Snarls from the Cosmic String in Leo

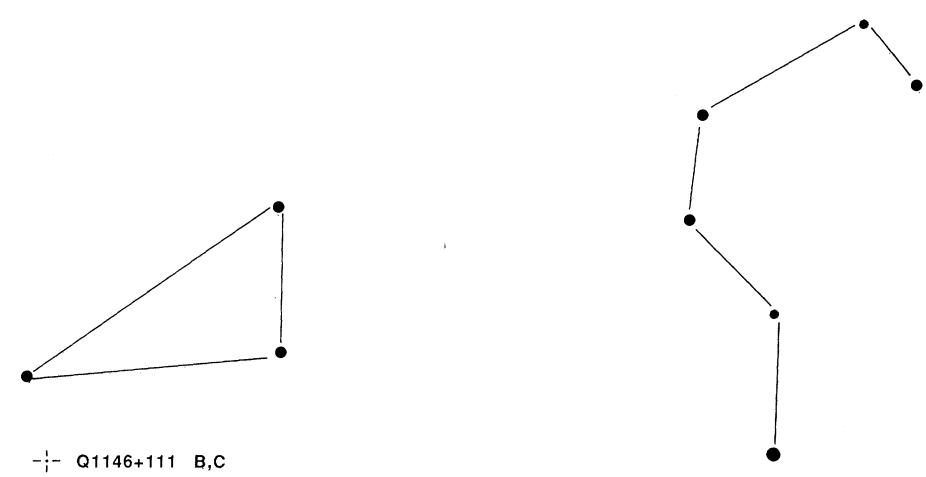
The case for an ultramassive gravitational lens is suddenly much weaker than it was; astronomers may have to settle for a more mundane explanation

ONLY a few weeks ago the evidence seemed compelling: Princeton University astronomer Edwin L. Turner and his colleagues had shown that two widely separated quasars located in the constellation of Leo possessed near-identical redshifts and very similar spectra; in fact they appeared to be the *same* quasar, split into two different images by the gravitational field of an object lying somewhere along the line of sight. However, this was no ordinary gravitational lens system. The 157-arc-second separation of the two quasars was more than 20 times greater than that of any previously known lens, which implied a lensing object as massive as a supercluster of galaxies (about 10^{15} times the mass of the sun). And yet, no sign of this object could be found. Excited astronomers have therefore been speculating about any number of exotic possibilities, including ultramassive black holes and infinitesimally thin cords of energy known as cosmic strings.

Now, however, the gravitational lens interpretation has been cast into doubt: the spectra and redshifts of the two objects may not be so similar after all.

The original spectra, which were obtained by Turner and his colleagues last March, lay between 4600 and 7500 angstroms in the visible band and were indeed virtually identical. But just over a month later, Peter A. Shaver and S. Cristiani of the European Southern Observatory obtained spectra extending to 9500 angstroms in the infrared. There they found that two hydrogen emission lines, part of the redshifted Balmer series, were prominent in one quasar and absent in the other. In view of these differences, they say in their recently published report, "It seems unlikely that the two objects are different images of the same quasar." It seems far more likely that they are different quasars that happen to have the same redshift, perhaps because they both happen to lie within the same cluster of normal galaxies.

Support for that last possibility has also come from E. Sterl Phinney and Roger D. Blandford of the California Institute of Technology, who argue that the quasars might well be a chance association. Starting from the known abundance of quasars, together with the observation that quasars seem to cluster in the same way that galaxies do, Phinney and Blandford calculate how many random quasar pairs one would expect to find in the sky with the same magnitude and redshift as the Leo pair and a separation of 157 arc seconds or less. Their answer: approximately one. "We should not be unduly surprised if [the Leo pair] fails tests of the lensing hypothesis," they write. "It may be that expected pair."



The Constellation of Leo

The location of the twin quasars, which are designated 1146+111 B and C, is indicated by a cross. Are they really evidence for a gravitational lens?

Meanwhile, John Huchra of the Harvard-Smithsonian Center for Astrophysics has obtained spectra extending down to 3200 angstroms in the ultraviolet. There he also finds striking differences between the two objects, particularly in certain emission lines of carbon and iron. In fact, he finds some evidence for significant differences in the redshifts of the two objects as well.

On the face of it, these observations would appear to put the gravitational lens to rest, along with all the speculation about ultramassive black holes and cosmic strings. But in fact they do not; the situation is still quite ambiguous. Quasars often show striking variations over time. They even show different redshifts in different spectral lines. Moreover, if these two images are being formed by a gravitational lens, then the light comprising the images has to follow different paths through space; for a lens of 10^{15} solar masses that difference could be as much as 1000 light years. In other words, one of the images that astronomers now see in Leo would show the same quasar as it existed a thousand years later than it appears in the other image. Given the intrinsic variability of quasars, the differences in spectra are perhaps not surprising; indeed, some theorists had previously expressed surprise that the spectra were as similar as they seemed to be.

In summary, about all one can say for the moment is that the picture is far more confused and uncertain than it was. Turner himself is the first to admit it: "The people I've talked to fall into two camps," he says. "Those who say it's definitely not a lens, and those who say, 'Of course it's a lens!' But I think we have to be skeptical at this point. Certainly we can get a lot more data than we have now."

Turner and his colleagues are planning further observations to confirm their own results and those of the other researchers. They will also look for evidence that the quasar varies on a month-to-month time scale, as suggested by the fact that Huchra's spectra and theirs fail to agree in the wavelength regions where they overlap. However, these observations will have to wait: Leo is rapidly being lost in the glare of the sun, and will not be accessible again for many months. ■ M. MITCHELL WALDROP

ADDITIONAL READING

M. M. Waldrop, "A cosmic string in Leo?" *Science* **232**, 936 (1986).

P. A. Shaver and S. Cristiani, "Test of the gravitational lens hypothesis for the quasar pair 1146+111B,C," *Nature (London)* **321**, 585 (1986).

E. S. Phinney and R. D. Blandford, "Q1146+111B,C quasar pair: Illusion or delusion?" *ibid.*, p. 569.