**Phase Transition in Molecular Gas?**

Often the coexistence region between two phasees is treated as equilibrium between two different substances – a gas phase and a liquid phase. These regions are separate because gravity will usually pull the liquid below the gas. Suppose that we have a substance coexisting in two different phases. Then we’d have something like:



and also have



so we see that in either description, we have only 3 d.o.f., as we should. Now let’s suppose that I consider two substances in equilibrium. One is just a gas of species A and the other a bonded state gas where the two A species bond together with a bond strength φ, which is negative. I’d like to see if there is a temperature where only one or the other will exist, etc. So I could write:



And then we need to maximize w/r to NB and UB. First I’ll do UB, which will basially say the temperatures are equal.



And then I’d differentiate w/r to NB. Well it’d be nice to have everything in terms of T already. So maybe I’ll consider the phase at temperature T and volume V instead. Then F = U – TS should be additive so,



And now must minimize w/r to NB.



Still quite complicated to solve. But if did, then solve for NB in terms of N and plug back in to get F(T,V,N) as we should. But graphing it yields expected results. So far as I can tell, there is not much of a phase transition per se΄. The # of particles in the bound state varies fairly continuously as adjust T or φ. Not sure how V affects it. But whatever.