What's up in Astronomy By Eric Erickson

Offered Title: Black Holes go Poof?

We don't know what's going on inside a black hole, and even outside, when close to the event horizon things get very weird.

Stephen Hawking's first attempt to describe black holes didn't sit well with his colleagues. In particular, his assertion that black holes do not lose mass/energy was challenged by Jacob Bekenstein who proposed that black holes have entropy, that is, release radiation and lose mass/energy over time.

So, in 1973 Steven Hawking goes to Russia (the Soviet Union back then) and visits with Yakov Zel'dovich and Alexei Starobinsky, two of his peers who also argue that black holes should emit particle radiation due to quantum effects at the event horizon.

Hawking takes his licks and revisits his calculations within the Alice in Wonderland place called quantum mechanics. He runs into a snag. His new calculations result in quantum particles with a wavelength shorter than the Plank length, (approximately 0.00000000000000000000000000000000016 meters), termed trans-Planckian wavelength. This appeared to be a problem and he struggled to solve it, then realized this is an effect of the event horizon. A particle that emerges from the event horizon has a finite frequency, but when traced back to the horizon, due to quantum gravitational effects, its frequency appears progressively compressed. On reaching the event horizon a particles frequency is effectively infinite and its wavelength shorter than the Planck length. For particles entering a black hole this is where time stops from a remote observer's perspective and the particle appears suspended at the event horizon. Said it was weird.

Stephen Hawking published his work in 1974.

So, what do we know about Hawking radiation? The theory appears sound but to date has not been supported by experimental or observational evidence. Hey, not to worry, Einstein's predictions are still challenging technology 100 years later. The agreement is that yes, black holes emit radiation, but the form is up for grabs.

One description is, due to quantum gravitational effects at the event horizon, particles form where one gets captured by the black hole and the other escapes. Since these particles were produced by the black holes gravitational energy, escape of one particle results in a net loss of mass/energy for the black hole.

Another suggested mechanism regards vacuum fluctuations producing particles and antiparticles near the event horizon. To conserve total energy (with respect to a remote observer) the antiparticle falls into the black hole. The antiparticle has negative energy (whatever that is) and causes a reduction in mass/energy of the black hole.

In either case, if the black hole does not receive mass/energy from the outside, it will evaporate…poof. Black holes typically feed on abundant surrounding dust, gas, stars. The Fermi space telescope is looking…

What's in the Sky?

April 2 and 7; One hour before sunrise: Look to the south-southwest and find the Teapot of Sagittarius. Saturn, Mars, and with the Moon on April 7 should be a pretty sight.