16.5.1: Quantum Gasses

It is possible to create a fundamentally quantum gas, however. If you can lower the temperature of a gas enough while allowing it to stay as a gas e.g. by keeping it at a low enough density that it does not condense into a liquid or solidify), you can get to the point that a substantial fraction of the gas is occupying the lowest states available to it. At this point, the gas is no longer adequately described by classical physics. If the gas is composed of fermions (i.e. each molecule has net half-integral spin), you will have what's called a "Fermi gas", that is analogous in many ways to the valence electrons in a solid. If, on the other hand, the gas is composed of bosons, and you can lower its temperature enough, it's possible to create a "Bos-Einstein condensate", where a substantial fraction of the gas molecules all drop into the same state (something that would be impossible for atoms). At this point, you can see coherent quantum phenomena for the whole gas, such as interference, because of all the molecules or atoms that are in the same state. A Bos-Einstein condensate was first created in 1995 (Anderson et al., 1995); this work received the Nobel Prize in physics in 2009.