Abstract

Black Holes are amongst the strangest objects in the universe. They form from the collapse of matter into an object whose gravitational pull is so strong, nothing can escape from them. Yet a black hole also radiates heat like a blackbody, with a temperature equal to its surface gravity, an entropy equal to its area, and an energy equal to its mass.

I will describe recent work that is transforming our perspective on black hole thermodynamics, one that indicates black holes behave more like chemical systems. When vacuum energy is taken into account, mass becomes chemical enthalpy, the notion of a thermodynamic volume appears, and black holes exhibit a broad range of chemical phenomena, including liquid/gas phase transitions similar to a Van der Waals fluid, triple points similar to that of water, re-entrant phase transitions that appear in gels and heat engines. Under certain conditions they can even behave like superfluid helium!

I will outline the foundations of this “black hole chemistry” and highlight both the new phenomena that have been recently discovered and their implications for our understanding of gravitational physics.