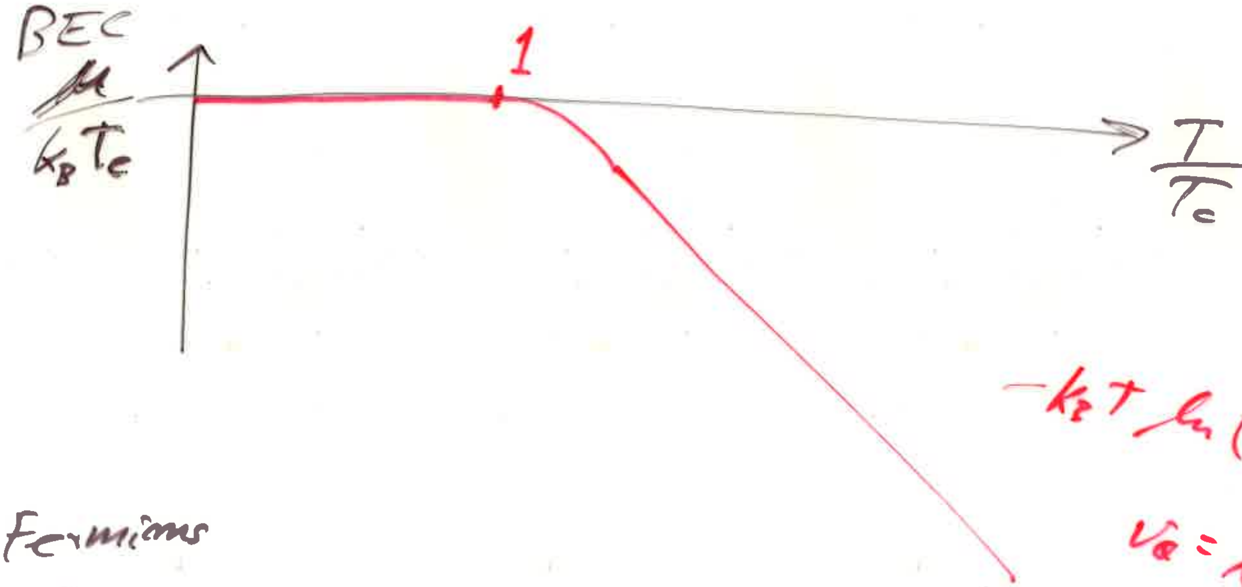
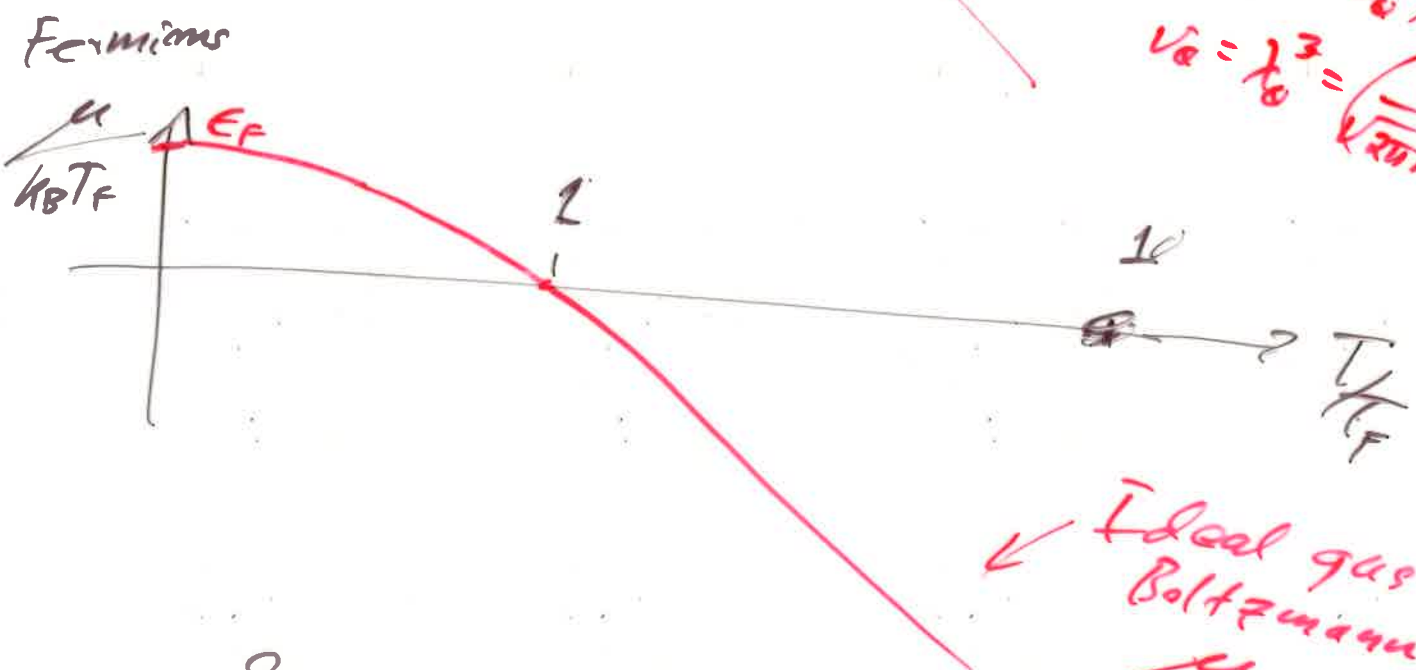
BEC is infinitely compressible.
BEC exerts no pressure.
BEC states fill the container.

BEC. space dimension dependent.
$\Rightarrow$ No BEC in 2 dimensions.



$$-k_B T \ln\left(\frac{V}{N v_Q}\right)$$

$$v_Q = \lambda_Q^3 = \left(\frac{h}{\sqrt{2\pi m k_B T}}\right)^3$$



$$\delta \ll \epsilon_0 \ll k_B T_c$$

$\epsilon_0 - \mu$ ground state energy

$N = 10{,}000$ atoms of Rb-87 $\qquad L = 10^{-5}\,m$

$$\epsilon_0 = \frac{h^2}{8mL^2}(1^2+1^2+1^2) = 7.1\times10^{-14}\ eV$$

m: atom-Rb87

$$k_B T_c = \frac{h^2}{2\pi m}\left(\frac{N}{V}\right)^{2/3}(0.527) = 7.4\times10^{-12}\ eV \sim 100\,\epsilon_0$$

$$\epsilon_0 \ll k_B T_c$$

$$T_c = 8.6\times10^{-8}\,K$$

$$T = 0.9\,T_c$$

$$N^* = \underbrace{\zeta\left(\tfrac{3}{2}\right)}_{2.6}\left(\frac{2\pi m k_B T}{h^2}\right)^{3/2} V = \zeta\left(\tfrac{3}{2}\right)\frac{V}{V_Q}$$

$$N_0 = N - N^* = \left[1-\left(\frac{T}{T_c}\right)^{3/2}\right]N = 0.1462\,N$$

$$N_0 = 1462$$

$$\delta = \frac{k_B T}{N_0} = \frac{k_B(0.9T_c)}{N_0} = \frac{0.9\ 7.4\times10^{-12}\,eV}{1462} =$$

$$= 4.5\times10^{-15}\ eV$$

$$\delta < \epsilon_0 \ll k_B T_c$$

$$\lim_{T\to 0}\delta = 0$$

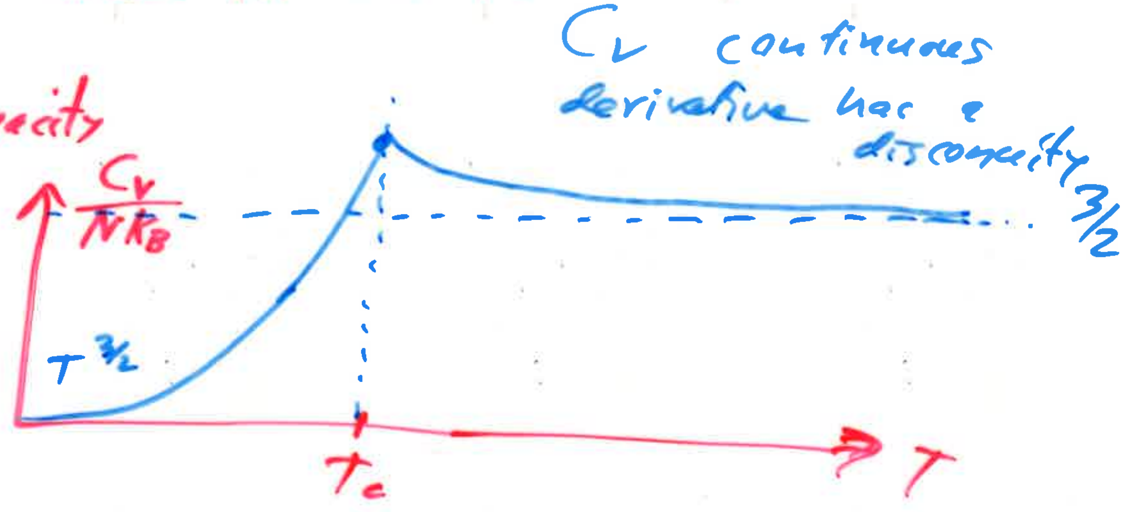
Is superfluid ^4He II a BEC?

Yes
- ^3He is a fermion and it does not form a superfluid at the T_c for ^4He. ($T_c \approx 2.6K$)
- T_c for $^4He \approx 3.3K$
- Two fluid model superfluid ^4He II
  Laszlo Tisza.

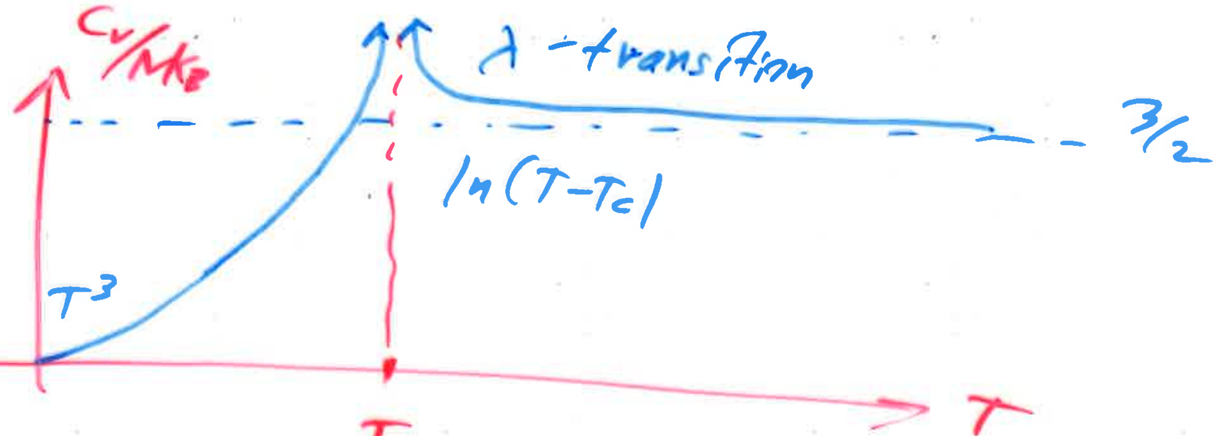
No
- BEC is infinitely compressible but ^4He II is almost incompressible.

Heat Capacity

BEC



^4He II



We are ignoring interactions between atoms.