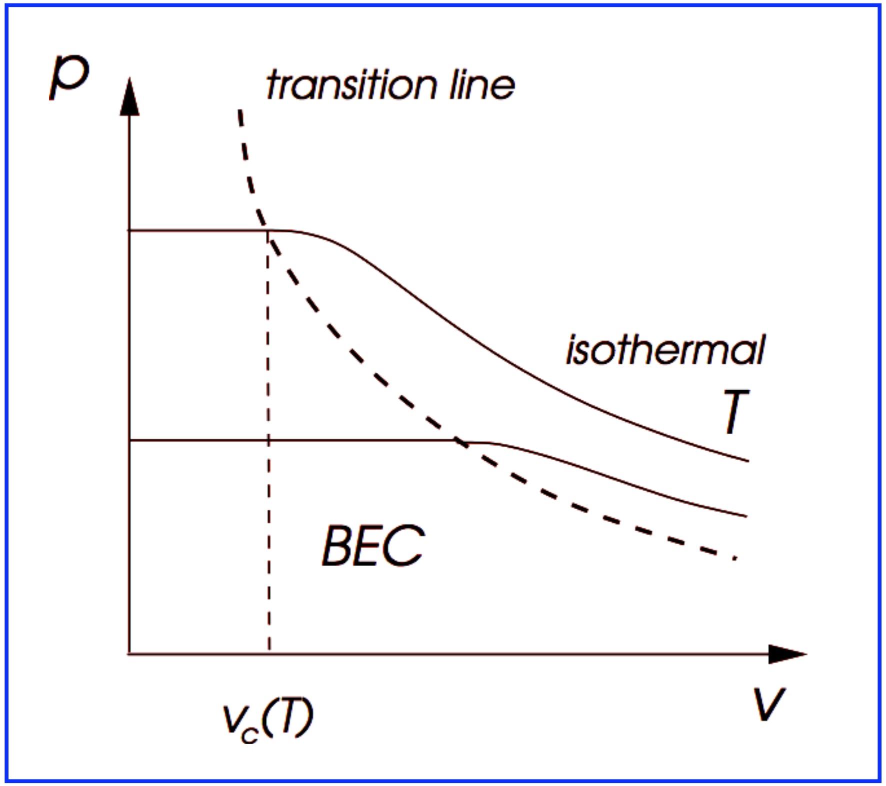
equation of state

$$p = \begin{cases} \dfrac{k_B T}{\lambda^3} g_{5/2}(z) \,, & V > V_c \\ \dfrac{k_B T}{\lambda^3} g_{5/2}(1) \,, & V < V_c \end{cases}$$



compressibility $V > V_c$

$$\kappa_T = \frac{N\lambda^6}{V k_B T g_{3/2}(z)^2} \frac{g'_{3/2}(z)}{g'_{5/2}(z)}$$

← diverges at $z = 1$

entropy (fixed μ)

$$S(T,V,\mu) = -\left(\frac{\partial \Omega}{\partial T}\right)_{V,\mu} = \begin{cases} Nk_B \left(\frac{5v}{2\lambda^3} g_{5/2}(z) - \ln z\right), & T > T_c, \\ Nk_B \frac{5}{2} \frac{g_{5/2}(1)}{g_{3/2}(1)} \left(\frac{T}{T_c}\right)^{3/2}, & T < T_c \end{cases}$$

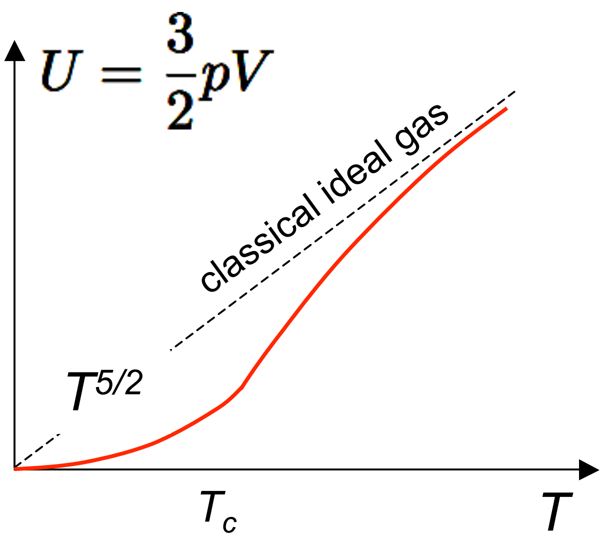
entropy per particle

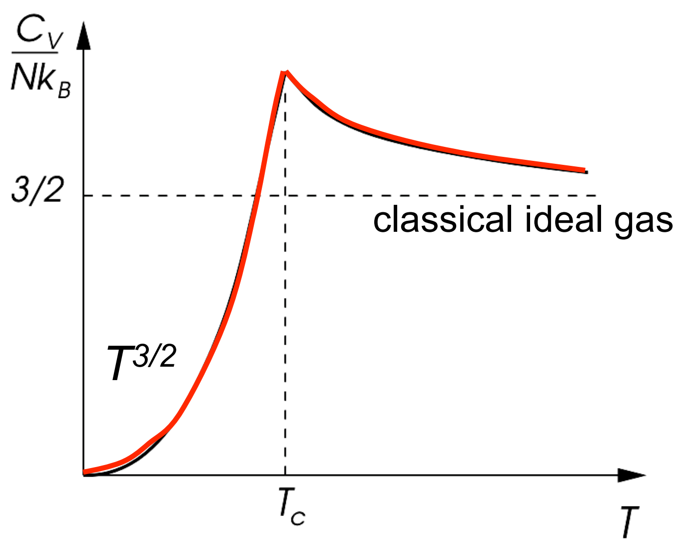
$$\frac{S}{N} = s\left(\frac{T}{T_c}\right)^{3/2} = \frac{n_n(T)}{n} s \qquad \text{with} \quad s = \frac{5}{2} k_B \frac{g_{5/2}(1)}{g_{3/2}(1)}$$

contribution to entropy from normal particles only

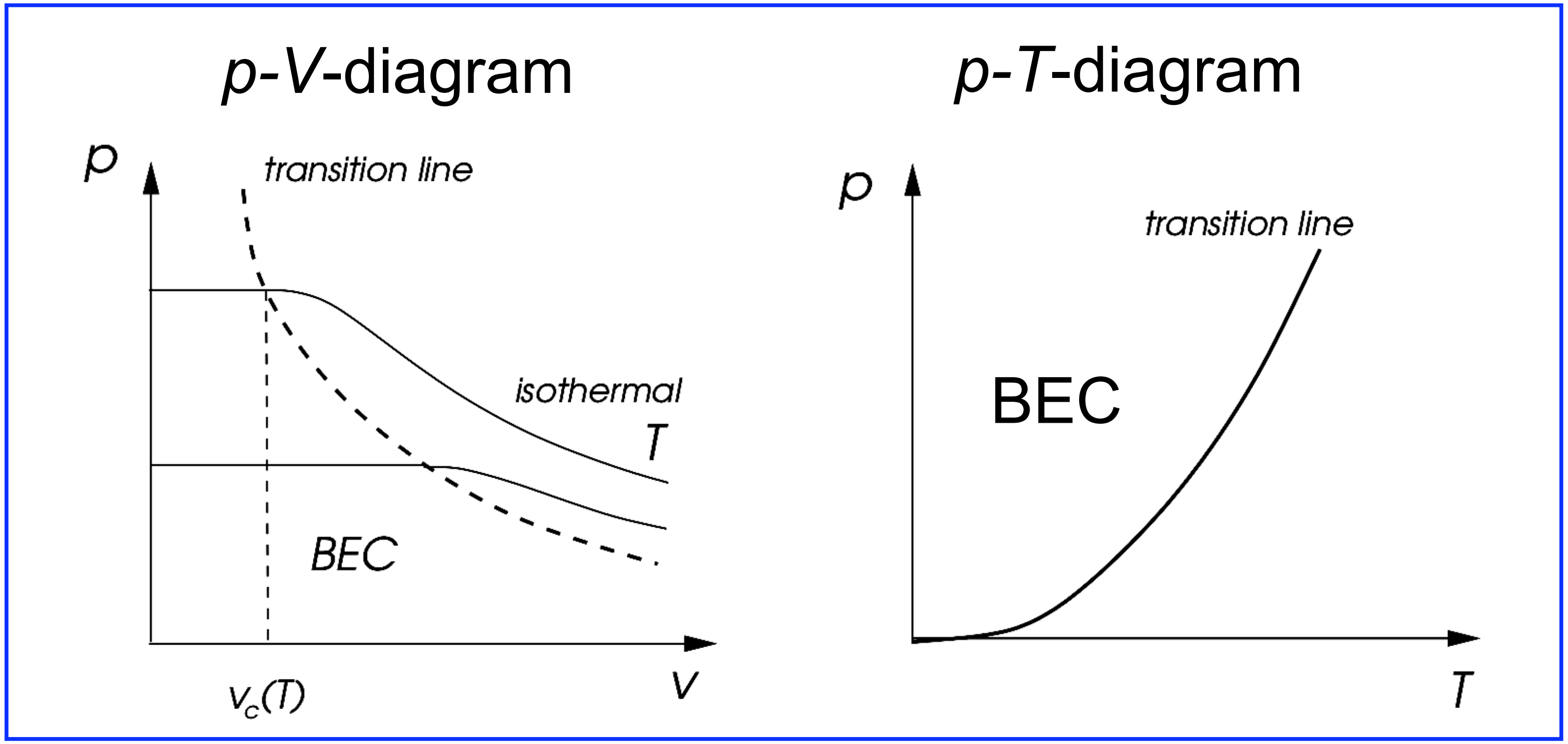
heat capacity (fixed N)

$$C_V = \left(\frac{\partial U}{\partial T}\right)_{V,N} = \begin{cases} Nk_B\left(\frac{15v}{4\lambda^3}g_{5/2}(z) - \frac{9}{4}\frac{g_{3/2}(z)}{g_{1/2}(z)}\right), & T > T_c, \\ Nk_B\frac{15}{4}\frac{g_{5/2}(1)}{g_{3/2}(1)}\left(\frac{T}{T_c}\right)^{3/2}, & T < T_c \end{cases}$$





phase diagram

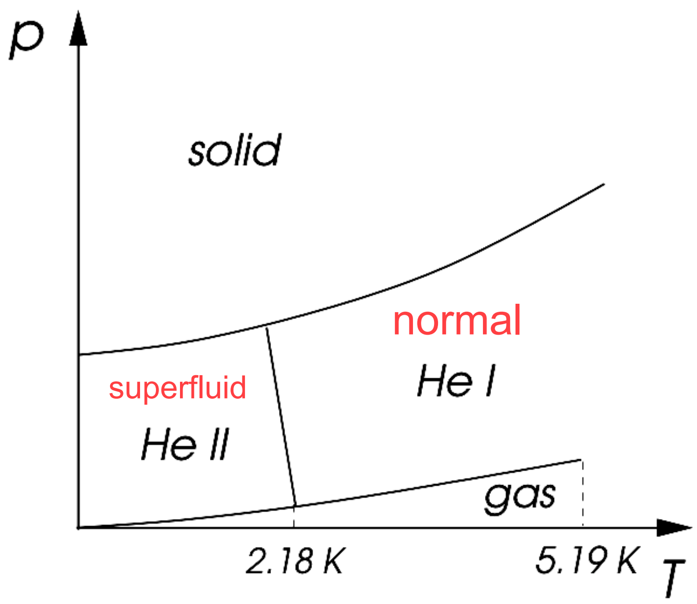


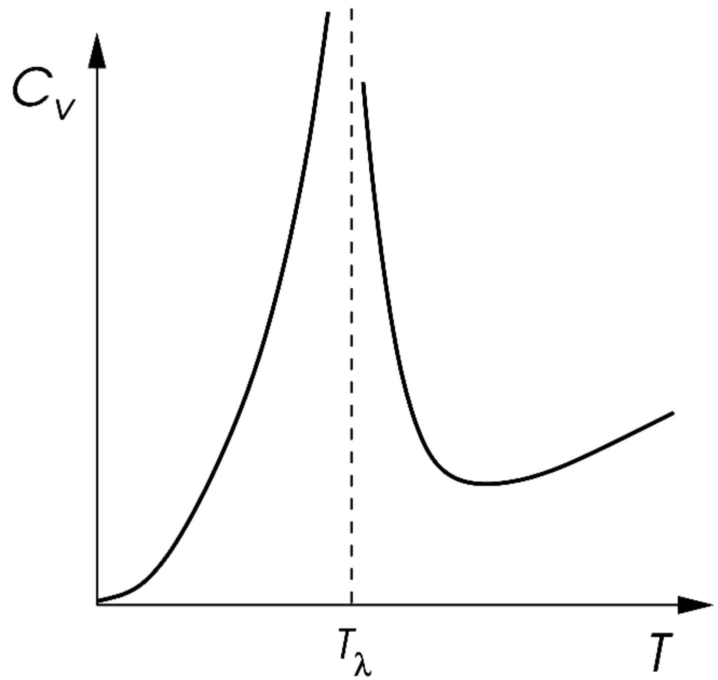
$$p_0 v^{5/3} = \frac{h^2}{2\pi m} \frac{g_{5/2}(1)}{[g_{3/2}(1)]^{5/3}}$$

$$p_0 = \frac{k_B T}{\lambda^3} g_{5/2}(1) \propto T^{5/2}$$

superfluid ^4He bosonic atoms

BEC ➡ superfluid ➡ frictionless flow
rigidity of condensate





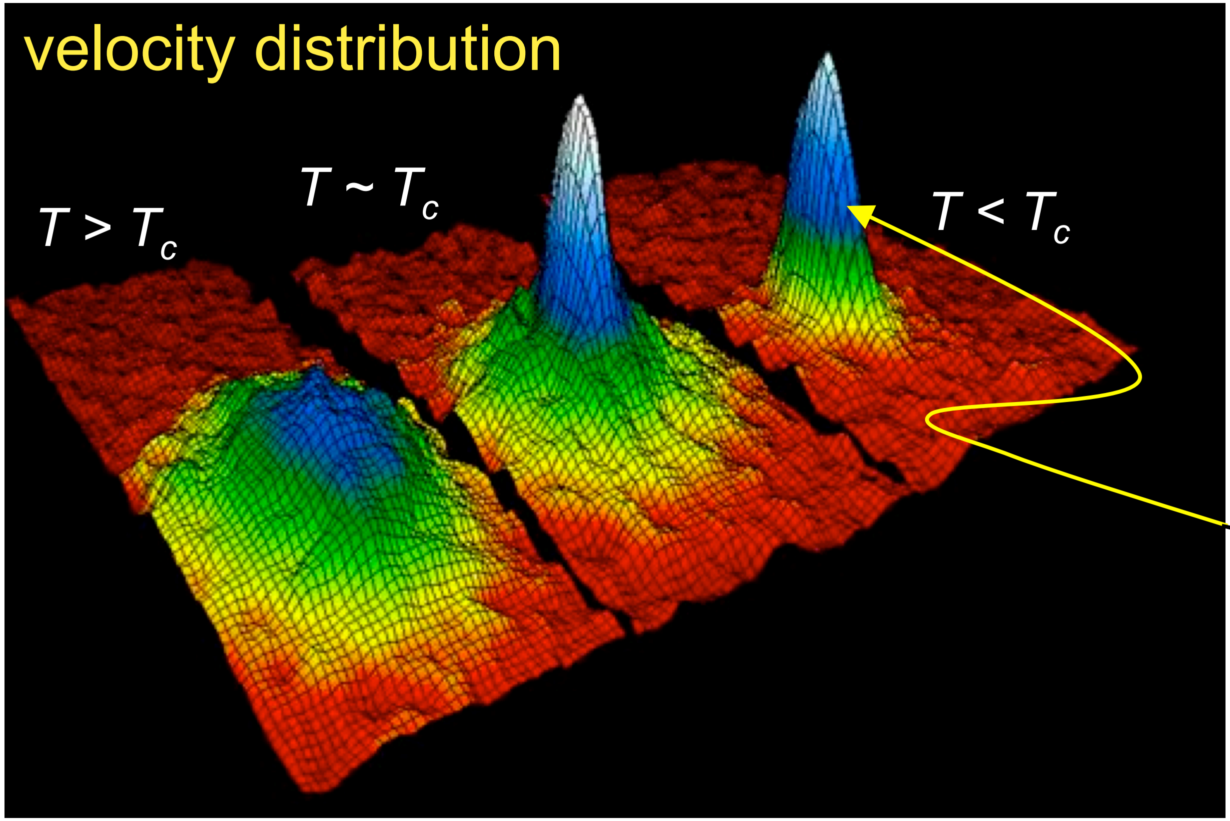
„ λ - transition “

Bose-Einstein condensation BEC

ultra-cold atomic gases

^{87}Rb 37 electrons + 87 nucleons = 124 Fermions ➡ Boson

2000 Rb atoms in a trap $T_c = 170\ nK$



macroscopic occupation of state with $p = 0$