium, nickel and aluminum. □

Wide World

Meteorite crater, two yards wide, six deep, is one of many from Chinese fall.

Quake prediction: Tale of two cities

On Feb. 4, 1975, a cataclysmic earthquake struck the town of Haicheng in Liaoning Province of northeastern China. It reached 7.3 on the Richter scale, damaged or destroyed about half the houses near the quake's epicenter (90 percent in some areas) and caused the death of an estimated 200 to 300 people. Because the quake was predicted in advance, however, "tens of thousands of lives were probably saved," says geophysicist Frank Press of Massachusetts Institute of Technology, strong evidence that "the Haicheng shock may well be the most significant earthquake in history." Last week another severe tremor—magnitude 5.5 to 6.5—was predicted for southern California's San Fernando Valley region some time in the next year, and whether or not that specific event occurs, there is concern that the United States may not be as prepared as it could be to meet seismic disaster.

The possibility of an impending California quake was announced by James H. Whitcomb of Calfornia Institute of Technology, based on seismic velocity changes along the San Andreas fault system east of Los Angeles. Geophysicists have also recently discovered evidence of a rise of as much as 25 centimeters in the elevation of thousands of square kilometers of land in the fault region, much of which may have taken place between 10 and 20 years ago. Whitcomb, who correctly anticipated an early 1974 quake around Riverside, Calif. (though it was a magnitude smaller than his estimate), thinks of his current projection not as a prediction but as "a test of an as yet unproven theory." To that end, he feels that scientists making quake projections should do so in writing, to help evaluate the various prediction techniques now being studied.

Equally important, if not more so, is the issue of what to do with such predictions once they have been made. The first proposed federal guidelines for evaluating predictions and responding to them were tentatively offered less than six months ago by Vincent E. McKelvey, director of the U.S. Geological Survey (SN: 11/15/75, p. 308). Instrumentation around the San Andreas fault region is insufficient for proper monitoring of the most seismically touchy area of the country, some geologists feel, and funds recently sought for the purpose were reportedly made available only at the expense of diverting them from other programs. Thus, the Chinese experience becomes particularly important, not only as information but, in the view of a number of researchers, as an indication to federal and California officials that preparedness is both possible and worthwhile.

In 1970, says Press, who gleaned details from the report of Chinese scientists at a UNESCO conference in Paris two months ago, Liaoning Province was declared to be "an important region for earthquake monitoring," based on its seismic history and high population and industrial densities. Professional seismological teams were organized to collect data and specifically charged with the task of making predictions. Fault activity, migration of strong quakes into the region, an increasing frequency of small quakes and a gradually growing rate of crustal deformation led to a preliminary estimate that the southern part of the province was due for a major tremor. Observations were strengthened from both fixed and mobile stations, and from July 1973 to June 1974, thousands of "amateur seismologists" were alerted to participation. Anomalous magnetic-field variations were detected, as was a rise in sea level at Liaotung Bay, and 1974 saw an increase in the seismic activity of the entire province.

In June of 1974, the Chinese Council of State, now guided by an interim prediction of a possible quake within one or two years, not only added further to the monitoring program but also initiated a major civil preparedness program. The provincial government took over control of the monitoring effort, and authorities