Quasar blobs, swift not superluminal

Ever since Einstein published his theory of special relativity it has been a commonplace of physics that no material object can go faster than light. This cosmic speed limit places constraints on the design of practical devices such as particle accelerators, and it has shaped the mathematics in which particle physics, gravitation and cosmology are described — one might even say confined. Any violation of this cosmic speed limit would open all those structures to new design considerations.

When radio astronomers studying quasars seemed to find evidence of objects moving faster than light, the report caused a sensation. A number of scientists rushed in with suggestions, models and theories that sought to explain away the appearance as an illusion. The ingenious (and for that reason suspect) complexity of the models and the simple persistence of the superluminal appearance kept the discussion simmering. Now a study of some of these quasars using a technique designed to extract more information about their structure than previous ones is published in the July 15 ASTROPHYSICAL JOURNAL by A. C. S. Readhead, T. J. Pearson, M. H. Cohen, M. S. Ewing and A. T. Moffet of the Owens Valley Radio Observatory of California Institute of Technology. The results are interpreted by Cohen, Pearson, Readhead, G. A. Seielstad, R. S. Simon and R. C. Walker, all of the same observatory. The explanation is simple and does not involve superluminous velocities. It would be interesting if the discussion ends there.

The present study, like the ones that started the ruckus, involves very long baseline interferometry (VLBI). VLBI takes signals received simultaneously at several widely spaced radiotelescopes (sometimes they can be a continent apart) and adds them together. Typically the signals from different telescopes will be out of phase with each other; they will reinforce each other in some places and cancel each other out in others. The reinforcements and cancellations produce a pattern of light and dark "fringes," and an analysis of these fringes yields information about the structure of the object that is too fine to be resolved by the observations of a single telescope. In this kind of view a few quasars appeared to be made of several parts, some of which gave the impression that they were separating from each other at superluminal speeds.

The usual VLBI study yields a kind of one-dimensional trace of the structure of the object along a line corresponding to the baseline (or baselines) between the telescopes. One-dimensional information is fraught with ambiguities: A single object may appear more than once; an object may appear to be single at one time, double at another. The present study attempts to resolve some of the ambiguities by deriving some two-dimensional information. The usual one-dimensional modeling is based mainly on the amplitude of the fringes, the relative brightness and darkness. To this is now added some of the data on phase of the signals contained in the recordings, and from this a certain amount of information about the second dimension can be extracted. A computer process then draws what is called a "hybrid map." This is not a true map, because it is not based on a point by point two-dimensional sampling of the object (such as a photograph, for example), but it contains more information than the one-dimensional "models."

The observations by Readhead et al. concerned three famous superluminal quasars, 3C 120, 3C 273, and 3C 345. They were done with telescopes at Haystack, Mass., Green Bank, W. Va., Fort Davis, Tex., Big Pine, Calif., and Hat Creek, Calif. The explanation of the "superluminal" motion that emerges from the resulting hybrid maps is as follows:

A central object ejects several blobs, all going at speeds near that of light. The blobs are flying toward the observer, on a line that makes a small angle with the line of sight. After a time the blobs will sort themselves out by velocity with the fastest outermost. Thus, as the blobs continue to gain distance from their source, they also continue to separate from each other. For a given range of blob velocities, the observer on earth will see some of these separations growing at rates that exceed the velocity of light even though nothing physical is moving at superluminal speed. □

Enkephalins in a bind

As scientists continue to unravel the complexities of the brain, perhaps one realization emerges with more clarity than anything else: Things are going to get more confusing before they're fully understood. In recent years, the discovery of natural opiates called enkephalins and endorphins has revolutionized the field of brain research, particularly in relation to the pain, memory and chemical addiction systems. Researchers found specific sites in the brain that are sought out by opiates — both the natural enkephalin and externally administered morphine.

The experimental manipulation of these receptor "binding" sites has already led to some intriguing animal studies, as well as very limited experimental administration of enkephalins and their larger-moleculed companions, endorphins, to human psychiatric patients (SN: 11/11/78, p. 326). However, some scientists have also begun to observe subtle discrepancies between the binding action of enkephalin and morphine on certain animal tissue. This could mean, among other things, that enkephalin may not be the exact natural equivalent of morphine and that perhaps there exist separate receptor sites for morphine within the brain.

Until now, there has been little reported evidence of this. But researchers report in a recent JOURNAL OF BIOLOGICAL CHEMISTRY (Vol. 254, No. 8) they have distinguished a receptor system for morphine separate from that of enkephalin. "Direct evidence has been obtained for at least two distinct types of opiate binding sites in the brain," report Kwen-Jen Chang and Pedro Cuatrecasas of the Molecular Biology Department of The Wellcome Research Laboratories in North Carolina. "One of these binds enkephalins with higher affinity than narcotics, while the other binds narcotics with higher affinity."

In a series of complex chemical procedures, the researchers administered very low concentrations of radioactively labeled morphine and enkephalin to the brain tissue of rats. Some previous studies have not isolated separate morphine binding sites, they suggest, because concentrations of the experimental chemicals may have been too high, causing enkephalins and morphine to bind to both their own and each other's receptor sites.

Now that they believe they have established the existence of a separate morphine-binding system, Chang and Cuatrecasas have barely had time to consider its implications. "At present, it is not clear what these data mean," they say. "It is conceivable that the relative affinity of these two opiate receptor sites may play some role in the ability of a compound to cause physical dependence or addiction.... The data suggest that morphine receptors may play a role in analgesic effects, and enkephalin receptors mediate behavioral epileptic seizures." (Researchers have previously found that low doses of enkephalins caused seizures in some rats.)

The more searching question prompted by these results, however, is: If enkephalins are not the true natural equivalent of morphine, does one exist, and if so, what is it? "It is quite possible that other, yet to be discovered, opiate-like substances ... may exist," say Chang and Cuatrecasas. "These may serve as neurotransmitter or modulator substances for one of these two opiate receptors, especially for the morphine receptor sites.... Our data suggest that the endogenous substances which normally interact with morphine receptors may not yet be known."

Psychopharmacologist Larry Stein of Wyeth Laboratories says the door may now be opened for tracking down these undiscovered chemicals in the brain. "There are many opiods in the brain; we probably don't have them all," he says. "I would not be totally surprised if there are going to be a whole zoo of them." □