Maxwell distribution

Apply Boltzmann distribution (8) to a monoatomic gas containing N free particles, each with mass *m*, all at cconstant temperature*T*. The energie of each atom is only kinetic: $\varepsilon = \frac{m}{2}\left(v_x^2 + v_y^2 + v_z^2\right)$. The sums are replaced by integrals $\sum g_i \Rightarrow \iiint \mathrm{d}v_x \mathrm{d}v_y \mathrm{d}v_z$. If we are interested only by the absolute values of the velocities and not by their direction we introduce spherical coordinates in the velocity space. În cazul izotrop se integrează dupa unghiuri şi se găseşteIntegrating ove the angles we get

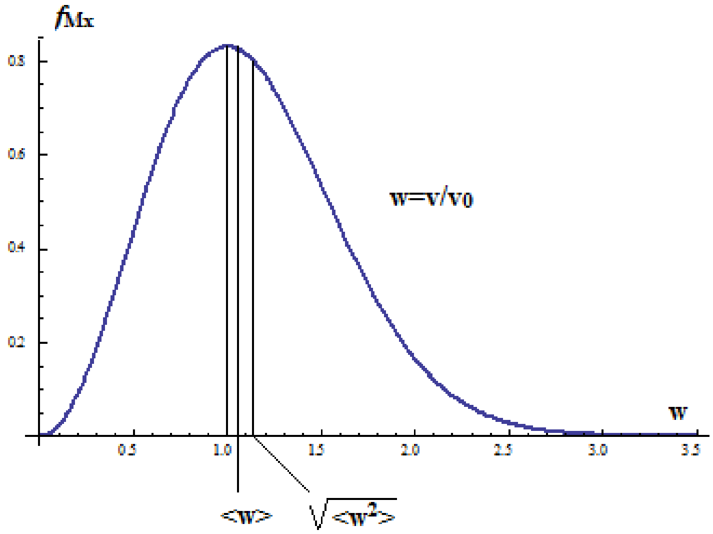
$$N = A\iiint \exp\left[-\frac{m\left(v_x^2 + v_y^2 + v_z^2\right)}{2kT}\right]\mathrm{d}v_x \mathrm{d}v_y \mathrm{d}v_z = 4\pi A\int_0^\infty v^2 \exp\left[-\frac{mv^2}{2kT}\right]\mathrm{d}v \qquad (12)$$

The number of particles with velocities between v and v+dv is given by $n_v \mathrm{d}v$, where

$$\boxed{n_v = 4\pi N\left(\frac{m}{2\pi kT}\right)^{3/2} v^2 \exp\left[-\frac{mv^2}{2kT}\right]} \qquad (13)$$

Dividing by *N* we find the Maxwell distribution function $f_{\mathrm{Mx}}(v)$ represented below as a function of the norrmalized velocity $w=v/v_0$:

$$\boxed{f_{Mx}(v) = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} v^2 \exp\left[-\frac{mv^2}{2kT}\right]} \qquad (14)$$



Important values:

The most probable velocity: $$v_0 = \sqrt{\frac{2kT}{m}} = \sqrt{\frac{2RT}{M_{mol}}} \qquad (15)$$

The men (average) velocity $$\langle v \rangle = \sqrt{\frac{8kT}{\pi m}} = \sqrt{\frac{8RT}{\pi M_{mol}}} \qquad (16)$$

The mean square velocity $$\sqrt{\langle v^2 \rangle} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M_{mol}}} \qquad (17)$$

Here m is the mass of a molecule and M_{mol} is the molar mass $M_{\text{mol}}=N_{\text{Av}}m$.