Key points from Lecture 15 of ASTR 350

1. When gas falls toward a black hole, whether from a companion star or from gas in the vicinity, that gas has angular momentum. Thus the gas can't fall radially onto the black hole. This also applies to other objects such as neutron stars, white dwarfs, ordinary stars, planets...
2. This explains why gas accreting onto a black hole often comes in an *accretion disk*, which is flattened because of angular momentum.
3. Interactions within the gas (viscosity, or for black hole disks magnetic field interactions) can transport angular momentum outward and gas inward.
4. The energy released by a bit of gas of mass m that has spiraled to a circular orbit of radius r around a mass M is $GMm/(2r)$ in Newtonian gravity, and slightly different from that in general relativity. When you put in the numbers at the innermost stable circular orbit (ISCO) of a black hole, that can be $\sim 0.1c^2$ per mass. That's at least $10\times$ the energy per mass that you get from fusing hydrogen into helium! This, fundamentally, is what allows accretion onto black holes to power the most luminous sources in the universe.
5. A crude model, backed up by more sophisticated models, suggests that the peak temperature in a black hole disk should scale inversely with the black hole mass M: $T_{\rm peak} \sim M^{-1/4}$. This can help us make crude estimates of a black hole's mass based on its spectrum.
6. Detailed investigations since the early 1990s have shown that the magnetic nature of the angular momentum transport process in accretion disks involves strong turbulence. Thus, instead of having a smooth flow of matter toward a black hole it comes (to a degree) in fits and starts, which naturally produces significant variations in accretion and luminosity. These are seen from real black holes.