

# Аппроксимация функции распределения :имеет вид

$$f = \begin{cases} f_1 = \frac{n_1}{(\alpha RT_1)^{3/2}} \exp\left(-\frac{\xi_x^2 - u_1^2 + \xi_y^2 + \xi_z^2}{2RT_1}\right) & x \\ f_2 = \frac{n_2}{(\alpha RT_2)^{3/2}} \exp\left(-\frac{\xi_x^2 - u_2^2 + \xi_y^2 + \xi_z^2}{2RT_2}\right) & x \end{cases}$$

## Ищем плотность потока массы

$$\int_{-\infty}^{+\infty} \xi_x f \cdot d\xi = \int_{-\infty}^{+\infty} \xi_x (f_1 + f_2) d\xi = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^0 \xi_x f_2 \cdot d\xi_x d\xi_y d\xi_z + \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^{+\infty} \xi_x f_1 \cdot d\xi_x d\xi_y d\xi_z$$

$$\begin{aligned}
& \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^0 \xi_x f_2 d\xi_x d\xi_y d\xi_z + \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^{+\infty} \xi_x f_1 d\xi_x d\xi_y d\xi_z = \\
& \frac{n_2}{(\hat{p} RT_2)^{3/2}} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^0 \xi \exp\left(-\frac{\xi_x^2 - u_2^2 + \xi_y^2 + \xi_z^2}{2RT_2}\right) d_x d_x d_y d_z + \\
& + \frac{n_1}{(\hat{p} RT_1)^{3/2}} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^{+\infty} \xi \exp\left(-\frac{\xi_x^2 - u_1^2 + \xi_y^2 + \xi_z^2}{2RT_1}\right) d_x d_x d_y d_z = \\
& = \frac{n_2}{(\hat{p} RT_2)^{3/2}} \int_{-\infty}^{+\infty} \xi \exp\left(\exp\frac{\xi_z^2}{2RT_2}\right) d_z \int_{-\infty}^{+\infty} \xi \left(\exp\frac{\xi_y^2}{2RT_2}\right) d_y \int_{-\infty}^0 \xi \left(-\frac{(\xi_x - u_2)^2}{2RT_2}\right) d_x + \\
& + \frac{n_1}{(\hat{p} RT_1)^{3/2}} \int_{-\infty}^{+\infty} \xi \exp\left(\exp\frac{\xi_z^2}{2RT_2}\right) d_z \int_{-\infty}^{+\infty} \xi \left(\exp\frac{\xi_y^2}{2RT_2}\right) d_y \int_0^{+\infty} \xi \left(-\frac{(\xi_x - u_1)^2}{2RT_1}\right) d_x
\end{aligned}$$

$$\begin{aligned}
& \int_{-\infty}^0 \xi \exp\left(-\frac{\xi^2}{2RT_2}\right) d\xi = \int_{-\infty}^0 \left(\xi \left(-\frac{(\xi)^2}{2RT_2}\right)\right) \left[\xi - u_2 + u_2\right] \cdot d\xi = \\
& = \int_{-\infty}^0 \xi \exp\left(-\frac{\xi^2}{2RT_2}\right) (\xi - u_2) d\xi + u_2 \int_{-\infty}^0 \left(\xi \left(-\frac{(\xi)^2}{2RT_2}\right)\right) \cdot d\xi = \\
& = \int_{-\infty}^{-u_2} \exp\left(-\frac{y^2}{2RT_2}\right) y dy + u_2 \int_{-\infty}^{-u_2} \exp\left(-\frac{y^2}{2RT_2}\right) \cdot dy = \\
& = \frac{1}{2} \int_{-\infty}^{-u_2} \exp(-\alpha_2 y^2) dy^2 + u_2 \int_{-\infty}^{-u_2} \exp(-\alpha_2 y^2) \cdot dy = \\
& = -\frac{1}{2\alpha_2} \int_{-\infty}^{-u_2} \exp(-\alpha_2 y^2) d(-\alpha_2 y^2) + u_2 \int_{-\infty}^{-u_2} \exp(-\alpha_2 y^2) \cdot dy = \\
& = -\frac{1}{2\alpha_2} \int_{-\infty}^{-\alpha_2 u_2^2} e^z dz + u_2 \int_{-\infty}^{-u_2} e^{-\alpha_2 y^2} dy
\end{aligned}$$

$$-\frac{1}{2\alpha_2} \int_{-\infty}^{-\alpha_2 u_2^2} e^z dz = -\frac{1}{2\alpha_2} e^{-\alpha_2 u_2^2}$$

$$u_2 \int_{-\infty}^{-u_2} e^{-\alpha_2 y^2} dy = u_2 \int_{-\infty}^0 e^{-\alpha_2 y^2} dy - u_2 \int_{-u_2}^0 e^{-\alpha_2 y^2} dy = u_2 \frac{1}{2} \sqrt{\frac{\pi}{\alpha_2}} - u_2 \int_0^{+u_2} e^{-\alpha_2 y^2} dy =$$

$$= \frac{u_2}{2} \sqrt{\frac{\pi}{\alpha_2}} - \frac{u_2}{2} \sqrt{\frac{\pi}{\alpha_2}} \operatorname{erf}(u_2 \sqrt{\alpha_2}) = \frac{u_2}{2} \sqrt{\frac{\pi}{\alpha_2}} (1 - \operatorname{erf}(u_2 \sqrt{\alpha_2}))$$

$$\int_0^{+u_2} e^{-\alpha_2 y^2} dy = \frac{1}{2} \sqrt{\frac{\pi}{\alpha_2}} \operatorname{erf}(u_2 \sqrt{\alpha_2})$$

$$\int_{-\infty}^0 \xi \exp\left(-\frac{\xi_x - u_2}{2RT_2}\right) e_x d_x = -\frac{1}{2\alpha_2} e^{-\alpha_2 u_2^2} \int_{-\infty}^{-u_2} z dz + u_2 \int_{-\infty}^{-u_2} -\alpha_2 y^2 dy =$$

$$= -\frac{1}{2\alpha_2} e^{-\alpha_2 u_2^2} + \frac{u_2}{2} \sqrt{\frac{\pi}{\alpha_2}} (1 - \operatorname{erf}(u_2 \sqrt{\alpha_2})) =$$

$$= -RT_2 \exp\left(-\frac{u_2^2}{2RT_2}\right) + \frac{u_2}{2} \sqrt{2\pi RT_2} \left(1 - \operatorname{erf}\left(\frac{u_2}{\sqrt{2RT_2}}\right)\right)$$

$$\begin{aligned}
& \frac{n_2}{(\hat{p} RT_2)^{3/2}} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^0 \xi \exp\left(-\frac{\xi_x^2 - u_2^2 + \xi_y^2 + \xi_z^2}{2RT_2}\right) d_x d_y d_z = \\
& = \frac{n_2}{(\hat{p} RT_2)^{3/2}} \int_{-\infty}^{+\infty} \xi \exp\left(\exp\frac{\xi_z^2}{2RT_2}\right) d_z \int_{-\infty}^{+\infty} \xi \left(\exp\frac{\xi_y^2}{2RT_2}\right) d_y \int_{-\infty}^0 \xi \left(-\frac{(\xi_x - u_2)^2}{2RT_2}\right) d_x = \\
& = \frac{n_2}{(\hat{p} RT_2)^{3/2}} \sqrt{\hat{p} RT_2} \cdot \sqrt{2\pi RT_2} \cdot \int_{-\infty}^0 \exp\left(-\frac{\xi_x - u_2}{2RT_2}\right) \xi_x d\xi_x = \\
& = \frac{n_2}{(\hat{p} RT_2)^{1/2}} \left(-RT_2 \exp\left(-\frac{u_2^2}{2RT_2}\right) + \frac{u_2}{2} \sqrt{2\pi RT_2} \left(1 - \operatorname{erf}\left(\frac{u_2}{\sqrt{2RT_2}}\right)\right)\right) = \\
& = -\frac{n_2 RT_2}{(\hat{p} RT_2)^{1/2}} \exp\left(-\frac{u_2^2}{2RT_2}\right) + \frac{n_2 u_2}{2} \left(1 - \operatorname{erf}\left(\frac{u_2}{\sqrt{2RT_2}}\right)\right) = \\
& = -n_2 \sqrt{\frac{RT_2}{\hat{p}}} \exp\left(-\frac{u_2^2}{2 RT_2}\right) + \frac{n_2 u_2}{2} \left(1 - \operatorname{erf}\left(\frac{u_2}{\sqrt{2RT_2}}\right)\right)
\end{aligned}$$

$$\begin{aligned}
& \frac{n_1}{(\hat{\alpha} RT_1)^{3/2}} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_0^{+\infty} \exp\left(-\frac{\xi_x^2 + \xi_y^2 + \xi_z^2}{2RT_1}\right) d_x d_y d_z = \\
& = n_1 \sqrt{\frac{RT_1}{\hat{\alpha}}} \exp\left(-\frac{u_1^2}{2 RT_1}\right) + \frac{n_1 u_1}{2} \left(1 + \operatorname{erf}\left(\frac{u_1}{\sqrt{2RT_1}}\right)\right) \\
& \int_{-u_1}^{+\infty} e^{-\alpha_1 y^2} dy = \int_{-u_1}^0 e^{-\alpha_1 y^2} dy + \int_0^{+\infty} e^{-\alpha_1 y^2} dy = \int_0^{+u_1} e^{-\alpha_1 y^2} dy + \frac{1}{2} \sqrt{\frac{\pi}{\alpha_1}} = \\
& = \frac{1}{2} \sqrt{\frac{\pi}{\alpha_1}} \operatorname{erf}(u_1 \sqrt{\alpha_1}) + \frac{1}{2} \sqrt{\frac{\pi}{\alpha_1}} = \frac{1}{2} \sqrt{\frac{\pi}{\alpha_1}} \left(1 + \operatorname{erf}(u_1 \sqrt{\alpha_1})\right)
\end{aligned}$$

$$\begin{aligned}
j_x \xi m & = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \xi_x f \cdot d_x d_y d_z = \\
& = n_1 \sqrt{\frac{RT_1}{\hat{\alpha}}} \exp\left(-\frac{u_1^2}{2 RT_1}\right) - n_2 \sqrt{2\pi} \exp\left(-\frac{u_2^2}{2 RT_2}\right) + \\
& + \frac{n_1 u_1}{2} \left(1 + \operatorname{erf}\left(\frac{u_1}{\sqrt{2RT_1}}\right)\right) + \frac{n_2 u_2}{2} \left(1 - \operatorname{erf}\left(\frac{u_2}{\sqrt{2RT_2}}\right)\right)
\end{aligned}$$

$$u_2 = 0$$

$$j_x / m = n_1 \sqrt{\frac{RT_1}{\hat{\alpha}}} \exp\left(-\frac{u_1^2}{2 RT_1}\right) - n_2 \sqrt{\frac{RT_2}{2\pi}} + \frac{n_1 u_1}{2} \left(1 + \operatorname{erf}\left(\frac{u_1}{\sqrt{2RT_1}}\right)\right)$$













