Watching a black hole's diet

A black hole is a kind of cosmic Pac-Man: If you get too close to it, it will eat you. Its gravitational field just drags things in. By now it has become a commonplace opinion among astrophysicists that giant black holes reside in the centers of quasars, Seyfert galaxies and other highly active galaxies and galaxy-like objects, and perhaps even in the ordinary, fairly quiet galaxies. In the Nov. 27 NATURE, two astronomers report that they have seen such a galactic black hole apparently eating a star.

The presumed black hole resides in the center of the Seyfert galaxy NGC 5548, which lies some 70 megaparsecs or 200 million light-years from earth. Since a black hole is invisible, insensible and never gives back anything it engulfs, direct evidence of the existence of one is hard to come by. According to Cambridge (England) University astrophysicist Stephen Hawking, a black hole's event horizon – the boundary around it that marks off the volume from which nothing can escape – should emit a particular kind of thermal radiation in reaction to things falling into it. A number of observers have searched for this Hawking radiation, but none has reported definitely finding it.

In the absence of Hawking radiation, the best evidence for black holes is dynamic: Observers have reported that things revolve around black holes. Now, Bradley Peterson and Gary J. Ferland of Ohio State University in Columbus say they have the first evidence of an object, possibly a star, falling into one.

The evidence comes from spectrograms of the center of NGC 5548 that Peterson took at monthly intervals for almost two years using a telescope located in Flagstaff, Ariz. NGC 5548 was known to vary in brightness from time to time, but nobody previously had studied the changes spectroscopically, trying to identify the chemical substances involved in the changes.

Between February and June 1984, the center of NGC 5548 increased in brightness by 60 percent, and the June spectrogram showed a large amount of helium that had not been there the month before. Helium is made in stars, and the sudden presence of a large amount of it led the observers to conclude that a star had come to grief – that is, had been torn apart by the gravitational field of a black hole residing in the center of NGC 5548.

Peterson and Ferland calculate that the disrupted star was about equal to the sun in mass, and that a small portion of it, a few dozen times the earth's mass, fell into the black hole. The rest of the torn star, composed mostly of helium, remained in the neighborhood of the black hole but outside its event horizon. There, compression due to the black hole's gravitational pull heated the helium to about 140,000°K and thoroughly ionized it. At that temperature it revealed its presence on the spectrogram. From the dynamics involved, Peterson and Ferland estimate the mass of the black hole at 30 million times that of the sun.

"What Brad saw was exactly what you would expect to see happen if a black hole had consumed a star-sized object," Ferland says.

"This could be the first direct evidence of accretion going on in the nucleus of a galaxy," Peterson says. Astrophysical theories of what happens in the centers of quasars, Seyfert galaxies and similar objects – what produces the tremendous energies they release – depend on the occurrence of this kind of accretion as a continuous feeding mechanism.

Peterson and Ferland say they intend to expand their program of monitoring changes in Seyfert galaxies, with the hope of finding more examples of this kind of phenomenon. – *D. E. Thomsen*