Physicist explains why quantum mechanics says a black hole should be able to let some things out

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Color composite image of Centaurus A, revealing the lobes and jets emanating from the active galaxy's central black hole. Composite images: ESO/WFI (Optical); MPIfR/ESO/APEX/A.Weiss et al. (Submillimetre); NASA/CXC/CfA/R.Kraft et al. (X-ray)

(Phys.org) -- The journal *Science* is running a series of Reviews and Perspectives on the current state of knowledge and theories regarding black holes, written by leaders in the field. Some discuss what is believed to happen if two black holes collide, others describe what happens as binary stars are sucked up by black holes and whether intermediate size black holes really exist as new evidence is indicating.

Yet another by doctoral fellow Rubens Reis, discusses a lucky break that allowed scientists to listen to the "cry" of the last bits of some matter just before being consumed by another black hole. But generating the most interest perhaps, is an article by Edward Witten of the Institute for Advanced Study in Princeton, New Jersey, a theoretical physicist, who argues that one of the most basic beliefs about black holes, namely, that nothing can ever escape it's gravitational pull, is wrong, but only sort of.

It was Einstein's theory of relativity that got everyone believing that because the gravity of a black hole is so great, it's not possible for anything to escape once it passes the event horizon, or point of no return. Witten says that while the theory is right, of course, it's only right in a certain respect, because it violates the laws of thermodynamics, which say that if a reaction is possible then there is always supposed to be an opposite reaction. Applied to black holes, it suggests that if something can be consumed, then it ought to be able to be un-consumed as well. This whole idea is backed up by something Stephen Hawking came up with back in 1974, where he suggested that certain quantum particles should be able to escape a black hole, but that they would be too small for anyone to detect. He called the process Hawking radiation, and sure enough, no one has ever been able to detect them.

Witten says that despite the seeming contradiction in the two views, there is a way to explain the differences; it's about perception and point of view or looking at things in a macroscopic versus microscopic way and using the idea of entropy. Seen up close and personal, a black hole surely is capable of the occasional lapse, allowing a particle or even a whole atom to escape. But looking at the hugeness of a black hole across the vast distance of space, it definitely appears all consuming; always taking and never giving, to us appearing as if nothing, not even a photon could ever escape it's clutches. That's how you reconcile the two viewpoints.

More information: Quantum Mechanics of Black Holes, *Science*, 3 August 2012: Vol. 337 no. 6094 pp. 538-540. DOI: 10.1126/science.1221693

ABSTRACT
The popular conception of black holes reflects the behavior of the massive black holes found by astronomers and described by classical general relativity. These objects swallow up whatever comes near and emit nothing. Physicists who have tried to understand the behavior of black holes from a quantum mechanical point of view, however, have arrived at quite a different picture. The difference is analogous to the difference between thermodynamics and statistical mechanics. The thermodynamic description is a good approximation for a macroscopic system, but statistical mechanics describes what one will see if one looks more closely.