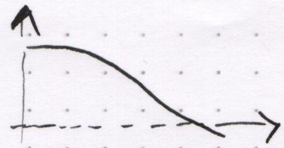
Looking at the heat capacity near the transition: 29/4/2018.

5.1

$$\frac{\partial^2 F}{\partial T^2} = \frac{2Z^2}{\pi T}\frac{d\Delta}{dT} + \ldots$$ ← other term which depend on $Z^2(T)$ having a temperature dependence.

∴ To avoid phase transition want to have $\frac{\partial^2 F}{\partial T^2}$ match on both sides of T_c. i.e. want $\frac{\partial^2 F}{\partial T^2} \to 0$ as $\Delta \to 0$.

☆ Have to justify why $\frac{d\Delta}{dT} \to 0$ is sufficient to remove phase transition.

∴ Then show the form of Δ vs. T 

Now go into weirdness of solving with $K \to \frac{K}{1+e^{-\beta\lambda_{sc}}} = \tilde{K}$

Show the parametric plot ← Obviously makes no sense.

Talk about restrictions on $\tilde{K}$ to be physical.

5.2 5/5/2018

$$F^* = -4T\,\mathrm{Re}\ln\left\{\cdots\right\} + \frac{2\Delta}{\pi J \rho} + \underbrace{\left(\tilde{K}\lambda_{sc} - T\ln(1+e^{\beta K\lambda_{sc}})\right)}_{F_n^*}$$

$\tilde{K} =$ const. here.

$\therefore$ Want to take $\left.\frac{dF_n^*}{dT}\right|_{\Delta=0} =$

$$\frac{dF_n^*}{dT} = \tilde{K}\frac{d\lambda_{sc}}{dT} + \lambda_{sc}\cdot\frac{d\tilde{K}}{dT} - \ln(1+e^{\beta K\lambda_{sc}}) - \frac{T}{1+e^{\beta K\lambda_{sc}}}\left[\frac{d}{dT}\left[\beta K\lambda_{sc}\right]\cdot e^{\beta K\lambda_{sc}}\right]$$

$\Rightarrow$ Take $\lambda_{sc}\to 0$ since $\Delta\to 0$ $\Rightarrow$ $\tilde{K}\left.\frac{d\lambda_{sc}}{dT}\right|_{T_c} - \ln 2 - \frac{T}{2}\cdot\beta K\left.\frac{d\lambda_{sc}}{dT}\right|_{T_c}$

$$= -\ln 2 + \underbrace{\left(\tilde{K} - \frac{K}{2}\right)}_{=0}\left.\frac{d\lambda_{sc}}{dT}\right|_{T_c}$$

$$\frac{d^2F_n}{dT^2} = \tilde{K}\frac{d^2\lambda_{sc}}{dT^2} - \frac{1}{1+e^{\beta K\lambda_{sc}}}\frac{d}{dT}\left[\beta K\lambda_{sc}\right]e^{\beta K\lambda_{sc}} - \frac{1}{1+e^{\beta K\lambda_{sc}}}\frac{d}{dT}\left[\beta K\lambda_{sc}\right]e^{\beta K\lambda_{sc}} + \frac{d\lambda_{sc}}{dT}\cdot\frac{d\tilde{K}}{dT} + \lambda_{sc}\frac{d^2\tilde{K}}{dT^2}$$

$$- T\frac{\frac{d^2}{dT^2}\left[\beta K\lambda_{sc}\right]e^{\beta K\lambda_{sc}}}{1+e^{\beta K\lambda_{sc}}} - \left(\frac{d}{dT}\left[\beta\lambda_{sc}K\right]\right)^2\frac{Te^{\beta K\lambda}}{1+e^{\beta K\lambda}} + T\frac{\left(\frac{d}{dT}\left[\ldots\right]\right)^2\left(e^{\beta K\lambda_{sc}}\right)^2}{\left(1+e^{\beta K\lambda_{sc}}\right)^2}$$

$\Rightarrow$ Take $\lambda_{sc}\to 0$ again!

$$\left.\frac{d^2F_n}{dT^2}\right|_{T_c} = \tilde{K}\frac{d^2\lambda_{sc}}{dT^2} - \beta K\frac{d\lambda_{sc}}{dT} - \frac{T}{4}\left(\beta K\frac{d\lambda_{sc}}{dT}\right)^2 - \frac{T}{2}\left[\beta K\frac{d^2\lambda_{sc}}{dT^2} + \frac{d}{dT}\left[\beta K\right]\frac{d\lambda_{sc}}{dT}\right]$$

$$= -\beta K\frac{d\lambda_{sc}}{dT} - \frac{K^2\beta}{4}\left(\frac{d\lambda_{sc}}{dT}\right)^2 - \frac{T}{2}\frac{d}{dT}\left[\beta K\right]\frac{d\lambda_{sc}}{dT}$$

$\therefore$ want $\frac{d}{dT}\left[\beta K\right]$, $\tilde{K} = \frac{K}{1+e^{-\beta K\lambda_{sc}}} \Rightarrow 0 = \frac{dK}{dT} - \frac{Ke^{-\beta K\lambda_{sc}}}{\left(1+e^{-\beta K\lambda_{sc}}\right)^2}\left(-\frac{d}{dT}\left[\beta K\lambda_{sc}\right]\right)$

$\therefore$ As $\lambda_{sc}\to 0$ $\quad \frac{dK}{dT} = -\frac{K}{4}\beta K\frac{d\lambda_{sc}}{dT}$

$$\left.\frac{d^2F_n}{dT^2}\right|_{T_c} = -\beta K\frac{d\lambda_{sc}}{dT} - \frac{K^2\beta}{4}\left(\frac{d\lambda_{sc}}{dT}\right)^2 + \frac{T}{2T^2}K\frac{d\lambda_{sc}}{dT} + \frac{1}{8}K^2\beta\left(\frac{d\lambda_{sc}}{dT}\right)^2$$

$$\left.\frac{d^2F_n}{dT^2}\right|_{T_c} = -\frac{\beta K}{2}\frac{d\lambda_{sc}}{dT} - \frac{1}{8}K^2\beta\left(\frac{d\lambda_{sc}}{dT}\right)^2 \Rightarrow$$

Extra term..., but still $\propto \frac{d\Delta}{dT}, \frac{d^2\Delta}{dT^2}$

5/5/2018

$$\lambda_{sc} = \frac{1-2\kappa}{\kappa(1-\kappa)} \cdot \frac{2\Delta}{\pi J_\rho} \quad \text{and previously} \quad \frac{\partial^2 F_{old}}{\partial T^2} = \frac{2Z^2}{\pi T}\frac{d\Delta}{dT} \quad @\ \Delta = 0$$

5.3

$$\left.\frac{d^2 F_n}{dT^2}\right|_{\Delta=0} = -\beta\kappa \frac{d\lambda_{sc}}{dT} - \frac{1}{2}\beta\kappa^2\left(\frac{d\lambda_{sc}}{dT}\right)^2$$

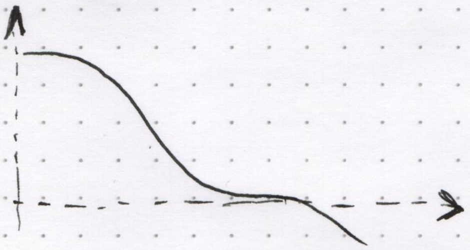
$$\therefore \left.\frac{\partial^2 (F_{old}+F_n)}{dT^2}\right|_{\Delta=0} = \frac{2Z^2}{\pi T}\frac{d\Delta}{dT} \underbrace{- \frac{(1-2\kappa)}{T(1-\kappa)} \cdot \frac{2}{\pi J_\rho}\frac{d\Delta}{dT} - \frac{1}{2T}\kappa^2 \frac{(1-2\kappa)^2}{\kappa^2(1-\kappa)^2}\frac{4}{\pi^2 J_\rho^2}\left(\frac{d\Delta}{dT}\right)^2}$$

How to get rid of J_ρ terms?

6/5/2018.

Have realised that it does seem to be possible to have $\frac{d\Delta}{dT} \to 0$ @ $\Delta = 0$, at least in practice because my previous code still had the line continuation error.

Can pick out



From before, $\frac{d\Delta}{dT} = \dots$

and

$$\frac{d\Psi}{dT} = \frac{d\Psi}{du}\frac{\partial u}{\partial \Delta}\cdot\frac{d\Delta}{dT} + \frac{d\Psi}{du}\cdot\frac{\partial u}{\partial Z^2}\cdot\frac{dZ^2}{dT} + \frac{d\Psi}{du}\cdot\frac{\partial u}{\partial T}$$

$$\Rightarrow \frac{d\Delta}{dT} = \left(\frac{\partial u}{\partial \Delta}\right)^{-1}\left[\frac{d\Psi}{dT}\cdot\left(\frac{d\Psi}{du}\right)^{-1} - \frac{\partial u}{\partial T} - \frac{\partial u}{\partial Z^2}\cdot\frac{\partial Z^2}{\partial T}\right]$$

$$\therefore \text{Would require } 0 = \left[-\frac{1}{T} - \frac{1}{J_\rho}\frac{d}{dT}\left[\frac{1}{Z^2}\right]\right] - \left(\frac{d\Psi}{du}\right)\left[-\frac{Z^2\Delta}{2\pi T^2} + \frac{\Delta}{2\pi T}\frac{d}{dT}\left[Z^2\right]\right]$$

↖ vanishes @ $\Delta = 0$

$$\therefore \text{Can have } \left. -\frac{1}{T} + \frac{dZ^2/dT}{J_\rho Z^4}\right|_{\Delta=0} = 0 \quad \text{i.e. same as before.}$$