

6 Important Stackexchange Links

6.1 Phase transitions

- In Landau theory, order parameter doesn't have to be small but the terms we throw away in the expansion have to be! - [Click this link in red](#)

Possible question: For Landau theory to work, which of the following is necessary:

- (a) f , the Landau free energy, is analytic in Δ i.e. the order parameter
- (b) Order parameter is small, so we can neglect irrelevant terms (e.g. higher powers/derivatives)
- (c) Phase transition is explicitly known to be 2nd order, since, Landau theory assumes that free energy can be expanded in power series of Δ . For first order P.T., Order parameter has a discontinuous jump, making such an expansion mathematically ill-defined expansion.
- (d) Fluctuations must be small i.e. it is a mean field theory.
- (e) Landau Free energy f must be convex.

The last point is crucial¹. Answers are (a), (d). Because Landau theory statements are made within the context of MFTs.

Are there situations where a MFT doesn't work but a Landau type theory does?

- There are situations where attempts have been made to improve MFT by including singularities into the Landau functional. This is due to the fact that a local description doesn't suffice to explain such transitions, and one needs to extend a local Landau description into a non-Local theory - for which there's no unique/universal algorithm. These extensions need to be made on a case by case basis.

¹Not true, it is the coarse grained free energy and not the actual thermodynamic Gibbs energy, which is given from

$$Z = \int D\Delta e^{-F(\Delta)}$$

The functional integration restores convexity