

ASTROPHYSICS

'Big Bang' Theory Upheld

So-called quasi-stellar blue galaxies may represent the next evolutionary step after quasars and thus confirm the 'big bang' theory of the origin of the universe.

► DISCOVERY of a new class of quasars, the brightest but the most puzzling objects in the cosmos, suggests the universe began with a "big bang." It also opens the way to determining in the near future the actual structure of the universe.

The detection of the new kind of quasars, combined with the study of normal quasars, suggests that the universe is a closed system, that the expanding universe is slowing down and that it probably pulsates once every 82 billion years.

Some of the clues to this model come from analyzing the light of objects tentatively named "quasi-stellar blue galaxies." They are 500 times more numerous than the so-called quasars, a contraction for quasi-stellar radio sources.

The new objects are related to quasars but do not send out radio energy. Many of the blue stars believed to lie in the outer regions of the Milky Way galaxy in which the sun and its planets are located are now suspected of being quasi-stellar blue galaxies—very distant, super-bright clusters of stars.

These objects may represent the next evolutionary step after quasars, and they also may be galaxies in the process of being born.

"The major significance of the discovery is that astronomers now have a power-

ful new tool to probe enormous distances into the cosmos to test the 'big bang' versus the steady-state model of the universe," Dr. Allan Sandage, astronomer of Mount Wilson and Palomar Observatories, said.

Details of the discovery are reported in the *Astrophysical Journal*.

The "big bang" theory holds that some 12 or more billion years ago all matter in the universe was in one place and was spewed outward in every direction by a gigantic explosion. The matter, now condensed into planets, stars and galaxies, continues to expand along the same paths.

According to the steady-state theory, matter is continually being formed and the universe has no beginning and no ending.

"The quasi-stellar galaxies are so numerous and reach so far into space," Dr. Sandage said, "that we should be able to determine the effects of space curvature and the slowing down of the expansion of the universe within the next few years." There are probably more than 100,000 of these blue objects down to the 19th magnitude, which is more than six million times more faint than can be seen by the naked eye.

The clues to a true model of the universe are emerging from the studies by Dr. Maarten Schmidt and Dr. Sandage using the 200-inch telescope atop Mt. Palo-

mar, operated jointly by California Institute of Technology and Carnegie Institution of Washington. Dr. Schmidt is also a Mt. Wilson and Palomar astronomer.

The existing evidence is based on the red shifts and light measurements of only nine quasars and the light measurements of three quasi-stellar blue galaxies.

"With these sources," Dr. Sandage said, "we already are looking out to slightly less than half-way to the observable horizon on the model of the universe that is emerging from the data."

Drs. Sandage and Schmidt obtained spectral red shifts for three of the quasi-stellar blue galaxies. The red shift for one, named BSO No. 1, for blue stellar objects, indicates a recession rate of 125,000 miles per second. This makes it the second most distant object known, the farthest being the quasar called 3C-9, which has a recession rate of 149,000 miles a second.

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GEOPHYSICS

Radio Waves From Sky Object, 3C-273, Variable

► THE RADIO WAVES sent out by what may be one of the most distant known objects in the universe increased 40% in strength during the last three years.

This is the first variation in radio waves from sources outside the Milky Way galaxy reported by U.S. scientists in which the sun and its planets, including earth, are located.

The Russians reported in April that they had found a repeating change in radio signals from another object, known as CTA-102. This was the basis for the claimed discovery of a "super civilization" in the far reaches of the universe.

The radio waves emitted by the object believed one of the farthest from earth in the cosmos, called 3C-273, so far do not show any regular pattern. However, the signal strength has increased 40% within 1,000 days. More observations will be needed to show whether this increase will continue or decline. A decrease would mean the radio waves vary rhythmically.

Both 3C-273 and CTA-102 are known as quasars.

Besides the increase of 40% in the radio waves from 3C-273, a variation in energy output of 20% has been found in the radio radiation from two other objects, 3C-279 and 3C-345. The discoveries were made by Dr. William A. Dent of the Radio Astronomy Observatory, University of Michigan, Ann Arbor, with financial support from the Office of Naval Research.

Details on the variations in radio signals from the three quasars are reported in *Science*, 148:1458, 1965.

The discovery means either than 3C-273 is not at the edge of space—or some one and a half billion light years away, one light year being six million million miles—or that quasars do not give out energy at the rate astronomers now think likely, in which case they would be in the galactic neighborhood of the Milky Way.

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Boeing

LUNAR "HOT SPOTS"—Gil Bruce of Boeing Scientific Research Laboratories points to the impact area of the Ranger 8 spacecraft in the Sea of Tranquility on this thermal contour map showing plateaus and peaks of heat rising from the surface of the eclipsed moon. The floor of the map represents a temperature of minus 144 degrees Fahrenheit, the moon's surface temperature during eclipse.