1.4: Phase Diagrams

Too often, books such as this one degenerate into a study of gases. . . or even into a study of the ideal gas! Statistical mechanics in fact applies to all sorts of materials: fluids, crystals, magnets, metals, polymers, starstuff, even light. I want to show you some of the enormous variety of behaviors exhibited by matter in bulk, and that can (at least in principle) be explained through statistical mechanics.

Because the axes of a phase diagram are pressure and temperature, the misconception arises that phase diagrams plot pressure as a function of temperature. No. Pressure and temperature are independent variables. For example, volume is a function of pressure and temperature, $V(T, p)$. Instead, the lines on a phase diagram mark the places where there are cliffs in the function $V(T, p)$.

End with the high Tc phase diagram of Amnon Aharony discussed by MEF at Gibbs Symposium. Birgeneau.

Resources

The problems of fluid flow are neglected in the typical American undergraduate physics curriculum. An introduction to these fascinating problems can be found in the chapters on elasticity and fluids in any introductory physics book, such as

> F.W. Sears, M.W. Zemansky, and H.D. Young, *University Physics*, fifth edition (Addison-Wesley, Reading, Massachusetts, 1976), chapters 10, 12, and 13, or
>
> D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, fourth edition (John Wiley, New York, 1993), sections 16–1 to 16–7.

More idiosyncratic treatments are given by

> R.P. Feynman, R.B. Leighton, and M. Sands, *The Feynman Lectures on Physics* (Addison-Wesley, Reading, Massachusetts, 1964), chapters II-40 and II-41, and
>
> Jearl Walker *The Flying Circus of Physics* (John Wiley, New York, 1975), chapter 4.
>
> Hansen and McDonald

An excellent description of various states of matter (including liquid crystals, antiferromagnets, superfluids, spatially modulated phases, and more) extending our section on “Phase Diagrams” is

> Michael E. Fisher, “The States of Matter—A Theoretical Perspective” in W.O. Milligan, ed., *Modern Structural Methods* (The Robert A. Welch Foundation, Houston, Texas, 1980) pp. 74–175.