Tell-tail. Astronomers currently spot merging galaxies such as this pair—known as the Mice Galaxies—by their anomalous shapes.

Waltzing Quasars Provide Signpost to Merging Galaxies

Astronomers want to know how frequently galaxies merge to understand the broader evolution of the universe. A team reported here at the annual meeting of the American Astronomical Society that it has found a new way of spotting galaxy mergers: by looking for the dance of death of their central black holes. Julia Comerford of the University of California, Berkeley, and her colleagues claim their findings add strength to the idea that merged galaxies can form quasars.

Traditionally, astronomers find mergers by scanning the skies for oddly shaped galaxies or galaxies close together, apparently on the point of merger. Because most galaxies have a supermassive black hole at their center, Comerford and her team reasoned that galaxies that had merged recently would have two black holes spiraling inward. If the black holes had enough gas around them, the gas would collapse inward, releasing energy and converting one or both black holes into active galactic nuclei (AGNs), or quasars.

So, the astronomers searched spectra from the DEEP2 Galaxy Redshift Survey—the most detailed picture of the universe from as far back as 8 billion years ago—to find the telltale light signature of AGNs. (They excluded galaxies with ongoing star formation because this mimics the AGN signature.) The researchers found 107 candidates and then examined their spectra for signs of a merger.

Comerford's team figured that in a recently merged galaxy, the two spiraling AGNs would be moving a lot quicker than the stars in the surrounding galaxies, and so the AGNs' emission lines would be Doppler-shifted out of step with the rest of the galaxy. Because the two AGNs would move in opposite directions, the emission lines of the first AGN would be shifted one way and the lines of the second the other, resulting in a double peak. That's exactly what the researchers found in two of the 107 galaxies, leading them to conclude that these were dual AGNs.

In another 35 galaxies, the emission lines appeared to be from a single AGN but were offset from the lines of the surrounding galaxy, suggesting an AGN spiraling around a black hole. So 37 galaxies in all—more than a third of the AGN-bearing galaxies in the study—seemed to have undergone a recent merger. From this, the researchers concluded that galaxies from between 4 billion and 7 billion years ago underwent three mergers every billion years. Although that's six times the rate predicted by theoretical models, Comerford says it is close to previous estimates of merger rates derived from observations. She says the discrepancy with the models is because they only consider mergers between two big galaxies.

Aaron Barth, an astronomer at the University of California, Irvine, says the new technique is "very useful because it's completely independent of other methods to estimate the merger rate." The surprisingly high percentage of AGNs showing "offset nuclei" points to "a very clear link between galaxy mergers and the buildup of black holes by accretion of gas," he says. **–YUDHIJIT BHATTACHARJEE**

Do Black Holes Seed the Formation of Galaxies?

Which came first, the galaxy or the black hole? Astronomers have been pondering that question because most galaxies have massive black holes at their centers. Are the black holes the seeds around which galaxies grow, or do they form after the galaxies have already taken shape? The verdict from a study presented here at the annual meeting of the American Astronomical Association is that black holes come first. The findings could lead to a better understanding of how galaxies are born.

Galaxies in the nearby universe appear to be uniformly about 700 times as massive as the black holes at their core. Many view this ratio as a clue to the link between galaxy formation and black holes. To understand that link, a team led by Chris Carilli of the National Radio Astronomy Observatory in Socorro, New Mexico, and Dominik Riechers of the California Institute of Technology in Pasadena set out to establish whether black holes lead to galaxy growth or vice versa.

The researchers looked at distant galaxies, as far back as 1 billion years after the big bang. Carilli and his colleagues, using the Very Large Array radio telescope in New Mexico and the Plateau de Bure Interferometer in France, looked at the radio signals from gas clouds in four such galaxies and deduced their masses. They then compared each mass with the mass of their black holes, which had been obtained using optical telescopes. They found that the galaxies were only about 30 times as massive as their central black holes. If galaxies in the early universe had less than 5% of the galactic flesh around their cores than galaxies of today, Carilli and his colleagues reasoned, then the black holes must have formed before the galaxies.

"It appears that the black holes come first and grow the galaxy around them," says Carilli. Eventually, like a ripening fruit, the galactic mass grows until its ratio to the black hole mass reaches what astronomers observe in nearby galaxies. Carilli and his colleagues acknowledge that the results seem to contradict findings suggesting that the enormous energy emanating from active black holes inhibits galaxy growth around them.

Astronomer Andrew Fabian of the University of Cambridge, U.K., calls the results "very interesting" and says they are "bound to generate theoretical work" on how black holes and galaxies influence each other. But he's reserving judgment on whether black holes did indeed come first because the conclusions are "deduced from gas motions, not stars," and gas clouds can be affected by nongravitational forces such as magnetic fields, causing astronomers to underestimate the ancient galaxy's mass. **–YUDHIJIT BHATTACHARJEE**

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