B25 + (2 δ_{00} = Find T_c such that $k_B T_c \ll \frac{p_F^2}{2m_A} < \epsilon_0$)

(2008 6.1)

N fermions spin $\frac{1}{2}$ type F

$F \leftrightarrow A + B$ A: fermion

B boson, $(dN_F = -dN_A = -dN_B)$

$$F = F_F(N_F) + F_A(N_A) + F_B(N_B) - \epsilon_0 N_A \Rightarrow dF = (\mu_F - \mu_A - \mu_B + \epsilon_0)\, dN_F = 0$$

$$n_A = 2 \sum_p \frac{1}{e^{\beta(\frac{p^2}{2m_A} - \mu_A)} + 1}$$

$$n_F = 2 \sum_p \frac{1}{e^{\beta(\frac{p^2}{2m_F} - \mu_F)} + 1}$$

$$n_B = \sum_p \frac{1}{e^{\beta(\frac{p^2}{2m} - \mu_B)} - 1} + n_B^0$$

(א

$$\begin{cases} n_A = n_B \\ n_F + n_A = n \\ \mu_F + \epsilon_0 = \mu_A + \mu_B \end{cases}$$

ב) בטמפרטורה אפס הבוזונים בקונדנסציה

$n_B = n_B^0$

$\mu_B = 0$

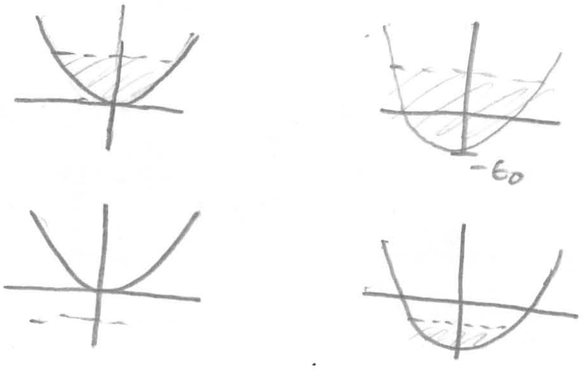
$\mu_F + \epsilon_0 = \mu_A$

מכאן

$$(*) \quad n_F + n_A = \frac{1}{3\pi^2\hbar^3}(2m_F\mu_F)^{3/2} + \frac{1}{3\pi^2\hbar^3}(2m_A(\mu_F + \epsilon_0))^{3/2} = n$$

$\mu_F = \mu_A - \epsilon_0$

F A



$\mu_F > 0$

$n_F = 0$ צריך $\mu_F < 0$ ⇐

$\mu_F < 0$

נקודה זו $\mu_F = 0$ מתחיל איכלוס n_F

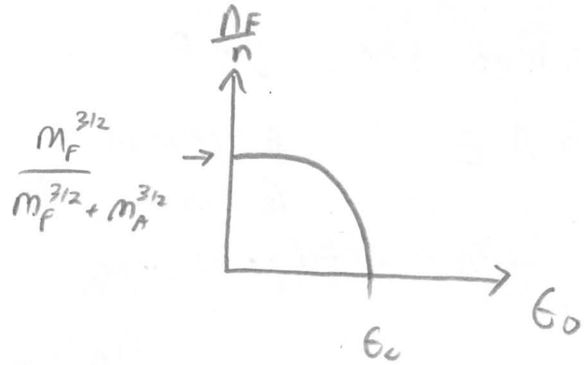
$\mu_F = \mu_A - \epsilon_0$

לכן צריך $\mu_F = 0$ ⇐ צריך $\epsilon_c = \epsilon_0$ $n_F = 0$

$$n = \frac{1}{3\pi^2\hbar^3}(2m_A\epsilon_c)^{3/2} = n_A$$

[illegible]

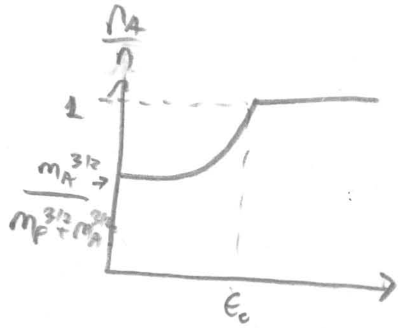
מכאן



בנקודה $\epsilon_0=0$ נקבל מ-(*)

$$\frac{n_F}{n} = \frac{m_F^{3/2}}{m_F^{3/2}+m_A^{3/2}}$$

ולכן עבור $n_A = n - n_F$ נקבל



ג) נתון $k_B T_c \ll \frac{p_F^2}{2m_A} < \epsilon_0$, p_F תנע פרמי לחלקיקים A

T_c - טמפרטורת BEC עבור חלקיקים B.

עבור $\frac{p_F^2}{2m_A} = \mu_F + \epsilon_0 < \epsilon_0$

נקבל $\mu_F<0$ ולכן $n_F=0$ מכאן $n_A=n$, $n_B=n$

אבל $\mu_F+\epsilon_0 = \frac{(3\pi^2\hbar^3 n)^{2/3}}{2m_A}$

ועבור $k_BT_c \ll \mu_F+\epsilon_0$. נקבל $k_BT_c \ll \frac{(3\pi^2\hbar^3 \overset{n_A}{n})^{2/3}}{2m_A}$

מכיון ש- $n_B=n$ אני יודע ש- $k_BT_c = \frac{2\pi\hbar^2}{m_B(2.612)^{2/3}} \underset{n_B}{n}^{2/3}$

ולכן $\frac{2\pi\hbar^2}{m_B(2.612)^{2/3}} \ll \frac{(3\pi^2\hbar^3)^{2/3}}{2m_A}$ או

$$\boxed{\frac{m_B}{m_A} \ll \frac{4\pi}{(3\pi^2)^{2/3}(2.61)^{2/3}} = 0.69}$$

$F \to A + B + \ell$

$$F = F_F(N_F) + F_A(N_A) + F_B(N_B) - \epsilon_0 N_A \qquad dN_F = -dN_A = -dN_B \quad (3$$

$$dF = (\mu_F - \mu_A - \mu_B + \epsilon_0)\, dN_F = 0$$

$n_F + n_A = n$

$n_A = n_B$

$$n_A = g_A \sum_p \left[e^{\beta(p^2/2m_A - \mu_A)} + 1 \right]^{-1} \quad \overset{T=0}{=} \quad (2m_A\mu_A)^{3/2}/3\pi^2\hbar^3$$

($g = 2$ spin states)

$$n_F = g_F \sum_p \left[e^{\beta(p^2/2m_F - \mu_F)} + 1 \right]^{-1}$$

$$n_B = g_B \sum_p \left[e^{\beta(p^2/2m_A - \mu_B)} - 1 \right]^{-1} + n_B^0$$

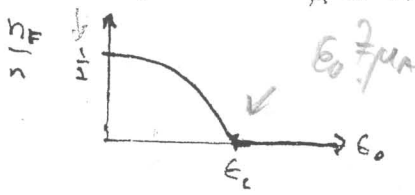
$T = 0$: $\mu_B = 0$ $\quad \mu_A = \mu_F + \epsilon_0$

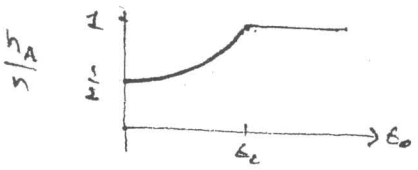
$$\frac{1}{3\pi^2\hbar^3}(2m_A\mu_F)^{3/2} + \frac{1}{3\pi^2\hbar^3}(2m_A(\mu_F+\epsilon_0))^{3/2} = n$$

(μ_F: m_F, n_F; $\mu_A - \epsilon_0$; μ_A: m_A, n_A)

if $\dfrac{(2m_A\epsilon_0)^{3/2}}{3\pi^2\hbar^3} < n$

if $n_A = n$ $\quad n_F = 0$ $\quad \epsilon_0 > \mu_F$





if $\dfrac{(2m_A\epsilon_0)^{3/2}}{3\pi^2\hbar^3} > n$

If $\epsilon > \epsilon_c$ highest level of A fermions below zero of F fermions