That's "very compelling" evidence that Ptc is the primary Hh receptor, says Roel Nusse, a developmental geneticist at Stanford University. But Columbia University developmental biologist Gary Struhl suggests that the story is even "more baroque." In the 1 November issue of *Cell*, Struhl and colleague Yu Chen try to reconcile the new findings with the earlier evidence suggesting a role for Smo. They argue that Ptc and Smo work together: Unbound Ptc, they propose, inhibits Smo from releasing a signal into the cell cytoplasm, but when a Hedgehog protein binds to Ptc, it triggers structural changes in Ptc and perhaps Smo that somehow free Smo's signal. Rosenthal and his colleagues propose similar models based on experiments indicating that Shh, Ptc, and Smo can bind together in a single complex. Says Rosenthal: "This finding links the sometimes conflicting evidence implicating both Patched and Smoothened as the Hedgehog receptor."

The new findings could also pave the way to treatment for basal-cell skin cancer, the most common form of cancer in humans. Researchers at Yale University and Stanford reported earlier this year that people carrying a mutation in the gene encoding Ptc suffer a high risk of this cancer (*Science*, 14 June, pp. 1583 and 1668). Now Rosenthal suspects Smo is the real culprit, reasoning that altered Ptc can't maintain its usual brake on Smo, allowing Smo to send a continuous signal that may activate cancerous cell division. "If we can find small molecules that inhibit Smoothened," says Rosenthal, "they could serve as therapeutic agents." And that would be something to phone home about.

–Wade Roush

ASTRONOMY

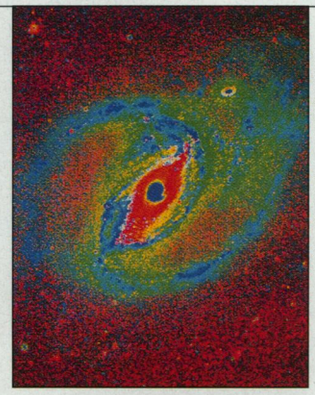
Quasar Pairs: A Redshift Puzzle?

When Galileo observed Jupiter through his homemade telescope in January 1610, he saw four stars in a straight line on either side of the planet. He rightly concluded that they were satellites of Jupiter—the odds against a coincidental alignment of the nearby planet with four distant stars are huge.

In a similar vein, Halton Arp of the Max Planck Institute for Astrophysics in Garching, Germany, has spent more than 25 years asserting that quasars, objects most astronomers believe are at the far edges of the universe, are actually the companions of relatively nearby galaxies. If he is right, the implications would be as revolutionary as those of Galileo's claim, which supported the idea that the Earth orbits the sun just as Jupiter's moons orbit the planet. The astronomical ruler, called redshift, that places the quasars and the galaxies at very different distances would be in jeopardy—and so would many of cosmologists' basic beliefs about the universe. Astronomers have largely rejected Arp's claims, but now he is presenting his most systematic study of quasar-galaxy pairings yet.

In a pair of papers soon to appear in *Astronomy and Astrophysics*, he and his colleague Hans-Dieter Radecke report that they examined 24 Seyfert galaxies, nearby galaxies that have brilliant, active nuclei, and found that 12 of them were accompanied by pairs of x-ray sources—almost certainly quasars with high redshifts—aligned on either side of the galaxy. The alignment implies, says Arp, that the galaxy itself ejected the quasars, in spite of the discrepancies in redshift. Arp believes he has struck a fatal blow at astronomers' favorite distance measure. "The astronomical establishment should be convinced by now," he says.

It isn't. "The theoretical implications [of this find] would be profound, if true," says theorist Jim Peebles of Princeton University. Andrew Wilson of the University of Maryland, who studies active galaxies, says "In some cases, the pairings are quite striking. [This is all] very hard to explain in terms of conventional cosmological theory." But Peebles, Wilson, and others say that 12 cases are not enough to spark a revolution, and that the high frequency of pairings could just be chance alignments that look impressive because the sample is small. "History teaches us that there can be apparent excesses that went away when a larger sample was observed," says Wilson.



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Distance dilemma. Are quasars around NGC 1097 connected to it?

Arp has been looking for convincing statistics for more than a quarter of a century, uncovering dozens of similar unnerving alignments and associations, especially among so-called active galaxies. His explanation is that quasars are created in and ejected by these galaxies, and have an "intrinsic" high redshift that has nothing to do with distance. Current physical theory cannot explain such an effect. As astronomers now understand redshift, it reflects the expansion of the universe. The more distant an object is, the faster it is being carried away by the expansion, which stretches its light to longer wavelengths—toward the red end of the spectrum.

Arp bases his latest assault on redshift on data from the German x-ray satellite Rosat. Examining the data, Radecke found far more x-ray sources than usual in the neighborhood of 24 Seyfert galaxies. When Arp looked at the Rosat maps of the sources, he found pairs of x-ray sources aligned across half the galactic nuclei. Although redshifts have not been measured for the majority of these sources, "99.9% of [such objects] have historically turned out to be high-redshift quasars," Arp says.

That was the case for the one pair of sources where redshifts have been measured—the two companions of a distorted, violent galaxy called NGC 4258. Wolfgang Pietsch of the Max Planck Institute for Extraterrestrial Physics in Garching, who discovered this particular quasar pair in the Rosat data, recalls that he "thought that it was rather unlikely that it could be a chance coincidence that the galaxy is showing up with these paired sources." However, he cautiously adds: "It's small number statistics, and therefore very unlikely things may happen."

Arp has heard that reaction before. "It has always been like this," he says. "There's a flurry of comment, worry, and anxiety, but after that, everybody slips back to the old way" of doing astronomy. Wilson acknowledges that some astronomers tend to ignore observational evidence that contradicts established theory. And Peebles agrees that "it would be very bad if we ignored evidence for new physics, since I'm sure there is new physics [out there] for us to discover. However, as a theorist, I'll be cautious as long as the observers disagree."

But there is a tried and tested way of proving Arp's point. Four centuries ago, Galileo proved himself right about Jupiter's moons by observing their motion around the planet, thus establishing a physical connection. In the case of the quasar pairs, similar observations "could be done by measuring diffuse emission connecting the paired sources to the galaxy," says Pietsch. Or, if the quasars were ejected by galaxies at high speeds and emit radio signals, their motion across the sky might be measurable with a radio interferometer. If someone succeeded in detecting such physical connections or proper motions in the companion objects, Arp's alignments might turn out to be the start of a revolution after all.

–Govert Schilling

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.