Most Distant Galaxies: Surprisingly Mature

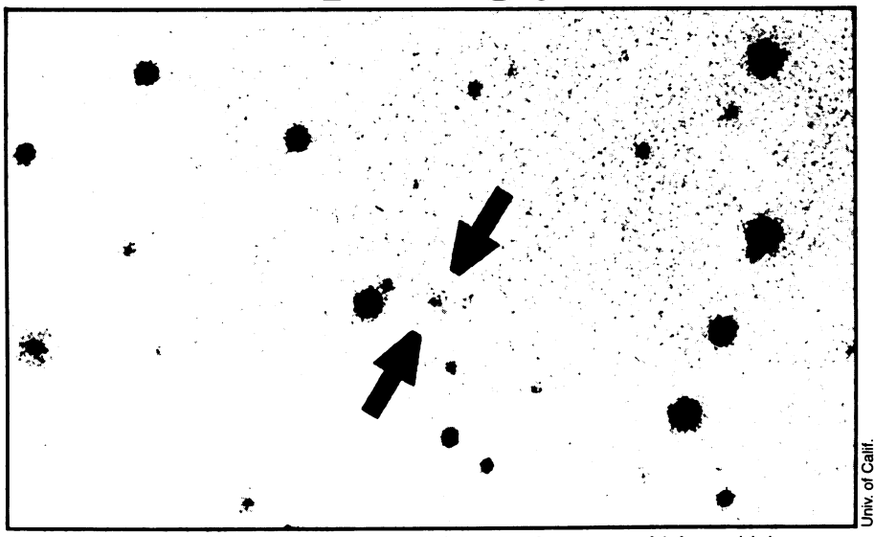
If the universe is in fact 18 billion years old — and that is the figure most often quoted these days — galaxies that are 10 billion light-years away are more than halfway back to the point of origin of the cosmos. Four such galaxies have been found by Hyron Spinrad and John Stauffer of the University of California at Berkeley and Harvey Butcher of Kitt Peak National Observatory. Two are described in a paper published in the March 1 ASTROPHYSICAL JOURNAL. Two more have been found since the paper was drawn up.

The two in the paper are optical galaxies associated with radio sources, and they are designated by their numbers in the Third Cambridge Catalog of radio sources, 3C 13 and 3C 427.1. The observations were done mainly with the Lick Observatory's largest telescope and the detecting instrument known as the Wampler scanner (after its developer, Joseph Wampler of Lick), which is able to build up spectral information from the light of these very faint objects. From the spectral information redshifts for the light of these objects could be calculated as 1.050 for 3C 13 and 1.175 for 3C 427.1. These are announced as the highest redshifts ever found for galaxies.

There are quasars with higher redshifts, up to and above 3, so these galaxies may not be the most distant astronomical objects known, but they are more reliable than quasars for the study of primordial astrophysics and cosmology. Redshift is a stretching of waves so that light is shifted toward longer wavelengths (redder color) than those at which it is normally emitted. Redshift may be due to relative motion between the light source and the observer. It may be due to a strong gravitational field in the source. Or it may be from some exotic cause, nobody knows quite what.

Galaxies near us have been so thoroughly studied that astronomers are confident that they have no gravitational fields capable of producing significant redshifts and none of the redshift exotica proposed for quasars. Galaxy redshifts can be referred completely to recession velocity (the expansion of the universe) and the distances of the galaxies can be calculated by using the Hubble constant. A Hubble constant value of 50 (which seems to be most widely used these days, though it is not uncontroverted) gives 10 billion light-years for these galaxies. The Hubble relation may not apply so simply to quasars. More important, the physical processes in quasars are not so well known nor so well agreed on that they can easily be used to make comparisons between the astrophysics of now and the astrophysics of the distant past.

Assuming the figure of 10 billion light-years is correct, these two — and now four — galaxies are being seen as they were 10 billion years ago, at a time when they could not have been more than 8 billion years old and were probably 6 billion, maybe younger. Similar elliptical galaxies observed near us are being seen as they were at about age 16 billion years. Comparison of the two groups yields the surprise that the far distant galaxies look more modern and mature than they were expected to. Their light appears not much bluer than that of the nearer galaxies. This indicates that star formation began and ran its course in the distant galaxies quite early, earlier than many theorists would have expected. If star formation was early, formation of the galaxy itself, which necessarily preceded star formation, had to be early too. This evidence indicates that both processes took place within two billion years of the moment of origin. □



Univ. of Calif.

A galaxy 10 billion years away appears as a faint smudge even at high sensitivity.

Interferon medley: Yeast, genes, hybrids

One act has grabbed the center ring in the frenzied circus of genetic engineering now playing campus and industry laboratories around the world. The star is interferon — the natural protein thought to boost the human immune system and expected to aid in the fight against viruses and cancers. Shortage of interferon from traditional sources created a demand for its production by biotechnology, and last year the gene for a human interferon was transplanted into bacteria (SN: 1/26/80, p. 52). Now scientists announce the successful splicing of an interferon gene into yeast — the first time that yeast has been engineered to produce a human protein.

Although the genetically engineered yeast and bacteria now make similar amounts of interferon — 200,000 molecules per cell — in the long run, yeast are expected to have advantages, David Goeddel of Genentech, Inc. explained in San Francisco at the First Annual Congress for Recombinant DNA Research. Genentech scientists and Gustav Ammerer and Ben Hall of the University of Washington obtained the high yield from yeast in very preliminary work, whereas the bacterial yield was reached only after a year of intensive development. In addition, techniques for growing yeast for commercial use already have been worked out in bread, beer and wine production. While the scientists expect to do even better using yeast, the current bacterial yield, which translates to 100 million to 200 million units of interferon per liter of culture, is as high as that provided by white blood cells in more traditional interferon preparation.

The interferon gene was transferred into yeast by joining it to a segment of yeast DNA that normally turns on the gene for a yeast enzyme. That composite then was inserted into a plasmid of both yeast and bacterial DNA, and the interferon produced demonstrated the expected pattern of antiviral activity.

While transfer of the interferon gene into yeast has obvious commercial applications, that achievement must share the spotlight with other exciting research results. One striking finding is the size of the interferon gene families. Scientists have characterized three types of human interferon, but the one produced by white

blood cells (leukocytes) when they are exposed to a virus is represented by genes in more than ten locations on human chromosomes. At least three of those genes are lined up together along one chromosome. The Genentech researchers have already transferred each of five interferon genes into bacteria and observed production of slightly different interferons. One other gene appears to be a "pseudogene" unable to code for a protein. In contrast, the scientists find only one gene (and perhaps a quite poorly related second gene) for the type of interferon made by fibroblasts, another class of human cells.

An impressive balancing act of the components of interferon molecules was reported by both Goeddel and Charles Weissmann, a University of Geneva biologist who is associated with the company Biogen. They have created new genes by combining portions of different human leukocyte interferon genes. For instance, by combining one end of an interferon more effective in bovine cells than in human cells with the other end from an interferon with the opposite specificity, the scientists created an interferon more active in mouse cells than either of the parent molecules. Goeddel reported preliminary evidence indicating that interferons also may be more active in some types of human cells than in others.

Learning how interferon production is controlled naturally in human cells is now a step nearer, according to Weissmann. In recent experiments he transferred an interferon gene and its surrounding DNA into mouse cells and found that the transplanted gene, like a naturally controlled interferon gene, was not expressed until the monkey cells were exposed to a virus. "Perhaps this is true induction of transformed cells," Weissmann says. □

Pirated genes key to viral cancer

The startling discovery that normal cells contain genes resembling those of cancer-causing viruses has been turned around. Now the viral genes are considered stolen versions of normal cellular genes, and scientists are beginning to see the cancer virus as a tool to learn about both cancer and the regulation of normal development. J. Michael Bishop told the meeting in San Francisco of the First Annual Congress for Recombinant DNA Research that certain viruses "may have excerpted vital regulatory elements from the vast pool of cellular genes; if so, these elements are readily accessible for study."

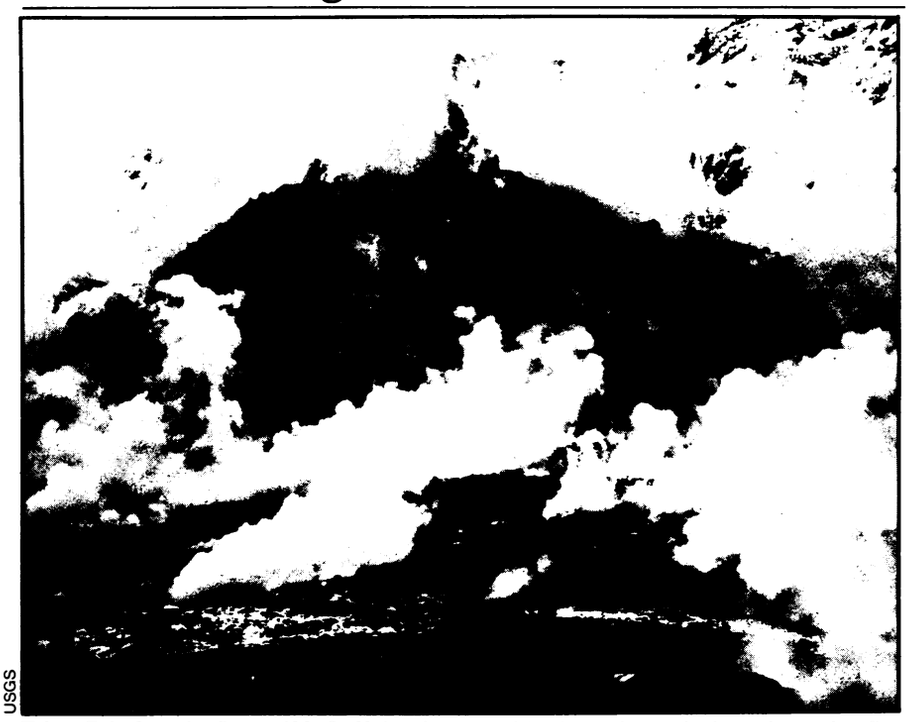
In each of about 15 animal viruses called retroviruses scientists have identified a single gene responsible for the virus's ability to transform a specific type of animal cell into a cancer cell. Although the genes that initiate cancer are different in these retroviruses, each has a corresponding normal vertebrate gene. In fact, in some experiments the normal cellular gene has been attached to a viral regulatory region and used to turn a normal cell into a tumor. The cellular genes that correspond to retrovirus genes appear to have a crucial function because they are highly conserved throughout the range of vertebrates. For example, viral genes that seem to have originated in chicken cells have homologues in creatures ranging from fish to humans.

A remarkable number of those genes responsible for cell transformation code for enzymes that attach phosphate groups to the amino acid tyrosine, Bishop says. The avian sarcoma virus was the first to be so identified (SN: 5/26/79, p. 345). Scientists have suggested that the gene inserted by the virus is overly enthusiastic, and an overabundance of the natural enzyme causes the cancer (SN: 8/4/79, p. 89).

Bishop now suggests that it is the timing of the activity, rather than simply the amount, that distinguishes cancerous from normal cells. At some points in an organism's development the natural cellular gene may be as active as the cancer-causing viral gene. The difference appears to be that the viral gene can't be turned off. Like developmental signals, the retroviruses are specific — each acts only on a limited set of cells. Bishop suggests each viral cancer gene aborts the developmental program of at least one line of normal cells. "We are pretty delighted to have our hands on one mechanism by which a neoplastic [cancerous] condition can be invoked," he says.

From the accumulated data Bishop speculates that the cellular genes identical to the genes that cause animal cancer via retroviruses are the same as the human "cancer genes," identified in pedigrees afflicted with high cancer risk, and also the same as the genes whose spontaneous or chemically induced mutation in body cells leads to cancer. Bishop, however, is skeptical that the recent results will have direct clinical applications. It will be difficult to meddle with a cancer gene that is also a normal gene essential for development. □

Mt. St. Helens grows a dome



USGS

Taken Feb. 6 on the floor of Mt. St. Helens's crater, this photo shows the lava dome that first developed in late December 1980. Between Dec. 27 and Jan. 4, scientists recorded an increased number of small earthquakes, accompanied by the oozing of molten rock through the small lava dome already in place. By mid-January, the dome was 300 feet high and 800 feet wide. Another flurry of small earthquakes occurred beneath the mountain Feb. 4 and 5, prompting scientists to issue an eruption alert. Plumes of steam rose about two miles above the volcano as more molten rock swelled the dome to about 500 feet high and 1,200 feet long by mid-February. Scientists monitoring the volcano, such as those in the lower center of the photo, have found little change in the shape of the volcano, but have detected a decline in the emission rates of carbon dioxide and sulfur dioxide since January. Based on the recent activity, scientists say the potential for explosive eruptions still exists, although the lack of precipitation and higher-than-normal temperatures in January have temporarily lessened the flood hazard from the sediment- and debris-laden rivers around the volcano.