SCIENCE NEWS OF THE WEEK

An Optical Three-Way Split

If two of something is good, three is usually better. That is true of the search for the astronomical phenomenon known as a gravitational lens. In fact three is not only a quantitative improvement, it is likely to be qualitatively more convincing. Three, in this case, is contained in the discovery of a triple quasar, PG1115+08, reported in the June 26 Nature by Ray J. Weymann of the University of Arizona, David Latham of the Smithsonian Astrophysical Observatory, J. Roger P. Angel, Richard F. Green, James W. Liebert, David A. Turnshek, and Diane E. Turnshek of the University of Arizona and J. Anthony Tyson of Bell Telephone Laboratories. They call it not a "possible" but a "probable gravitational lens."

A triple quasar is not some kind of astronomical trefoil or clover leaf. It is a configuration that appears to be a single quasar repeated three times. What the observers first seek—they are doing a survey—is groups of quasar images that appear substantially similar to each other and are close enough together in the sky to give a statistical suspicion that they may have something to do with each other. This was the case with the three images designated PG1115+08 A, B and C, lying at right ascension 11 hours 15 minutes 41.5 seconds and declination +08° 02′24″. (The object's emission redshift is a fairly substantial 1.722; its visual magnitude is 15.8.)

The test for identity of images is to compare the spectra of the three images. Most of the Nature paper is concerned with describing this work, which was done with the Multiple Mirror Telescope on Mt. Hopkins near Tucson and the (University of Arizona) Steward Observatory's 2.3-meter telescope. The operation is complicated first by the universal problem that all astronomical spectra are contaminated by background light that enters the telescope. This must be properly subtracted. The standard method is to sample a bit of nearby sky in which no star is visible. In this particular case a more important complication is that the images are so close together that they may contaminate each other's spectra by slopover light (particularly B to A). Techniques to correct for this intercontamination were also applied.

When all of this had been worked through — and it is this procedure that other astronomers will study to determine whether they accept the conclusion — Weymann and his co-workers conclude that this is three identical images. If that becomes generally accepted, the step to a gravitational lens is almost inevitable. Quasars are not generally that identical with one another. For nature to have put a multiplicity of identical ones that close together in space is highly improbable. To some astronomers (Weymann and co-workers particularly) it is even less probable than that nature should have set up the particular configuration of objects that leads to a gravitational lens.

That configuration involves an alignment of the quasar, the earth and a massive, dense body (a compact galaxy or maybe even a black hole) between them. The massive body, which is invisible from earth, has a very strong gravitational field, one capable of bending the path of a light ray passing through it slightly off center.

Light coming from the quasar to the earth along the common line will not be bent and will arrive and make an image of the quasar in the usual way. Light proceeding at a slight angle to the common axis will be bent. Normally these rays would not reach the earth. After bending, some of them will. In the simplest geometry and with the easiest gravitational field configuration for the massive dark object, the bent rays form two secondary images of the quasar, which fall on either side of the primary in our field of view.

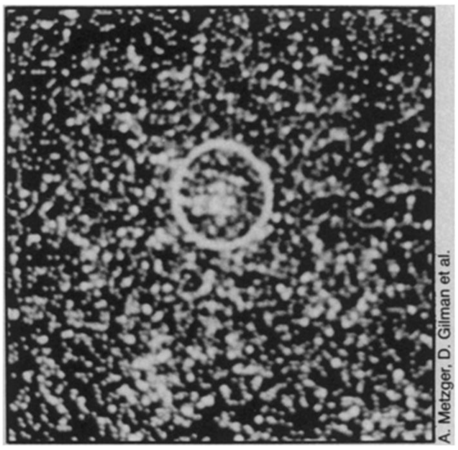
Thus the appearance of the triple image should be convincing for reasons apart from statistical arguments. Certainly it should be more convincing than the double image first alleged as a gravitational lens (0957+56 A, B). Many astronomers seem willing to believe that 0957+56 is a gravitational lens, but to explain it they have to resort to multiple light scatters and Tinker-to-Evers-to-Chance-to-whatever kinds of light paths. In this business the triple play is more likely than the double. ☐

X-rays detected from Jupiter

Years ago, scientists discovered that energetic bursts of electrons reaching the earth from the depths of space were in fact coming from Jupiter, accelerated by the titanic Jovian magnetic field. It was one of the first clues to the giant planet's power, an attribute that has become all the more impressive with data from the four spacecraft that have gone there for a close look. Now there is yet another indicator of the planet's electromagnetic muscle, with a research group's report of the first detection of X-rays from Jupiter.

The X-rays were spotted more than half a billion kilometers from their source by a focusing X-ray telescope aboard the earth-orbiting HEAO-2 satellite, second in NASA's High-Energy Astronomy Observatory series. Devoted almost entirely to stellar observations, HEAO-2 has spent only three six-hour periods looking at Jupiter since the satellite was launched more than a year and a half ago. During those brief spans, the instrument's detector saw only about one X-ray every 100 seconds (looking at energy levels from 100 to 2,000 electron-volts), but that is enough to make the point: According to Albert Metzger, David Gilman and colleagues from Jet Propulsion Laboratory and elsewhere, the observed X-ray brightness suggests that energetic electrons, some of which produce the X-rays, are constantly pouring hundreds of quadrillions of watts of power into the Jovian system. (This is consistent with calculations based on Voyager spacecraft measurements at other wavelengths. According to S.M. Krimigis of Johns Hopkins Applied Physics Laboratory, for example, low-energy charged-particle data suggest a total energy dissipation of about 3×10^{14} watts.)

The only planet other than Jupiter from which X-rays have actually been detected is earth itself, although any planet hit by sufficiently energetic electrons will have at least a little X-ray emission. In the case of both earth and Jupiter, Metzger says, the X-rays may be produced by electrons that spiral into the atmosphere from the planet's trapped radiation belts, colliding with atmospheric atoms and molecules to trigger a broad band of radiation that also includes visible auroras and ultraviolet light. The calculated energy dissipated in the system by the electron torrent means that, in order to sustain the radiation belts, an equal amount of power must be provided from the planet's rotational energy (transmitted by the magnetic field) and by the force of the solar wind.


A. Metzger, D. Gilman et al.

Jupiter by X-ray in HEAO-2 image.

The HEAO researchers have also looked for signs of X-rays from Saturn, but their analysis is not yet complete. A geiger tube aboard the Pioneer 11 spacecraft that passed Saturn last September failed to find X-rays even when inside the outer edge of the planet's rings (and thus free from the "noise" of other charged particles), possibly because Saturn's moons "sweep up" many X-ray-producing electrons. ☐