# MAKSVELL BOLTSMANN TAQSIMOT FUNKSIYASI

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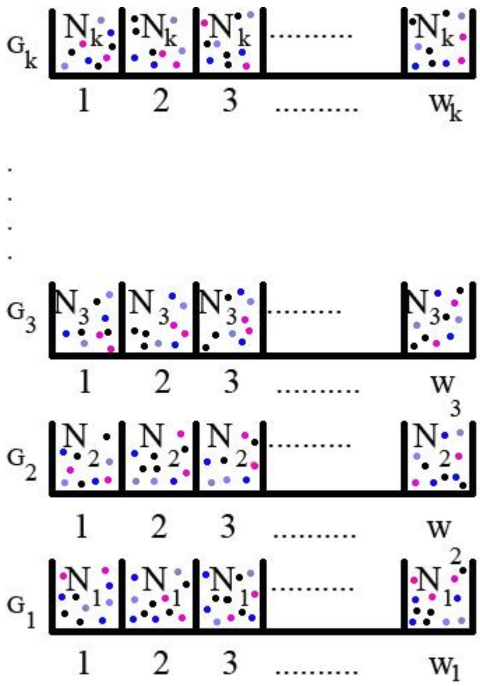
**Annotatsiya:** Maksvell Botsmann taqsimot funksiyasi aynimagan gaz taqsimot funksiyasidir, demak biz aynimagan gaz taqsimot funksiyasini o'rganamiz.

Kalit so'zlar: Maksvell Botsmann, Aytaylik, gazlar, molekulalar

**1-Ta'rif.** Aytaylik ma'lum hajimda N ta holat (joy) bo'ilb bu holatlarga G ta gaz molekulalari (bir hil isimlilari) takrorli joylashgan bo'lsin. Agar gaz molekulalarining joylashuvlar chastotasi $\nu = \frac{N}{G}$ nisbat birdan juda kichik bo'lsa ya'ni: $\frac{N}{G} << 1 \Rightarrow N << G$ **(1)** u holda bunday holatlarni egallagan gazlar aynimagangan gazlar deb ataladi, (1) ifoda esa gazlarning aynimaslik sharti deyiladi.

Yuqoridagi ta'rifdan ko'rinadiki gaz molekulalarining soni holatlar sonidan juda ham ko'p bo'lsa (bir hil isimli) gaz molekulalari holatlarga majburan takroran joylashadi. Shuning uchun gaz molekulalarining holatlarga taqsimlashda takroriy o'rinlashtirish va takroriy o'rin almashtirish qonunlaridan foydalanamiz.

**1°.** Aytaylik $G_1$ ta molekulani har bir holatga $N_1$ tadan takrorli o'rinlashtirib joylashtirsak, u holda barcha holatlar soni $W_1$ ga teng, $G_2$ ta molekulani har bir holatga $N_2$ tadan takrorli o'rinlashtirib joylashtirsak, u holda barcha holatlar soni $W_2$ ga teng, $G_3$ ta molekulani har bir holatga $N_3$ tadan takrorli o'rinlashtirib joylashtirsak, u holda barcha holatlar soni $W_3$ ga teng va ho kazo $G_k$ ta molekulani har bir holatga $N_k$ tadan takrorli o'rinlashtirib joylashtirsak, u holda barcha holatlar soni $W_k$ ga teng (rasmga qarang). Albatta bunda bir hil isimli molekulalar takrorlanadi.



Endi holatlar sonini tahlil qilamiz; $G_1$ ta molekulani har bir holatga $N_1$ tadan takroriy o'rinlashtirishlar soni $W_1 = G_1^{N_1}$ ga teng, $G_2$ ta molekulani har bir holatga $N_2$ tadan takroriy o'rinlashtirishlar soni $W_2 = G_2^{N_2}$ ga teng, $G_3$ ta molekulani har bir holatga $N_3$ tadan takroriy o'rinlashtirishlar soni $W_3 = G_3^{N_3}$ ga teng vahokazo $G_k$ ta molekulani har bir holatga $N_k$ tadan takroriy o'rinlashtirishlar soni $W_k = G_k^{N_k}$ **(2)** ga teng deb olamiz va $W_1; W_2; W_3; \ldots W_k$ barcha sathlardagi molekulalarni birgalikda bo'lish sharti: $W = W_1 \cdot W_2 \cdot W_3 \cdot \ldots \cdot W_k$ **(3)** dan quydagini olamiz.

(3) ifodaga (2) ifodalarni qo'ysak

$$W = G_1^{N_1} \cdot G_2^{N_2} \cdot G_3^{N_3} \cdot \ldots \cdot G_k^{N_k} = \prod_{k=1}^{k} G_k^{N_k} \quad \textbf{(4)}$$

ifoda hosil bo'ladi bu (4) ifoda barcha sathlardagi molekulalarni birgalkda bo'lish shartini ifodalaydi.

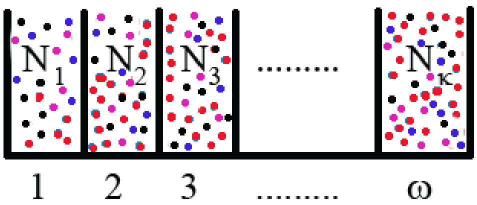
**2°.** Ma'lum hajimda $N$ ta molekula bo'lib bu molekulalarni har bir holatga $N_1$ tadan, $N_2$ tadan, $N_3$ tadan vahokazo $N_k$ tadan takorli o'rin almashtirib joylashtiraylik, bunday o'rin almashtirib joylashishlar soni (albata bunda bir hil isimli gaz molekulalari takrorlanadi )

$$\Omega = \frac{N!}{N_1! \cdot N_2! \cdot \ldots \cdot N_k!} = \frac{N!}{\prod_{k=1}^{k} N_k!}$$

**(5)** ga teng.

Bunda:

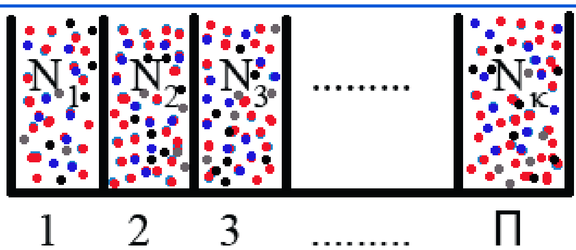
$$N = N_1 + N_2 + N_3 + \ldots + N_k = \sum_{k=1}^{k} N_k \quad \textbf{(6)}.$$




**3°.** Yuqoridagi ifodalardan ko'rinadiki aynimagan gaz molekulalarining taqsimoti (4) va (5) ifodalarning ko'paytmasi bilan aniqlanadi chunki (4) va (5) ifodalarning bir vaqitda ro'y berish ehtimoli bu ifodalarning ko'paytmasiga teng, shu sababdan bu ifodalarni ko'paytmasini topamiz.

$$\Pi = W \cdot \Omega = \prod_{k=1}^{k} G_k^{N_k} \cdot \frac{N!}{\prod_{k=1}^{k} N_k!} \quad \textbf{(7)}.$$

Bu (7) ifoda barcha holatlarda gaz molekulalarini taqsimlanishlar chastotasini ifodalaydi.




**4°.** (7) ifodani ko'paytuvchilarini yig'ndi ko'rinishga o'tish uchun bu ifodani logarifmlab quydagi natijaga kelamiz:

$$\ln \Pi = \ln\Big(\prod_{k=1}^{k} G_k^{N_k} \cdot \frac{N!}{\prod_{k=1}^{k} N_k!}\Big) = \ln\Big(\prod_{k=1}^{k} G_k^{N_k}\Big) + \ln(N!) - \ln\Big(\prod_{k=1}^{k} N_k!\Big)$$ **(8)**.

Endi (8) ifodani soddalashtiramiz:

$$\ln\Big(\prod_{k=1}^{k} G_k^{N_k}\Big) = \ln(G_1^{N_1} \cdot G_2^{N_2} \cdot G_3^{N_3} \cdot \ldots \cdot G_k^{N_k}) = \ln G_1^{N_1} + \ln G_2^{N_2} + \ln G_3^{N_3} + \ldots + \ln G_k^{N_k} =$$

A) $$N_1 \cdot \ln G_1 + N_2 \cdot \ln G_2 + N_3 \cdot \ln G_3 + \ldots + N_k \cdot \ln G_k = \sum_{k=1}^{k} N_k \cdot \ln G_k$$

Demak natija quydagicha: $$\ln\Big(\prod_{k=1}^{k} G_k^{N_k}\Big) = \sum_{k=1}^{k} N_k \cdot \ln G_k$$ **(9)**

B) $$\ln(N!) = \ln 1 \cdot 2 \cdot 3 \cdot \ldots \cdot N = \ln 1 + \ln 2 + \ln 3 + \ldots + \ln N = \sum_{N=1}^{N} \ln N = \int_1^N \ln N dN \Rightarrow$$

$$\int_1^N \ln N dN \Rightarrow \begin{cases} for: \int u dv = u \cdot v - \int v du \\ belgilash: u = \ln N \Rightarrow du = \dfrac{du}{N} \Rightarrow (N \ln N)\Big|_1^N - \int_1^N N \cdot \dfrac{dN}{N} = \\ dv = dN \Rightarrow v = N \end{cases}$$

$$= N \ln N - 1\ln 1 - N\Big|_1^N = N \ln N - N + 1$$

Demak: $$\int_1^N \ln N dN = N \ln N - N + 1$$ **(10)**

$$\ln\Big(\prod_{k=1}^{k} N_k!\Big) = \ln N_1! \cdot N_2! \cdot N_3! \cdot \ldots \cdot N_k! = \ln N_1! + \ln N_2! + \ln N_3! + \ldots + \ln N_k! = \sum_{k=1}^{k} \ln N_k! =$$

C) $$\sum_{k=1}^{k} [N_k \cdot \ln N_k - N_k + 1] = \sum_{k=1}^{k} [N_k \cdot \ln N_k] - \sum_{k=1}^{k} [N_k] + \sum_{k=1}^{k} [1] = \sum_{k=1}^{k} [N_k \cdot \ln N_k] - N + 1$$

(6) formuladan; $\sum_{k=1}^{k} [N_k] = N$ va $\sum_{k=1}^{k} 1 = 1$ dan foydalandik.

U holda: $$\ln\Big(\prod_{k=1}^{k} N_k!\Big) = \sum_{k=1}^{k} [N_k \cdot \ln N_k] - N + 1$$ **(11)** ga teng bo'ladi.

Endi (9), (10) va (11) ifodalarni (8) ifodaga ga qo'yamiz:

$$\ln \Pi = \ln(\prod_{k=1}^{k} G_k^{N_k} \cdot \frac{N!}{\prod_{k=1}^{k} N_k!}) = \ln(\prod_{k=1}^{k} G_k^{N_k}) + \ln(N!) - \ln(\prod_{k=1}^{k} N_k!) =$$

$$\sum_{k=1}^{k} N_k \cdot \ln G_k + N\ln N - N + 1 - \sum_{k=1}^{k}[N_k \cdot \ln N_k] + N - 1 = \sum_{k=1}^{k} N_k \cdot \ln G_k + N\ln N - \sum_{k=1}^{k}[N_k \cdot \ln N_k]$$

Demak (8) ifodani soddalashgan ifodasi quydagicha:

$$\ln \Pi = \sum_{k=1}^{k} N_k \cdot \ln G_k + N\ln N - \sum_{k=1}^{k}[N_k \cdot \ln N_k] \quad \textbf{(12)}.$$

**5°.** Shunday qilib hosil qilingan (12) ifoda aynimagan gaz molekulalarining holatlar funksiyasi bo'lib; bunda $N_k$- $\Pi$-holatga to'g'ri keluvchi molekulalar sonidir, ya'ni holatlar zichligidir, shuning uchun $N_k$ ni erkli o'zgaruvchi deb qarab $\ln \Pi$ funksiyani statsionar holatlarini aniqlaymiz.

Ferma teoremasiga ko'ra $\ln \Pi$ funksiyaning statsionar holatlar sharti

$$\partial \ln \Pi = 0 \quad \textbf{(13)}.$$

Demak (12) ifodani har ikki tarafini differensallaymiz:

$$\partial(\ln \Pi) = \partial\left[\sum_{k=1}^{k} N_k \cdot \ln G_k + N\ln N - \sum_{k=1}^{k}[N_k \cdot \ln N_k]\right]$$

Endi o'ng tarafdagi ifodani alohida alohida differensallarini guruhlab olamiz:

$$\partial(\ln \Pi) = \partial(N\ln N) + \left[\partial(\sum_{k=1}^{k} N_k \cdot \ln G_k) - \partial\left[\sum_{k=1}^{k}[N_k \cdot \ln N_k]\right]\right] \Rightarrow$$

$$\partial(N\ln N) + \left[\partial(\sum_{k=1}^{k} N_k \cdot \ln G_k) - \partial\left[\sum_{k=1}^{k}[N_k \cdot \ln N_k]\right]\right] = 0 \quad \textbf{(14)}.$$

Demak ifoda ikki guruhga ajradi, endi bu ifodalarni differensallaymiz:

$$\partial(N\ln N) = \partial[(N_1 + N_2 + N_3 + .... + N_k) \cdot \ln(N_1 + N_2 + N_3 + .... + N_k)] =$$
$$= \partial(N_1 + N_2 + N_3 + .... + N_k) \cdot \ln(N_1 + N_2 + N_3 + .... + N_k) +$$

1) $$+ \partial[\ln(N_1 + N_2 + N_3 + .... + N_k)] \cdot (N_1 + N_2 + N_3 + .... + N_k) \quad \textbf{(15)}$$

$N_1; N_2; N_3; ....; N_k$ lar alohida alohida o'zgaruchilar bo'lgani uchun, ko'p o'zgaruvchili funksiya differensalidan foydalanamiz:

A) $$\partial(N_1 + N_2 + N_3 + .... + N_k) = \partial N_1 + \partial N_2 + \partial N_3 + .... + \partial N_k = \sum_{k=1}^{k} \partial N_k \quad \textbf{(16)}$$

B)

$$\partial[\ln(N_1 + N_2 + N_3 + .... + N_k)] = \partial[\ln(N_1 + N_2 + N_3 + .... + N_k)] \cdot \partial(N_1 + N_2 + N_3 + .... + N_k) =$$
$$= \partial[\ln(N_1 + N_2 + N_3 + .... + N_k)] \cdot (\partial N_1 + \partial N_2 + \partial N_3 + .... + \partial N_k) =$$
$$= \partial[\ln(N_1 + N_2 + N_3 + .... + N_k)] \cdot \sum_{k=1}^{k} \partial N_k \quad \textbf{(17)}.$$

(16) va (17) larning natijalarini (15) tenglamaga qo'yamiz:

$$\partial(N\ln N)=\partial(N_1+N_2+N_3+....+N_k)\cdot\ln(N_1+N_2+N_3+....+N_k)+$$
$$+\partial\left[\ln(N_1+N_2+N_3+....+N_k)\right]\cdot(N_1+N_2+N_3+....+N_k)=$$
$$=\sum_{k=1}^{k}\partial N_k\cdot\ln\left[\sum_{k=1}^{k}N_k\right]+\partial\left[\ln(N_1+N_2+N_3+....+N_k)\right]\cdot\sum_{k=1}^{k}\partial N_k\cdot\left(\sum_{k=1}^{k}N_k\right)=$$
$$=\sum_{k=1}^{k}\partial N_k\left[\ln\left[\sum_{k=1}^{k}N_k\right]+\partial\left[\ln\left[\sum_{k=1}^{k}N_k\right]\right]\cdot\left(\sum_{k=1}^{k}N_k\right)\right]$$

Demak (15) ifodaning natijasi quydagicha:

$$\partial(N\ln N)=\sum_{k=1}^{k}\partial N_k\left[\ln\left[\sum_{k=1}^{k}N_k\right]+\partial\left[\ln\left[\sum_{k=1}^{k}N_k\right]\right]\cdot\left(\sum_{k=1}^{k}N_k\right)\right] \quad \textbf{(18)}.$$

Shunday qilib $\sum_{k=1}^{k}\partial N_k=\partial N_1+\partial N_2+\partial N_3+....+\partial N_k$ ifoda erkli o'zgaruvchilarning difrensiali bolib bu tenglamaning nolga teng bolishi $N_k$ larning stasionar holatlar shartini beradi;

$\sum_{k=1}^{k}\partial N_k=0$ **(19)** bundan (15) ifodaning ham natijasi quydagicha:

$$\sum_{k=1}^{k}\partial N_k\left[\ln\left[\sum_{k=1}^{k}N_k\right]+\partial\left[\ln\left[\sum_{k=1}^{k}N_k\right]\right]\cdot\left(\sum_{k=1}^{k}N_k\right)\right]=0\Leftrightarrow\partial(N\ln N)=0 \quad \textbf{(20)}.$$

$$\partial(\sum_{k=1}^{k}(N_k\cdot\ln G_k))-\partial\left[\sum_{k=1}^{k}[N_k\cdot\ln N_k]\right]=$$
$$=\sum_{k=1}^{k}[\ln G_k\partial N_k]+0-\sum_{k=1}^{k}[\ln N_k\partial N_k]-\sum_{k=1}^{k}\partial N_k$$

2) .

(19) ifodadan ko'rinadiki:

$$\sum_{k=1}^{k}\partial N_k=0\Rightarrow\sum_{k=1}^{k}[\ln G_k\partial N_k]-\sum_{k=1}^{k}[\ln N_k\partial N_k]=0\Leftrightarrow\sum_{k=1}^{k}[\ln G_k\partial N_k-\ln N_k\partial N_k]=0\Rightarrow$$
$$\sum_{k=1}^{k}\ln\frac{G_k}{N_k}\partial N_k=0$$

$$\partial(\sum_{k=1}^{k}(N_k\cdot\ln G_k))-\partial\left[\sum_{k=1}^{k}[N_k\cdot\ln N_k]\right]\Rightarrow\begin{cases}\sum_{k=1}^{k}\partial N_k=0\rightarrow(19)\\ \sum_{k=1}^{k}\ln\frac{G_k}{N_k}\partial N_k=0\rightarrow(21)\end{cases}$$

Endi 1,2,3,...,П sathlardagi molekulalarni to'la energiyasini statsionar holatlar shartini olamiz:

Aynimagan gaz molekulalari birinchi holatda $E_1\partial N_1$, ikkinchi holatda $E_2\partial N_2$, uchinchi holatda $E_3\partial N_3$ vahokazo k-holatda $E_k\partial N_k$ energiyaga ega. Umumiy barcha holatlarda

$\sum_{k=1}^{k} E_k \partial N_k$ **(22)** ushbu energiyaga ega, demak to'la energiyaning stasionar holatlar sharti: $\sum_{k=1}^{k} E_k \partial N_k = 0$ **(23).**

Shunday qilib (14) tenglamani yechimi bo'lgan statsionar holatlar shartlari topildi. Endi bu tenglamalarni tahlil qilamiz va taqsimot funksiyani aniqlaymiz:

(21) tenglama halatlar taqsimot funksiyasining teskari funksiyasi bolgani uchun bu tenglamani shunday qoldiramiz, bu tenglama albatta birlaksiz kattalik chunki $N_k$ ham $G_k$ ham molekulalar soni.

(19) tenglama esa holatlardagi molekulalar soni, bu ham birliksiz kattalik shuning uchun bu ifodani $\frac{\mu}{kT}$ ga ko'paytiramiz, chunki gaz molekulalarining energiyasi $E = \frac{3}{2}kT$ , $\mu$ esa energiya demak $\mu \approx kT$ .

Endi (23) tenglamaga qaraymiz bu tenglama to'la energiyani ifodalaydi shuning uchun bu tenglamani $\frac{1}{kT}$ ga ko'paytiramiz.

Demak hosil bo'lgan (21), $(19)\cdot\frac{\mu}{kT}$ va $(23)\cdot\frac{1}{kT}$ tenglamalarni yig'indisini olamiz va bu tenglamani yechimini topamiz:

$$\sum_{k=1}^{k} \ln\frac{G_k}{N_k}\partial N_k + \frac{\mu}{kT}\cdot\sum_{k=1}^{k}\partial N_k - \frac{1}{kT}\cdot\sum_{k=1}^{k} E_k\partial N_k = 0$$

k va T lar yig'indiga bog'liq bo'lmagani

$$\sum_{k=1}^{k} \ln\frac{G_k}{N_k}\partial N_k + \sum_{k=1}^{k}(\partial N_k\cdot\frac{\mu}{kT}) - \sum_{k=1}^{k}(E_k\partial N_k\cdot\frac{1}{kT}) = 0 \Rightarrow$$

uchun: $$\sum_{k=1}^{k}\left[\ln\frac{G_k}{N_k} + \frac{\mu}{kT} - E_k\cdot\frac{1}{kT}\right]\partial N_k = 0$$ **(24).**

Bu tenglamani yechimi: $$\ln\frac{G_k}{N_k} + \frac{\mu}{kT} - E_k\cdot\frac{1}{kT} = 0 \Leftrightarrow \ln\frac{G_k}{N_k} = \frac{E_k-\mu}{kT} \Leftrightarrow \frac{G_k}{N_k} = e^{\frac{E_k-\mu}{kT}} \Rightarrow$$

$$\frac{N_k}{G_k} = \frac{1}{e^{\frac{E_k-\mu}{kT}}}$$ **(25).**

(25) funksiya $G_k$ ta aynimagan gaz molekulalarini $N_k$ tadan П ta sathlarga taqsimlanib chiqishi yani taqsimot funksiyasini ifodalayda va aynimagan gaz taqsimot funksiyasi yoki Maksvell Boltsmann taqsimot funksiyasi deyiladi.

Agar (25) funksiyani $\frac{N_k}{G_k} = f_{MB}(E_k)$ deb olsak u holda:

$$f_{MB}(E) = \frac{1}{e^{\frac{E-\mu}{kT}}}$$ **(26)** funksiya hosil bo'ladi.

Demak energiyaga bog'liq Maksvell Boltsmann taqsimot funksiyasi (26) formula bilan ifodalanadi.

**6°. Mikrozarralarning holatlar zichligi:** Mikrozarralarning fazoviy hajmini $\Delta G$ bilan belgilab quydagicha ifodalaymiz:

$\Delta G = \Delta G_V \cdot \Delta G_p = \partial x \partial y \partial z \partial p_x \partial p_y \partial p_z$ **(27)**; bunda $\Delta G_V = \partial x \partial y \partial z$ **(28)**-koordinatalar fazosi hajmi elementi, $\Delta G_p = \partial p_x \partial p_y \partial p_z$ **(29)**-impulslar fazosi hajmi elementi.

Kvant statistikasida Gezmbergning noaniqliklar prinpiga ko'ra olti o'lchamli fazoning hajmi $\hbar^3$ dan kichik emas ya'ni:

$$\begin{cases} \partial p_x \cdot \partial x \geq \hbar \\ \partial p_y \cdot \partial y \geq \hbar \\ \partial p_z \cdot \partial z \geq \hbar \end{cases} \Rightarrow \partial x \partial y \partial z \partial p_x \partial p_y \partial p \geq \hbar^3 \Rightarrow \begin{cases} \partial x \partial y \partial z = V \\ \partial p_x \partial p_y \partial p = \Delta G_p \end{cases} \Rightarrow V \cdot \Delta G_p \geq \hbar^3 \Leftrightarrow \Delta G_p \geq \frac{\hbar^3}{V}$$

**(30)**.

Agar $\Delta G_p$ ni eng kichik ifodasini hisobga olsak u holda (30) ifoda quydagiga teng bo'ladi:

$$\Delta G_p = \frac{\hbar^3}{V}$$ **(31)**.

Bunda $\Delta G_p$ - impulslar fazosi hajmi elementi ya'ni bitta katakchaning impulslar hajmi.

Endi impulslar fazosida radiuslari $p$ va $p + \Delta p$ sferalar qatlamlari orasida hajmi $4\pi p^2 \partial p$ **(32)** bo'lgan shar qatlamini olamiz.

(31) bitta katakcha hajmi (32) qatlamdagi barcha katakchalar hajmi bo'lsa u holda;

$\Delta G_p \cdot G(p) \partial p = 4\pi p^2 \partial p$ bundan barcha katakchalar (holatlar) sonini topsak:

$$g(p)\partial p = \frac{4\pi p^2 \partial p}{\Delta G_p} \Rightarrow g(p)\partial p = \frac{4\pi V p^2 \partial p}{\hbar^3}$$ **(33)** hosil bo'ladi.

**2-Ta'rif.** O'zaro ta'sirlashmaydigan, tashqi maydon ta'sirida bo'lmagan zarralarning potensial energiyasi nol bo'lib faqat knetik energiyaga ega bo'ladi, ya'ni:

$$E_t = E_k = \frac{m\upsilon^2}{2} = \frac{m\vartheta m\vartheta}{2m} = \frac{pp}{2m} = \frac{p^2}{2m}$$ **(34)** ga teng.

Demak erkin zarralar uchun;

$$E = \frac{p^2}{2m} \Rightarrow \begin{cases} p = \sqrt{2mE} \\ \partial E = \partial \frac{p^2}{2m} \Rightarrow \partial E = \frac{p}{m} \partial p \end{cases} \Rightarrow \partial p = \frac{m}{p} \partial E = \frac{m}{\sqrt{2mE}} \partial E = \frac{\sqrt{2m}}{2\sqrt{E}} \partial E$$ **(35)**.

(35) dan $p$ va $\partial p$ ni olib (33) ga qo'yamiz: $g(p)\partial p = \frac{4\pi V m E \sqrt{2m} \partial E}{\hbar^3 \sqrt{E}}$ bu ifoda E ga bog'liq bo'lgani uchun; $$g(E)\partial E = \frac{4\pi V m E \sqrt{2m} \partial E}{\hbar^3 \sqrt{E}} = \frac{2\pi V (2m)^{3/2} \sqrt{E} \partial E}{\hbar^3}$$ **(36)**.

(36) ifoda energiyaga bog'liq holatlar sonidir.

Shunday qilib holatlar zichligini aniqlash uchun (36) ni 0 dan E gacha oraliqda integrallaymiz: $$\int_0^E g(E)\partial E = \int_0^E \frac{2\pi V (2m)^{3/2} \sqrt{E}}{\hbar^3} \partial E \Rightarrow G(E) = \frac{2\pi V}{\hbar^3} \cdot (2mE)^{3/2}$$ **(37)**.

Demak (37) formula mikrozarralarning holatlar zichligini bildiradi.

**7°.** Aynimagan gazlar uchun; $E=\frac{3}{2}kT$ va $n=\frac{N}{V}$ o’rinli bundan (37) ni quydagicha yozamiz: $G(E)=\frac{2\pi V}{\hbar^3}\cdot(2mE)^{3/2} \Leftrightarrow G(E)=\frac{2\pi N}{n}\cdot\left(\frac{3mkT}{\hbar^2}\right)^{\frac{3}{2}} \Leftrightarrow$

$\frac{G(E)}{N}=\frac{2\pi}{n}\cdot\left(\frac{3mkT}{\hbar^2}\right)^{\frac{3}{2}}$ **(38)**.

(22) formuladan $E=\sum_{k=1}^{k}E_k\partial N_k$ ifodani olamiz buni (23) ga qo’yib $E=0$ ni olamiz.

Agar (38) ni $E=0$ bo’lgan holda (25) ga qo’ysak, u holda:

$$\begin{cases}\frac{N}{G}=e^{\frac{\mu-E}{kT}}\\ \frac{G(E)}{N}=\frac{2\pi}{n}\cdot\left(\frac{3mkT}{\hbar^2}\right)^{\frac{3}{2}}\\ E=0\end{cases} \Rightarrow e^{\frac{\mu}{kT}}=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{\frac{3}{2}} \Rightarrow \mu=kT\ln\left[\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\right]$$ **(39)** hosil bo’ladi, bu formula kimyoviy potensial deyiladi.

Endi (39) ni taqsimot funksiyasiga qo’ysak ya’ni (26) ga u holda taqsimot funksiyani E ga bog’liq ifodasini olamiz;

$f_{MB}(E)=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\cdot e^{-\frac{E}{kT}}$ **(40)**.

Agar aynimagan gaz energiyasini $E=\frac{m\vartheta^2}{2}$ ekanligini hisobga olsak (40) tenglama quydagicha bo’ladi: $f_{MB}(\vartheta)=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\cdot e^{-\frac{m\vartheta^2}{2kT}} \Leftrightarrow f_{MB}(\vartheta)=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\cdot e^{-\frac{m\vartheta^2}{2kT}}$ **(41)**.

**Xulosa.**

Shunday qilib aynimagan gaz taqsimot funksiyasi ya’ni Maksvell-Boltsmann taqsimot funksiyasi quydagicha ifodalanadi.

1. To’la ynergiya hamda kimyoviy potensial energiyasiga bog’liq Maksvell-Boltsmann taqsimot funksiyasi: $f_{MB}(E)=\frac{1}{e^{\frac{E-\mu}{kT}}}$.
2. To’la ynyrgiyaga bog’liq Maksvell-Boltsmann taqsimot funksiyasi: $f_{MB}(E)=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\cdot e^{-\frac{E}{kT}}$.
3. Gaz molekulalarini harakatlanish tezligiga bog’liq Maksvell-Boltsmann taqsimot funksiyasi: $f_{MB}(\vartheta)=\frac{n}{2\pi}\cdot\left(\frac{\hbar^2}{3mkT}\right)^{3/2}\cdot e^{-\frac{m\vartheta^2}{2kT}}$.

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