Quasars: New evidence for cosmological distances

Quasars or quasistellar objects are a decade-old astronomical mystery. They are objects that look as if they have dimensions comparable to stars and yet radiate energy in both radio and visible light that outdoes most galaxies.

Quasars also appear to be the most distant known objects in the universe. Their light reaches earth very strongly shifted to the red end of the spectrum. This red shift is the standard way astronomers measure velocity of recession and, therefore, of the distance of galaxies: the greater the red shift the greater the distance.

If the quasar red shifts are accepted as a representation of distance, quasars are the most distant objects known. They, therefore, are also some of the oldest and can give important information about the history of the universe. But there is a counterargument: A strong gravitational field can cause a red shift in light emitted from the midst of it. The apparent dimensions and energy output of quasars give grounds for believing that they are very dense and massive and have strong gravitational fields. This would mean that a large part of a quasar's red shift might be due to gravity and that quasars may therefore be much nearer than they seem to be.

This week new evidence for placing quasars at cosmological distances—as opposed to more nearby areas of the universe—is presented in the March 15 ASTROPHYSICAL JOURNAL by Dr. James E. Gunn of California Institute of Technology. On pictures taken with the 200-inch Hale telescope of the Palomar Observatory, he finds that the quasar Parkes 2251 + 11 in the constellation Pegasus appears to be associated with a cluster of galaxies. The red shift of the quasar and that of the brightest galaxy in the cluster are the same.

The chances that this is a coincidence are very small, in his opinion. He believes that the quasar is associated with the cluster and is, therefore, at generally the same distance, about 3 billion light years. Since galaxies are not dense enough to have noticeable gravitational red shift, this would mean that quasar red shifts are also reliable measures of distance and would place the known quasars at distances ranging from 1 billion to 10 billion light years.

The finding is also indirect evidence for big-bang theories of cosmology. If the red shifts do measure distance, then there are many more distant and, therefore, old quasars than nearby ones. If more quasars were made in the early history of the universe than later, that fact argues for a changing or evolutionary universe as proposed by big-bang theories and against an unchanging or steady-state universe as proposed by objectors to the big bang.

Dr. Halton C. Arp of the Mt. Wilson and Palomar Observatories disagrees. He said this week that he cannot see that this quasar belongs to a cluster. Furthermore he said the known quasars tend not to be associated with known rich clusters of galaxies. He believes quasars are much nearer the earth, and if they associate with clusters, the clusters are too near to be seen as clusters in the sky.

Dr. Gunn replies that part of the argument is over the definition of a cluster. His is not a rich cluster, but a sparse one of 20 or 30 members. He maintains that even if only the one galaxy has a red shift equivalent to the quasar's, the fact that they are so near each other in projection on the sky would still be highly significant. Furthermore there seems to be a physical connection between the quasar and the galaxy. In addition to starlight the galaxy shows radiation from hot interstellar gas. If the quasar is really near the galaxy, its radiation could be exciting the gas, and Dr. Gunn says a rough calculation shows the amount of heat is about right. □

Toward correction of genetic defects

In 1965 Dr. Henry Harris at the University of Oxford reported that he had successfully overcome the natural antibody mechanism of cells and fused together the cells of mice and men (SN: 3/20/65, p. 182). In 1966 he reported further success in the production of hybrid cells (SN: 4/16/66, p. 259). Over the years this type of genetic manipulation has been responsible for great hopes and great fears in many people. Geneticists envisioned a future for gene manipulation that would enable them to correct for cell deficiencies and mutations. Some members of the general public, on the other hand, foresaw a future in which gene manipulation would be a tool in the hands of ruthless men who could control the world by creating superspecies and subspecies of men.

It will be many years before these fears, expressed in Aldous Huxley's "Brave New World," have any foundation. But Dr. Harris and his Oxford colleagues, Drs. A. G. Schwartz and P. R. Cook, report in the March 3 NATURE that they have taken what seems to be an important step in the field of genetic control.

They have discovered that it is possible to transfer genetic information from one type of cell to another type of defective cell, thereby correcting for a genetic deficiency in that cell. Using a certain type of mouse cell, deficient in the enzyme inosinic acid pyrophosphorylase (IAP), and the red blood cells of embryonic chicks, they have produced a hybrid mouse cell which has the power to synthesize the previously absent IAP.

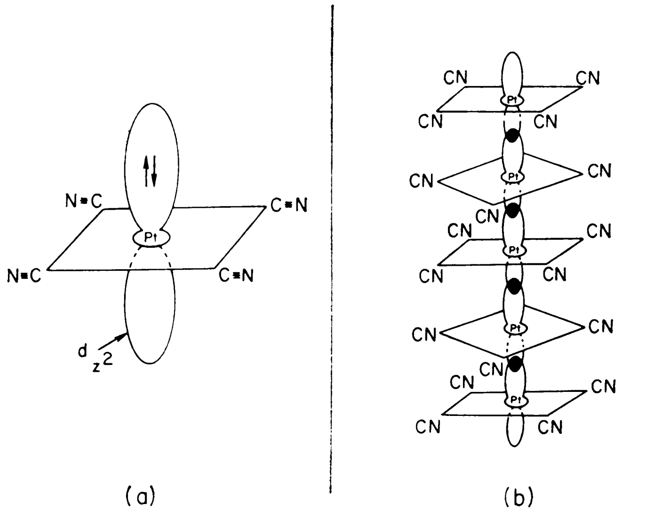
The erythrocite, or red blood cell, of chicks has a nucleus in which the genetic functions are switched off. By fusing this cell with the mouse cell, a new, or hybrid, cell is formed which contains the nuclei of both cells. When this multinuclei cell reproduces, only the original mouse nucleus survives. The chick nucleus breaks up in a process described as "chromosome pulverization." The daughter cells, those resulting from the reproduction of the original multinuclei hybrid, have only one nucleus, like the original mouse cell, but they have been exposed to the genetic contents of the pulverized chick nucleus and have been able to absorb bits of it. With this new information they are now able to synthesize the IAP and are, in effect, whole cells directly descended from defective cells.

Previous experiments along these lines have not been successful because the introduction of a foreign body into a cell triggers a specific and highly complicated defense mechanism which causes rejection of the foreign body. Use of the chromosome pulverization method apparently enables the cell to pick up such extremely small amounts of the needed genetic material that the defense mechanism is not put into action. Overcoming this antigen-specifying mechanism is the experiment's outstanding engineering achievement.

The experiments were conducted in specific tissue cultures that enabled the researchers to study the growth and reproduction of the cells and to monitor the presence of chick genetic material. The next step will be to find out if the same genetic transfer is possible in cells other than chick and mouse. If so, the correction of genetic defects in humans may actually be possible in the future. "Approaches to this problem are, however," Dr. Harris and his colleagues report, "hampered by a number of difficulties." If and when these problems are overcome it would be possible to take defective cells from a patient, treat them and then resupply the patient with his own corrected cells. □

SUPERCONDUCTIVITY

New heat in a chilly argument



Structure of the one-dimensional conductor, potassium tetracyano platinate: In the center of each plane is a platinum atom.

Johns Hopkins

Finding a substance that would be an electrical superconductor at room temperature is a dream that has haunted students of the solid state since superconductivity was discovered 60 years ago. Superconductivity is the ability to pass electric currents without resistance. It appears in a number of metals at temperatures near absolute zero, but in none so far known does the property persist at temperatures above 21 degrees K.

If superconductivity could be found at room temperature, many power-saving technological innovations might follow.

The most widely accepted theory of superconductivity sees no bar in principle to high-temperature superconductors. All that is needed is a molecule of the proper structure, and several investigators, most notably Dr. W. A. Little of Stanford University, have been trying to make one (SN: 2/15/69, p. 169).

Other experts in the field deride the idea. Most outspoken of these is Dr. Bernd T. Matthias of the University of California at San Diego, who has repeatedly said that searches for high-temperature superconductors are futile and that the theory on which they are based is erroneous.

Proponents of high-temperature superconductivity now have a new datum that adds to their hope of winning the argument. It is the discovery, by Dr. Jerome H. Perlstein and Michael J. Minot of Johns Hopkins University, that the compound potassium tetracyano platinate with bromine added is a one-dimensional electric conductor, a basic ingredient in Dr. Little's prescription for building a high-temperature superconductor.

Most ordinary electrical conductors are three-dimensional: conduction electrons will move through them in any direction. But in potassium tetracyano platinate currents can propagate only along the chains formed by the platinum atoms. The platinum chains are surrounded by carbon-nitrogen groups in such a way that they are insulated from each other, and currents cannot propagate in oblique directions.

The average conductivity that Minot and Dr. Perlstein find for potassium tetracyano platinate is 5×10^{-7} mho per centimeter. This is about 1,000 to 10,000 times smaller than the conductivity of common electrical materials like copper or silver, but it is still a respectable conductivity and the first time, says Dr. Perlstein, that a reasonably high one has been found in a substance with one-dimensional properties.

Chains like the platinum ones in potassium tetracyano platinate could form the spine for a superconducting macromolecule based on Dr. Little's prescription, says Dr. Perlstein. When one has such a spine, the next step is to surround it with groups of atoms that can be electrically polarized, and if these can be properly put onto the spine, superconductivity should result.

The essence of superconductivity is that the conduction electrons bind themselves together in pairs. Pairs are able to proceed without feeling the resistance that single electrons feel. But electrons naturally repel each other, so some intermediary is necessary to bind them together.

In low-temperature superconductors, theorists reason, the chilling permits vibrations of the lattice of the metal crystal, called phonons, to perform the intermediary function, altering the balance of forces between electrons so that a net attraction exists. In the high-temperature case, the polarized atom groups surrounding the spine would do the job: An ordinary current of single electrons running along the spine would polarize the surrounding groups. The polarization would attract electrons and bind them to each other, and the current would become a resistanceless supercurrent.

The carbon-nitrogen groups of potassium tetracyano platinate are not properly polarizable, and the substance is an ordinary conductor, not a superconductor. But, says Dr. Perlstein, "The initial barrier that had to be overcome was making [an electrically] one-dimensional molecule." Now that this has been done, experiments can go to attempts to replace the carbon-nitrogen groups with others more likely to produce superconductivity.

The way to go is not very well mapped. "The theoretical stuff on this is pretty much in the dark," says Dr. Perlstein. Experimenters don't know exactly what kind of polarization of side groups will do the trick. Dr. Perlstein and Minot are going to try some sulfur ligands that look promising. If these don't work they will go on to something else. □