field, but, warns Daniel Dennett of Tufts University, it also carries the danger of training, which might also be misleading. "But the major problem with studying deception is that evidence for it will always be close to the level of chance, even when it is true," says Dennett. The reason is that, for deception to work, it must be extremely subtle and probably infrequent: the boy who cried wolf discovered that. "What we really need," says Humphrey, "is evidence of creative deception, a situation in which there was no possibility of past learning. That will be difficult to achieve."

Philosophers have long acknowledged that, with the advent of the capacity to communicate also came the ability to deceive. But, creative deception requires not only a certain level of intelligence, but also opportunity and motive. "Whether we will see tactical deception in nonhuman primates will depend to some extent on their social organization," explains Byrne. "Monogamous species, for instance, or groupings in which individuals must regularly help each other for maintenance, are not going to be conducive to deception. Nor are species in which groups are highly cohesive."

Chimpanzees are clearly intelligent, and their fluid social structure of group fission and fusion offers the required opportunity. However, neither the harem structure of gorillas nor the more solitary social system of orangutans is particularly fertile ground for social deception. According to Byrne and Whiten's survey, not much is seen. To be fair, however, the relevant data are few.

Monkeys, such as baboons, score in every category of apparent deception in the survey, but they are the most intensively studied of primates, which may bias the data. Bush babies and their like have not been reported to deceive each other.

If baboons were found to be intentionally deceptive, it would be something of a surpise, as they fail to score at all on certain tests of "self-consciousness." In fact, on such tests, only chimpanzees and orangutans appear to have a concept of self. And without a concept of self it is surely impossible to be able to read the mind of another individual.

Byrne and Whiten's survey was not meant to answer the question of how extensive self awareness is among primates, partly because, as they acknowledge, anecdotes by themselves probably always will remain insufficient evidence. Nevertheless, they plan to collect more cases by survey, and hope to reach some agreement on "some fundamental questions concerning the way behavioral scientists should approach phenomena that are so elusive yet critical to our understanding of the evolution of social cognition." ■ ROGER LEWIN

The Giant Arcs Are Gravitational Mirages

The arcs appear to be highly magnified and highly distorted images of far-distant galaxies; as such they could offer new insight into galactic evolution and a unique probe of cosmic dark matter

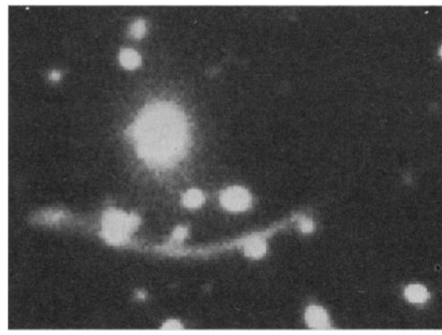
LAST January, when astronomers C. Roger Lynds of the Kitt Peak National Observatory and Vahe Petrosian of Stanford University announced that they had found giant luminous arcs lying in at least two massive clusters of galaxies—with each arc being far larger than any single galaxy—the phenomenon seemed as mysterious as it was bizarre. Now, however, the mystery appears to have been solved: Lynds and Petrosian believe they have proof that the clusters are acting as gravitational lenses, and that the arcs are far-distant galaxies whose images have been magnified and distorted beyond recognition.

"All the facts I know of support that explanation," says Lynds. "It's about as good as it can look."

The gravitational lens hypothesis has always been an attractive one, the researchers say, especially since each of the arcs is roughly centered on a huge elliptical galaxy that provides an obvious candidate for the lensing mass. On the other hand, it was also possible that the arcs were real physical structures embedded in the clusters themselves. One model, for example, assumed that the two giant ellipticals were moving very rapidly through their clusters in a direction perpendicular to our line of sight, and were therefore producing "bow shocks" in the clusters' tenuous intergalactic gas; the arcs were just the bow shocks as viewed from the side. Granted that no one had ever seen such a thing, no one could rule it out, either.

The resolution had to wait until September, when Lynds and Petrosian were finally able to obtain spectra of the arcs at the Mayall 4-meter telescope on Kitt Peak. Their results from the brighter arc, located in the cluster Abell 370, were particularly intriguing: the spectrum showed a single strong emission line. "We've spent most of our time since September trying to identify that line," says Lynds.

That effort quickly led Lynds and Petrosian to rule out a cluster origin for the arcs. After subtracting Abell 370's overall redshift of 37%, they did find that the emission line corresponded quite closely to the 4686-angstrom line of doubly ionized helium, an element that is second only to hydrogen in cosmic abundance. However, they also knew that the helium line almost never occurs in isolation. If the arc emission were really helium then its spectrum ought to include lines from ionized oxygen and neon, as well as from the hydrogen Balmer series. "We just don't see them," says Lynds. Furthermore, the helium line requires a very high excitation energy, which means that it only occurs under correspondingly rare physical conditions. It is typically found in the spectra of Wolf-Rayert stars, for example. These objects are massive, fiercely hot stars that have recently shed their outer layers of hydrogen and that are on the verge of going supernova. "But to expect to see a whole system of Wolf-Rayert stars is pretty preposterous," says Lynds.



National Optical Astronomy Observatories

Abell 370. *The arc is centered on a giant elliptical galaxy, presumably the lensing mass.*

In short, the helium identification was unworkable. The natural alternative was then the 3727-angstrom line of singly ionized oxygen, which is one of the standard signposts of spectroscopy. As Petrosian points out, "anytime an astronomer sees *one* strong emission line, he assumes that it's 3727."

With this identification the gravitational lens model became mandatory: the required redshift works out to 72%, which puts the source of the observed line almost twice as far away as Abell 370 itself. At the same time, however, everything else about the spectrum falls into place. For example, Lynds and Petrosian were able to identify three very faint absorption features lying just to one side of the emission peak. Given a redshift of 72%, these features correspond quite well to known lines of cyanogen molecules, ionized calcium, and iron. Given a redshift of 37%, however, they do not correspond to anything.

Meanwhile, the gravitational lens model also provides a natural explanation for the strikingly blue color of the arcs. (Their emissions peak in the blue and ultraviolet.) They have the color of hot young stars because they are the images of hot young stars—swarms of them residing in the far-distant lensed galaxies. Indeed, the model even explains why the width of the Abell 370 arc varies with wavelength. It is about 1 arc second wide in red light and about 3 arc seconds wide in the ultraviolet. "This is exactly what you would expect if you were imaging a disk galaxy in which the older, redder stars are concentrated in the central bulge," says Lynds, "while the newer, hotter stars are mostly out in the disk."

Finally, the gravitational lens model gives a good explanation for the shape of the arcs. "We've tried to model the process on a computer," says Petrosian. "If you assume a spherical mass distribution for the lensing object, and if the source is directly behind it, then you expect the image to be a perfect ring. Then if you displace the source to one side slightly, you find that the ring breaks up into two arcs." So the semicircular shape arises naturally.

Next, says Petrosian, consider a more realistic cluster that has a nonspherical mass distribution and several lensing masses orbiting close together. "Then you find that one of the arcs can shrink and get lost in the background," says Petrosian. "It seems to happen very naturally when you have two scattering centers." Indeed, he thinks it is significant that both Abell 370 and Cluster 2242–02 contain a pair of massive elliptical galaxies in close proximity, whereas most other clusters have only one such elliptical galaxy or none at all.

Strictly speaking, Lynds and Petrosian's results only apply to the arc in Abell 370. They are not yet ready to say anything conclusive about their spectra of the second arc, which is located in a cluster known as 2242–02; the object is fainter, it contains nothing as dramatic as the Abell 370 oxygen emission, and the researchers are still analyzing their data. Nonetheless, they feel confident that this arc, too, is a gravitational image.

If true, then one is left with some intriguing implications. First, since the arcs represent the first gravitational images of normal galaxies as opposed to quasars, and since the images are magnified and brightened by a factor of about 25, they offer a unique probe of star formation at early times. (At a redshift of 72% we are seeing the universe at 15% of its present age.) The source of the arc in Abell 370 seems to be a heftier than average spiral galaxy. "And yet from the strong ultraviolet signal," says Lynds, "you know that it has lots of stars that are very, very hot, which is consistent with the early stages of star formation."

Second, Lynds and Petrosian have found from their computer simulations that a cluster can only form the kind of images they see if it contains about ten times as much mass as accounted for in the visible stars. This discrepancy is presumably the famous "dark matter." It is also the kind of increase that is called for in currently fashionable cosmological models, which postulate a great deal of extra mass to make the universe geometrically flat.

And finally, the computer simulations suggest that clusters can produce highly fragmented images as well as arcs. "I wouldn't be surprised if we hadn't seen a lot of artifacts already and interpreted them as galaxies," says Lynds. "That means we have to start being more cautious about interpreting the odd little things we see in clusters." ■ M. MITCHELL WALDROP

Role of Alzheimer's Protein Is Tangled

Duplication of the gene for the amyloid β protein does not cause Alzheimer's disease, but a role for the protein has not been completely ruled out

Early this year hopes were high that the genetic defect that causes the hereditary form of Alzheimer's disease might soon be identified. The finger of suspicion pointed to the gene encoding a protein, called amyloid β, that is a prominent component of the plaques that are a pathological feature of the brains of Alzheimer's patients. The idea then was that duplicaton of the amyloid gene might result in an overproduction of the protein, thereby causing the neurological disease.

That possibility has now been ruled out, as results presented at the annual meeting of the Society for Neuroscience* and in recent issues of *Science* and *Nature* have made clear. Nevertheless, some intriguing observations about the expression of the amyloid gene have kept it in contention as a contributor to Alzheimer's development, if not as the primary cause.

The original reasons for thinking that amyloid gene duplication might be implicated in the etiology of Alzheimer's disease included its position on chromosome 21, very close to, and perhaps at, the site where James Gusella and Peter St George-Hyslop of Harvard's Massachusetts General Hospital and their colleagues had located the gene that causes the hereditary form of Alzheimer's disease. The observations were especially interesting in view of the connection between chromosome 21 and Down syndrome.

Down syndrome occurs in individuals who inherit an extra copy of the chromosome. People with the condition not only suffer mental retardation, but the brains of those who live into their thirties and forties,

Laboratory of Neuroscience, NIA

Plaques in an Alzheimer's brain. *Amyloid-containing plaques, stained dark in this view, occur in high numbers in deteriorating areas of Alzheimer's brains.*

*The 17th Annual Meeting of the Society for Neuroscience was held in New Orleans on 16 to 21 November.