

Evidence for internal structure in quasars

Quasars or quasistellar objects are believed by many astronomers to be the most distant celestial bodies now under study. They are definitely among the most energetic of astronomical entities. Their energy outputs outdo most galaxies, yet in the sky they look like stars.

Since the quasars appear to be very distant, on the edge of the observable universe, they should necessarily also be the oldest objects in view. Astronomers studying them are looking not only outward in space but backward in time. Information about quasars could help answer questions about the history of the universe and its shape and size.

One way of attacking the quasar mystery is to see if something can be learned about the size, shape and internal structure of quasars. But for even the largest single telescopes quasars look like bright points; no internal detail can be distinguished. (The fineness of the detail that any telescope can distinguish depends on its aperture, the size of its collecting area for light or radio waves.) In the last few years astronomers have had a technique called very long baseline interferometry (VLBI) by which two telescopes far apart can be used to simulate one telescope larger than any that could be built, and according to a report in the April 2 SCIENCE, VLBI has yielded the first evidence for internal structure in quasars.

The work was done by Drs. Curtis A. Knight, Douglas S. Robertson, Alan E. E. Rogers, Irwin I. Shapiro, and Alan R. Whitney of Massachusetts Institute of Technology; Thomas A. Clark of the Goddard Space Flight Center; Richard M. Goldstein of the

Jet Propulsion Laboratory and Gerard E. Marandino and Nancy R. Vandenberg of the University of Maryland. They used the Haystack Radio Telescope at Tyngsboro, Mass., and the Jet Propulsion Laboratory's Goldstone antenna in the Mojave Desert of California.

VLBI works by combining signals taken simultaneously at the two antennas. Because of the separation of the receivers, there is a phase difference between the two signals, that is, the crest of any given wave arrives at different times in the different places. The two signals are recorded and later combined electronically. The phase difference produces a so-called beat signal, and this can resolve detail in the source that only a very large single aperture could see. In some cases the aperture thus simulated is as large as the distance between the telescopes. VLBI could not be done many years ago because clocks were not precise enough to synchronize the signals.

The distance from Goldstone to Haystack is about 3,900 kilometers, and the combination saw details in the quasar 3C 279 as small as 1.5 milli-seconds of arc apart.

The simplest interpretation of the Goldstone-Haystack data is that 3C 279 consists of two point sources, each of which contributes an equal amount of energy to the combined signal. If the distance to the quasar suggested by other evidence, 3 billion light-years, is correct, by triangulation the two points would be about 20 light-years apart. If there really are two points, the suggestion can be made that they may have originated at some time in an explosion at a point halfway between them and be flying away from each

other. Some color is lent to this by the finding that the apparent separation increased by about 10 percent in four months.

The data are equally consistent with other interpretations. There could be two extended objects. There could be flares emanating from a larger hot body. There could be a clump of electrons revolving around a central body.

Dr. Goldstein cautions against jumping to premature conclusions. The data are ambiguous, he says. Reports of further observation may bring more certainty. What the group wanted to do in this report, he says, was to show that structure exists in the quasar. The observations also give evidence for structure in the quasar 3C 273, but this case is more difficult to interpret.

The ambiguity comes about because VLBI is a one-dimensional view. The data refer only to a single line, the projection, on the object in view, of the baseline between the telescopes. Thus a ring would look like two points, the points where it intersected the line. The change in the apparent separation could be brought about by rotation bringing different parts of an irregularly shaped object across the baseline.

To get a two-dimensional picture of the quasar requires observation with different sets of telescopes having different baselines. Dr. Goldstein does not yet know of any other VLBI observations of 3C 279 or 3C 273, but he says, "I'd be surprised if a lot of guys don't try to verify this. I'm quite anxious to see what the data are going to look like when they start coming in from all points." □

Soviet support for ban on germ warfare

In his first year in office, President Nixon announced termination of United States projects for developing offensive use of germ warfare, and last year at the urging of a number of scientists (SN: 2/21/70, p. 194) he added toxins to the ban.

Last week, the Soviet representative at Geneva disarmament talks unexpectedly announced that the Soviet Union would support a treaty to ban germ warfare. This brings the world's two major nations into agreement on the issue and augurs an early international ban.

Previous to the Soviet announce-

ment, progress in arriving at a germ and chemical warfare ban had been deadlocked by the Soviet insistence on considering the two together and United States insistence they must be considered separately because of differing problems.

The matter of banning chemical agents is far more difficult than the germ warfare ban, mainly because the United States is using some of them in Vietnam. Last Aug. 19 President Nixon submitted the old 1925 Geneva Protocol against poison gas to the Senate for ratification. But the Senate Foreign Relations Committee in execu-

tive session recently tabled the treaty.

The problem is disagreement between committee members and the Administration over whether herbicides and the theoretically nonlethal CS gases should be included, and to what extent. Although the herbicides are being phased out in Vietnam, Secretary of State William P. Rogers told the committee the Administration wishes a new review of the use of the "riot control agents" so that there can be an examination of the "implications and consequences for the United States policy of their future use in war." □

April 10, 1971

245