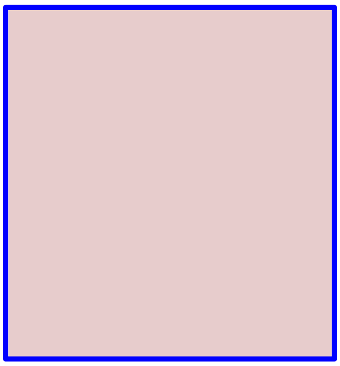
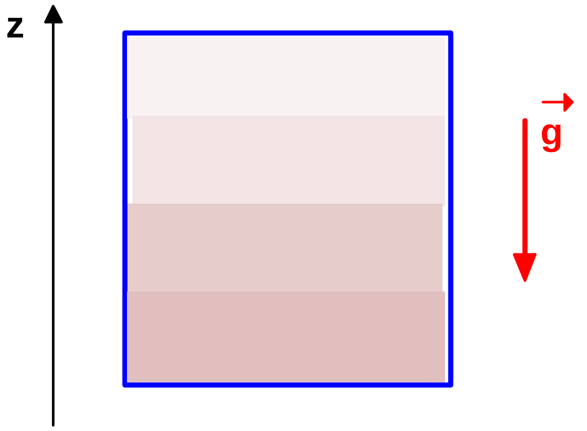
Distribuzione delle velocità

La formula barometrica

a) Senza campi esterni **b) Campo di gravità**



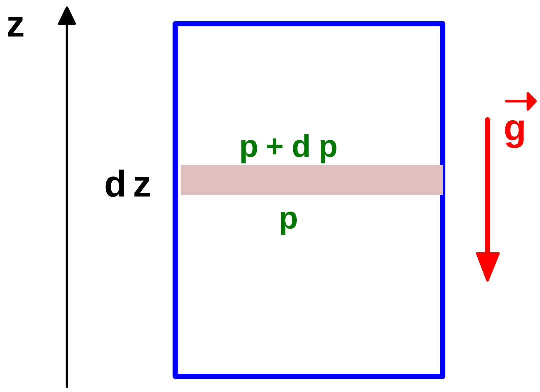


p, ρ uniformi

p, ρ funzioni di *z*

- **Campo di gravità (con T e g costanti)**

$$dp = -r\,g\,dz = -p\,\frac{mg}{k_B T}\,dz$$



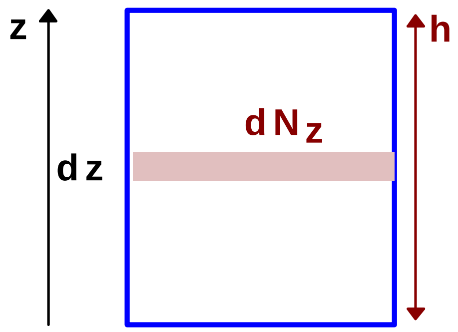
$$\frac{dp}{dz} = -\frac{mg}{k_B T}\,p$$

$$p(z) = p(0)\exp\left[-\frac{mgz}{k_B T}\right] \qquad r(z) = r(0)\exp\left[-\frac{mgz}{k_B T}\right]$$

Distribuzione spaziale

Esempio N atomi

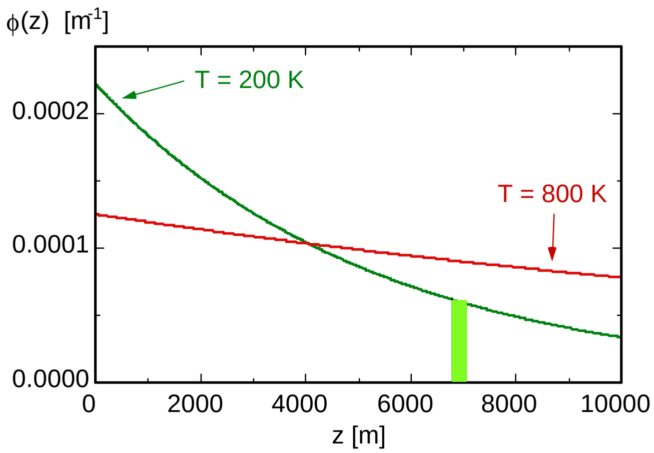
h = 10 000 metri
T = costante
g = costante
m = 32 amu



- **In funzione della posizione**

$$f(z) = C \exp\left[-\frac{mgz}{k_B T}\right]$$

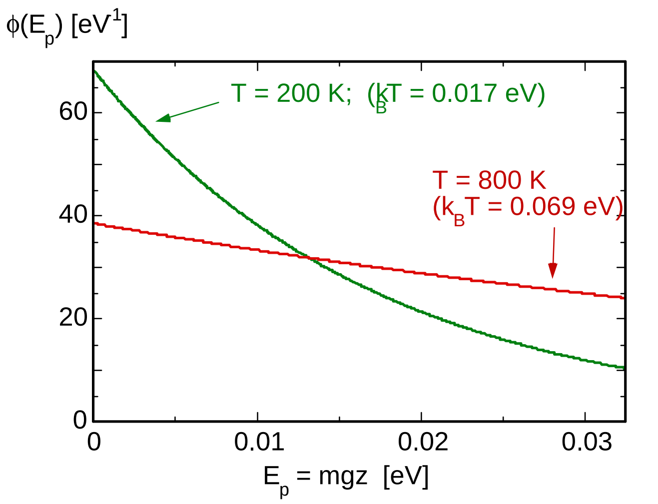
$$f(z)\,dz = \frac{dNz}{N}$$



- **In funzione dell'energia potenziale**

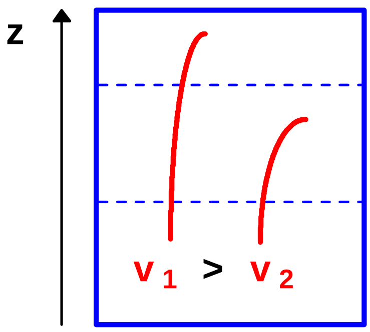
$$f(E_p) = C \exp\left[-\frac{E_p}{k_B T}\right]$$

(Distrib. di Boltzmann)



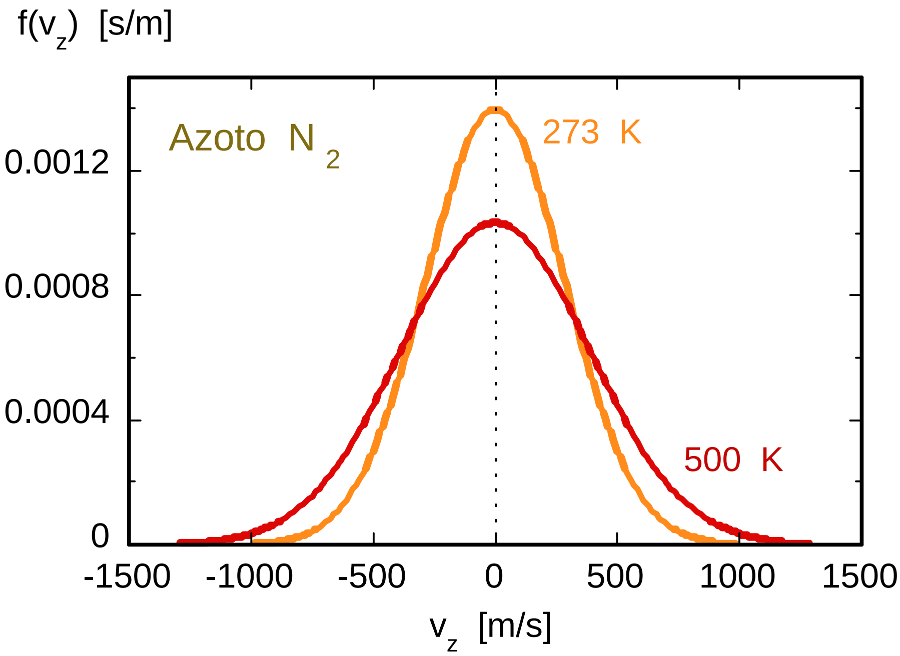
Distribuzione di v_z

Distrib. velocità + campo g = formula barometrica



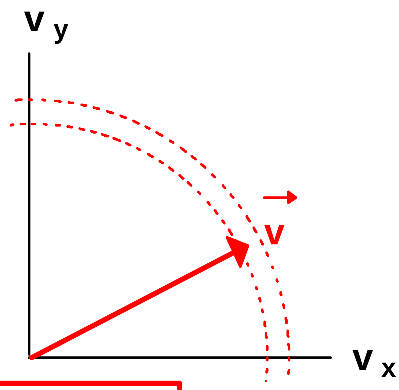
$$f(v_z) = \sqrt{\frac{m}{2pk_B T}}\ \exp\left[-\frac{mv_z^2}{2k_B T}\right]$$

$$f(v_z)\ dv_z = \frac{dN_{v_z}}{N}$$

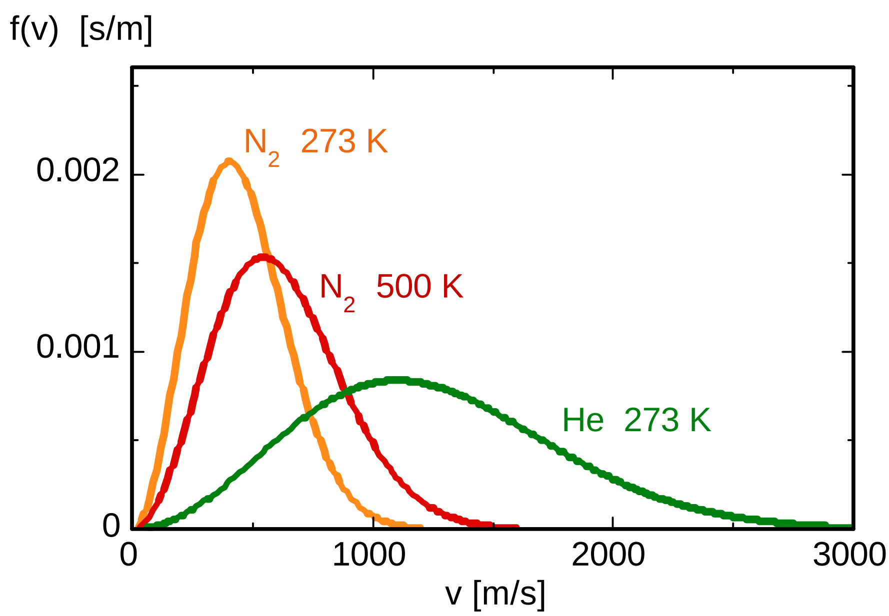


Distribuzione di Maxwell

$$v^2 = v_x^2 + v_y^2 + v_z^2$$



$$f(v) = 4\pi \left(\frac{m}{2\pi k_B T} \right)^{3/2} v^2 \exp\left[-\frac{mv^2}{2k_B T} \right]$$



Dipendenza da: massa
temperatura

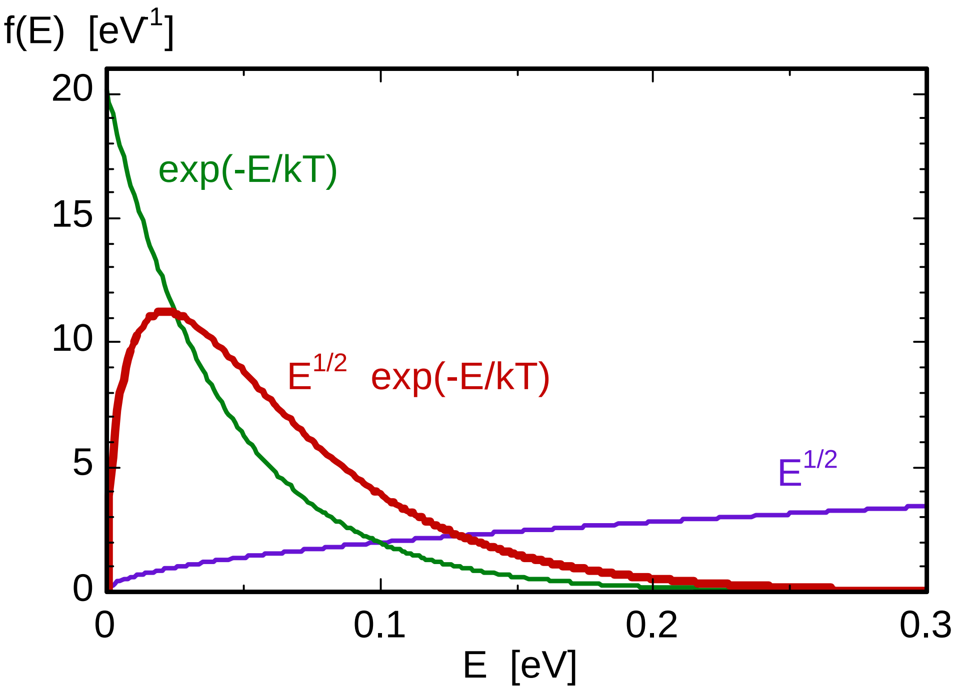
Distribuzione e temperatura: posizione
dispersione

Distribuzione in energia

$$E = \frac{1}{2} m v^2$$

$$f(E) = \left(2\pi\sqrt{E}\right)\frac{\exp\left[-E/k_B T\right]}{\left(\pi k_B T\right)^{3/2}}$$

densità degli stati — **fattore di Boltzmann**



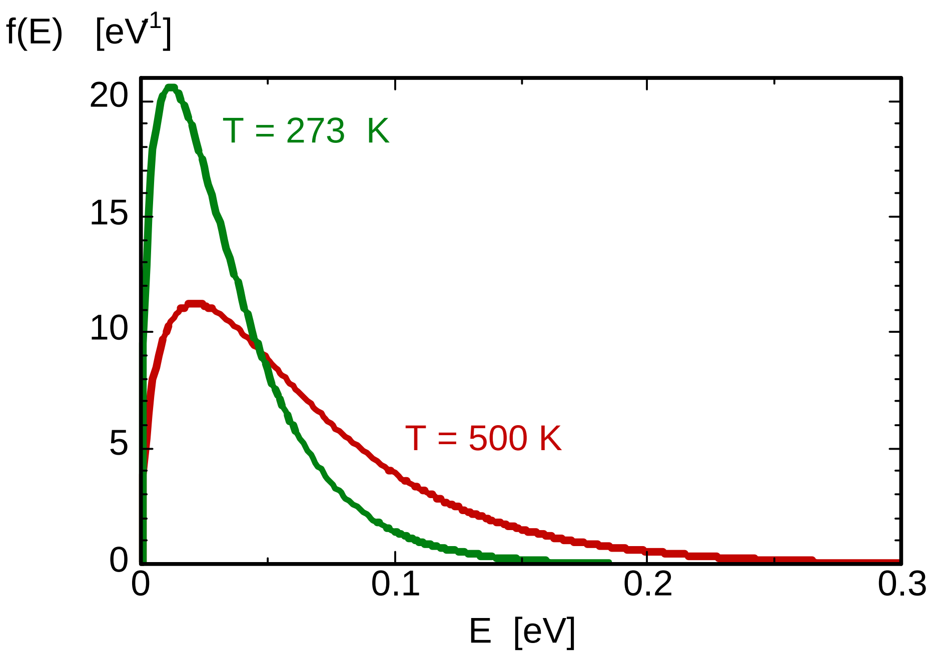
1 eV = 1.6×10^{-19} J

k_B = 8.61×10^{-5} eV/K

$$f(E) = \frac{2\pi}{(\pi k_B T)^{3/2}} \sqrt{E} \exp\left[-\frac{E}{k_B T}\right]$$

$$f(E)\, dE = \frac{dN_E}{N}$$

[*f(E)* dipende solo da *T*, non da *m.***]**



T	$k_B T$	$\langle E \rangle = 3k_B T/2$
273 K	0.023 eV	0.034 eV
500 K	0.043 eV	0.064 eV