Disappointment over double quasar

There now seems a high chance that what seemed, two weeks ago, to be a particularly interesting double-quasar image may simply be a record of two independent objects.

Two articles elsewhere in this issue (pp. 419 and 420) provide what appear to be plausible explanations of the remarkable report by E.L. Turner *et al.* (*Nature* **321**, 142; 1986) of the apparent identity of two quasar images separated from each other on the sky by more than two minutes of arc (2.6 minutes, to be precise). The significance of this report was quickly appreciated not merely by its authors but by many others. Although there has accumulated since the first observation in 1979 a handful of cases in which the image of a single quasar is split into two or even three by the interposition of a massive galaxy along the line of sight to the distant object, the angular separations previously reported have been very much smaller than that of the pair of images measured by Turner *et al.*, a few seconds of arc rather than a few minutes.

This week's authors, both Princeton colleagues of Turner, explore the possibility that the very large separation may be caused by the interposition either of a very massive black hole or, alternatively, of one of the galactic structures called a cosmic string. Readers will note that their calculations, interesting in their own right, are at once tentative and suffused with a sense of what good luck it must be that observations should have led so simply to such striking inferences. Now, unfortunately, it appears that these endeavours may have been misplaced.

In a field where it is never easy to be sure that quasar images have been accurately identified with each other, it is too soon for certainty. But stimulated by the report of Turner *et al.*, others have looked at the components of the supposed double quasar in spectral regions other than that on which the original identification was based, and they find enough discrepancies to suggest that the apparent identity of the two objects is in doubt.

Before jumping to the conclusion that Turner *et al.* are in some way to blame for having published their data too quickly, or that they have made an elementary mistake that might have been avoided by taking greater care, readers should consider carefully what is involved in the identification of a gravitationally split quasar image. That an intervening massive object can split one image into two or more follows from the way in which, in relativity, the gravitational field of a massive object distorts the usual straight-line paths open to light. The magnitude of the effect and the apparent separation of the two images depend on the mass of the intervening object. The known cases of split quasar images require intervening masses comparable with those of galaxies. Turner's separated images would require more massive objects, whence the speculation about black holes and cosmic strings.

To establish that a close pair of quasar images has indeed been generated by the interposition of a gravitational lens is, in reality, quite difficult. The first test is that the two images should have the same measured red-shift (which is not affected by the bending of the gravitational lens). One difficulty is that the red-shifts are usually so large that it is hard to tell which atomic transitions are ultimately responsible for the spectral lines observed in the emission from the quasar. Another is that the lines, even if accurately identified, may be so broad that the accuracy of inferences about their displacement is bound to be limited. Turner's two images were reported to have a red-shift defined by $z = 1.012$ on the strength of an emission line from magnesium which, while normally in the ultraviolet, has been displaced by the recession of its source to the middle of the visible light spectrum.

Those who search for double-quasar images also pay close attention to the general characteristics of the spectra of the two candidate images, but there are some important complications. Thus the spectra of quasars can vary rapidly on quite short timescales. Most of the variations show up in the continuum flux, but there may also be substantial variations in the strength of emission lines in the spectra. Because one of the consequences of the effect of a gravitational lens is that different images of the same quasar may reach the observer by paths which differ considerably in the traverse-time of light, there is room for some latitude in the comparison of the spectra of two images. In Turner's case, the two light paths may have differed by as much as 1,000 light years, ample to account for the spectral differences he and his associates reported in the two quasar images.

The new development is a set of measurements by P.A. Shaver and S. Christiani of the European Southern Observatory in a part of the spectrum extending towards the infrared from the longer wavelength limit of the range covered by Turner *et al.* An article describing these measurements will appear in *Nature* two weeks from now. In this previously unexplored region of the spectrum of the Turner quasar, there appear to be pronounced differences in the intensity of certain hydrogen lines. Readers will have to judge for themselves, when this evidence appears, whether the quasar images are indeed produced by a gravitational lens from the same single distant object. Advance notice of these measurements is being provided now, with the consent of its authors, merely because of the excitement generated by the original measurements.

If Turner *et al.* were unlucky in their choice of a spectral range in which to carry out measurements of the components of the double quasar, there will be a widespread sense of disappointment that a potentially fascinating phenomenon has so quickly vanished. But that does not imply that the two quasar images concerned are without interest. The supposition that they might be gravitationally split images of the same object seems first to have been raised by Paczynski (*Nature* **319**, 567; 1986) on the basis of measurements originally due to C.H. Hazard.

If the two images are now gravitational artefacts, then they are most probably distinct quasars (with nearly identical red-shift) which are also members of a distinct galactic cluster. But the measured difference between the velocities of the two images is less than 200km s^{-1}, which is less than the spread of velocities found in typical galactic clusters, and which may therefore suggest some special relationship between the two quasars. That would be an interesting if less spectacular development in its own right, one that would no doubt bring comfort to those who, like H. Arp, have long argued for some systematic relationship between the positions of quasars in the sky.

Meanwhile, the urgent need is further to test the relationship between the two images of Turner's quasar. Detailed study of the relative intensity of the iron and magnesium lines in the two images will no doubt persuade most people one way or the other. When all this has been done, there will remain one logical ambiguity. If the travel times of widely split quasars may be of the order of 1,000 years, and very much greater than the timescale of substantial variability of individual quasars, will it ever be possible to prove (or disprove) that such widely split images are caused by gravitational lenses, however massive or peculiar? □