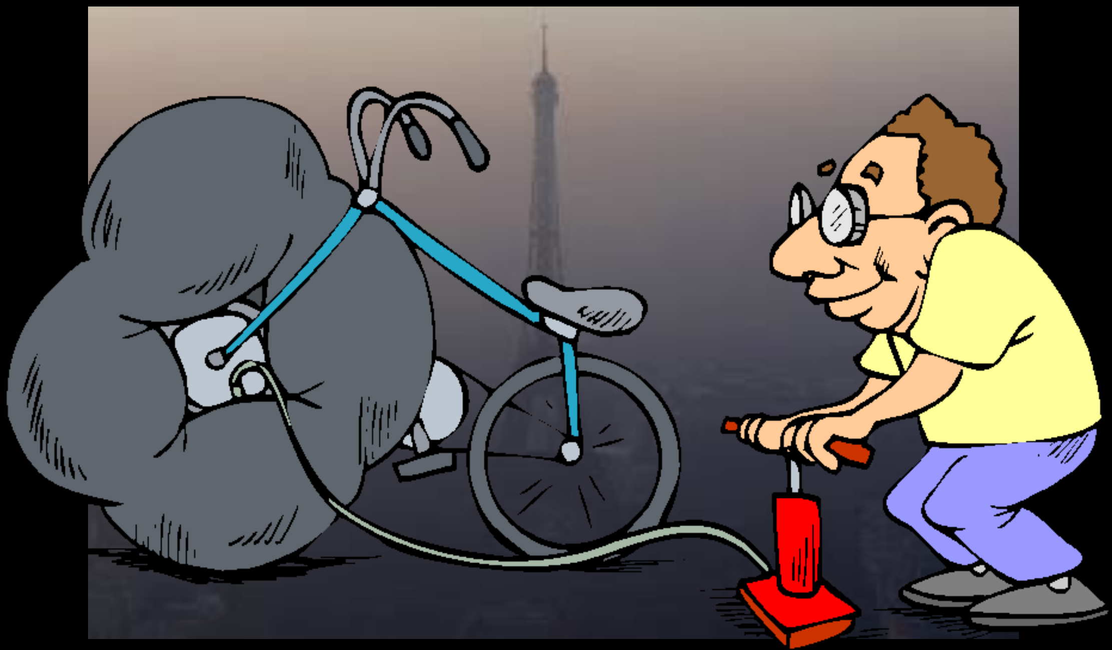
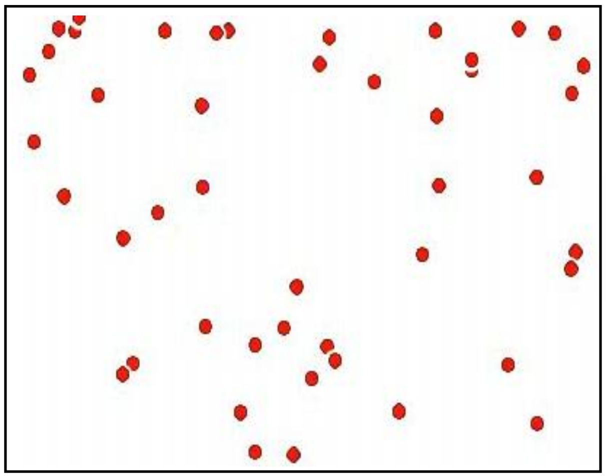


Du microscopique au macroscopique

Description microscopique
(Position, vitesse)



Problème compliqué :

1mm^3 de gaz $\sim 10^{16}$ particules

Propriétés macroscopiques
(Variables d'état)

Pression (Pa)

Température (K)

$$PV = nRT$$

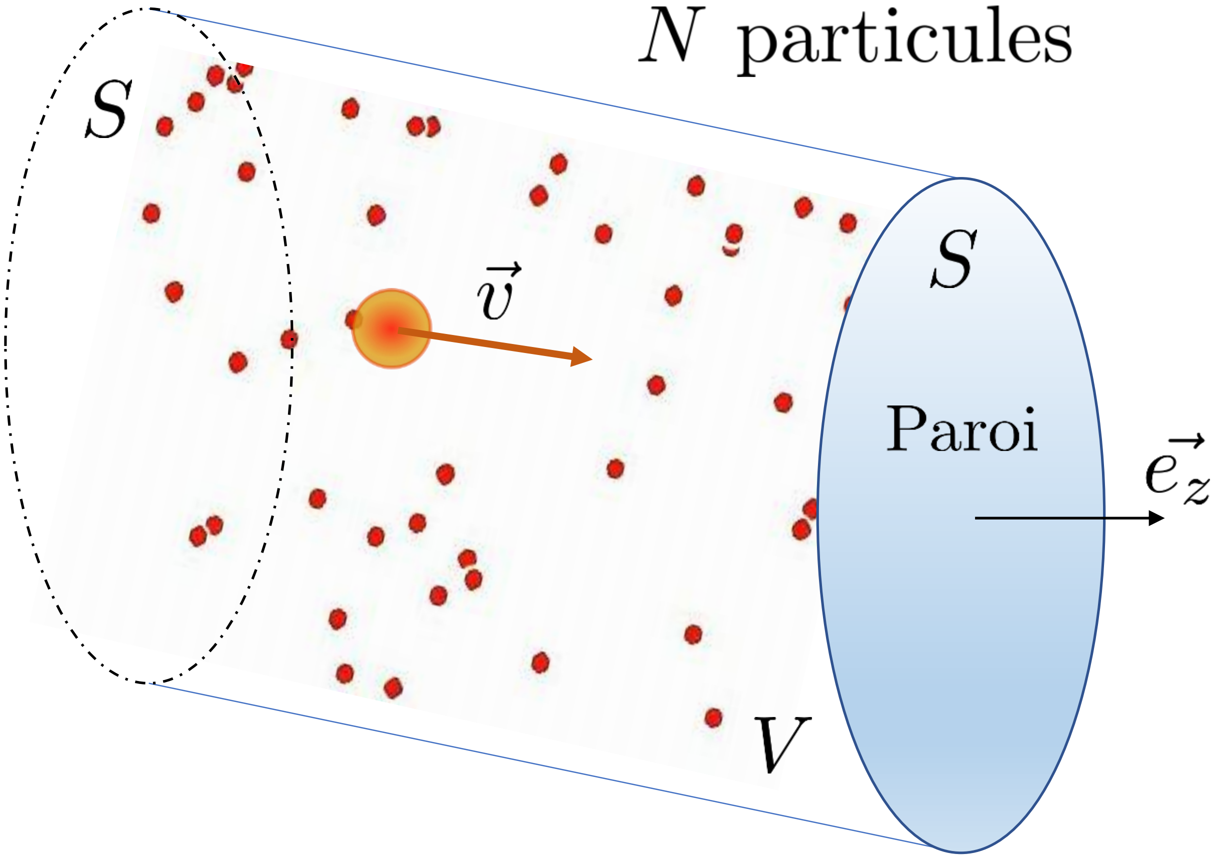
Volume (m^3)

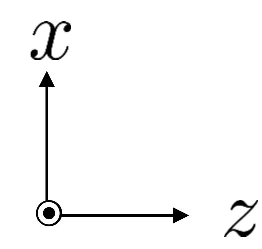
Qte de matière (mol)

Loi des gaz parfaits

Système thermodynamique considéré

N particules



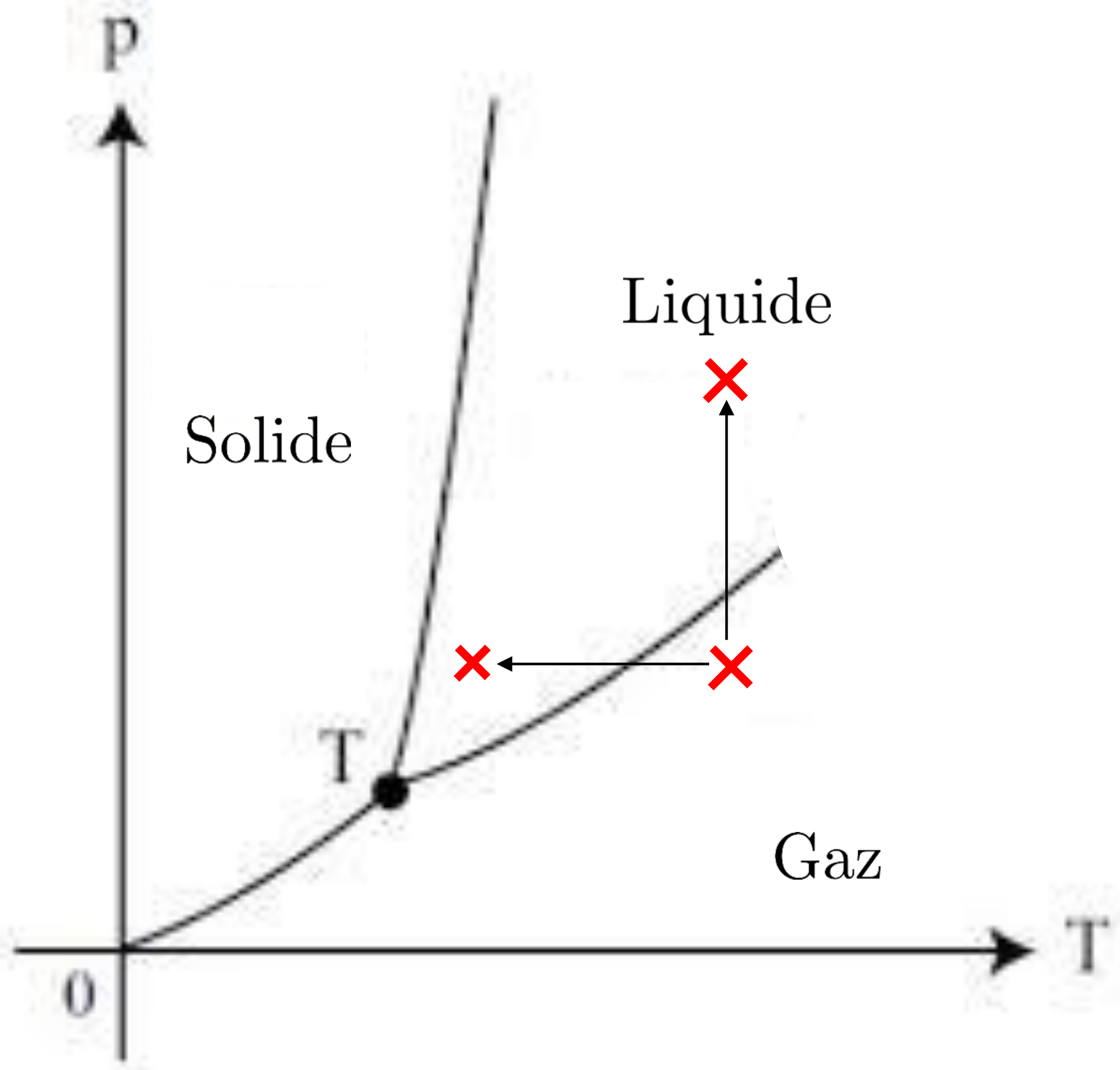


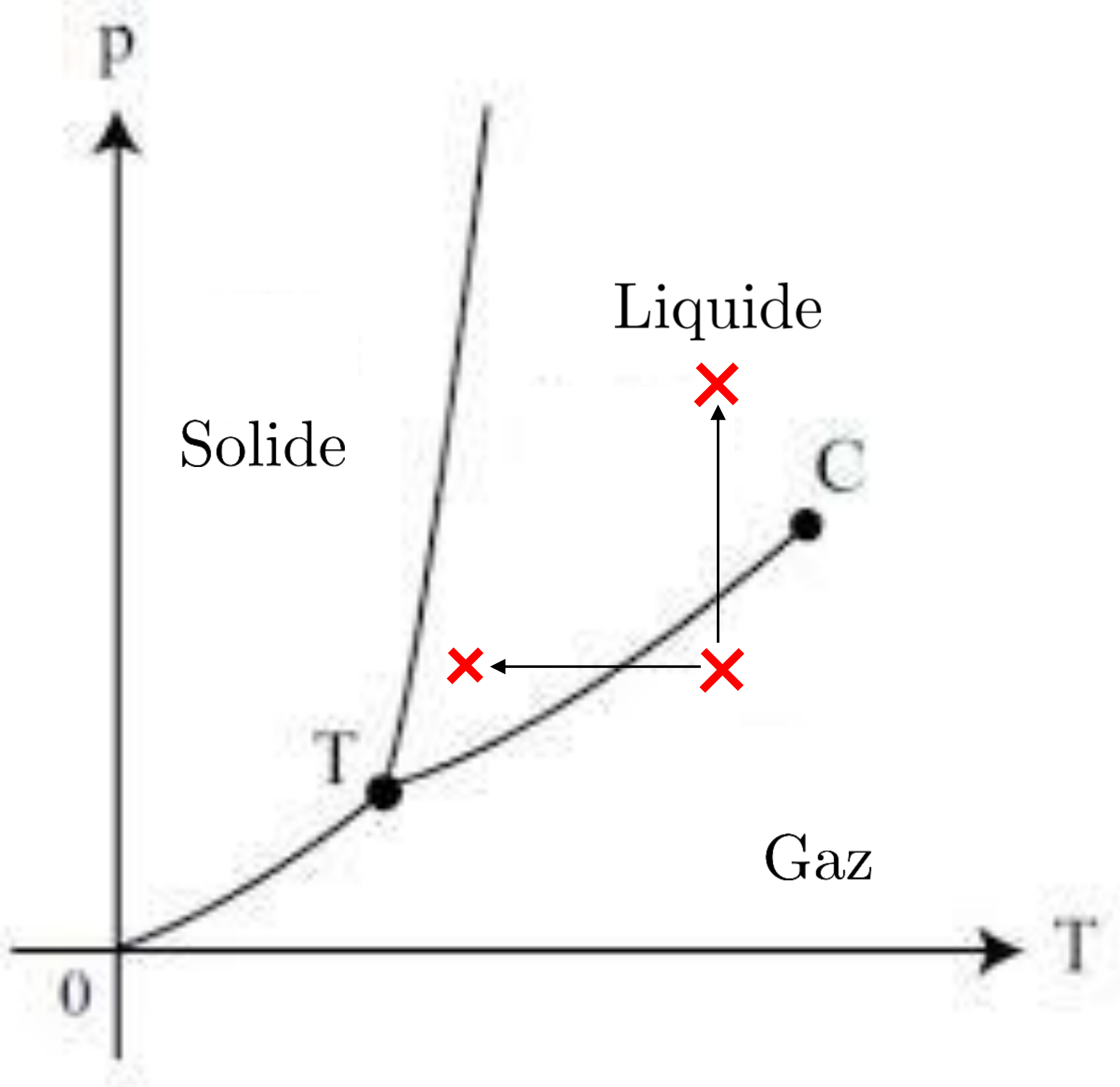
Distribution des vitesses (Maxwell Boltzmann)

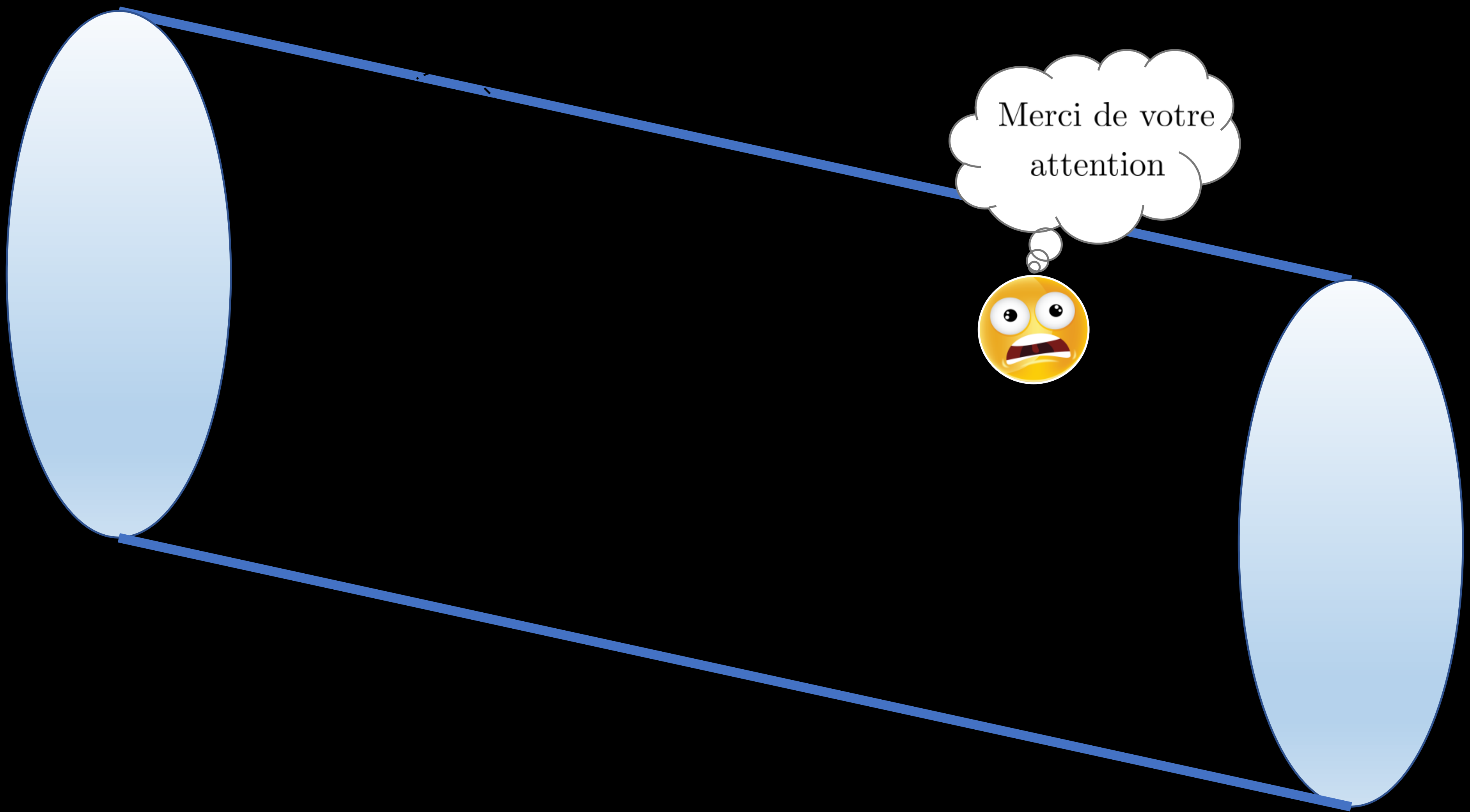
$$dP(v) = \left(\frac{m}{2\pi k_B T}\right)^{3/2} e^{-\frac{mv^2}{k_b T}} dv$$

Résultat admis

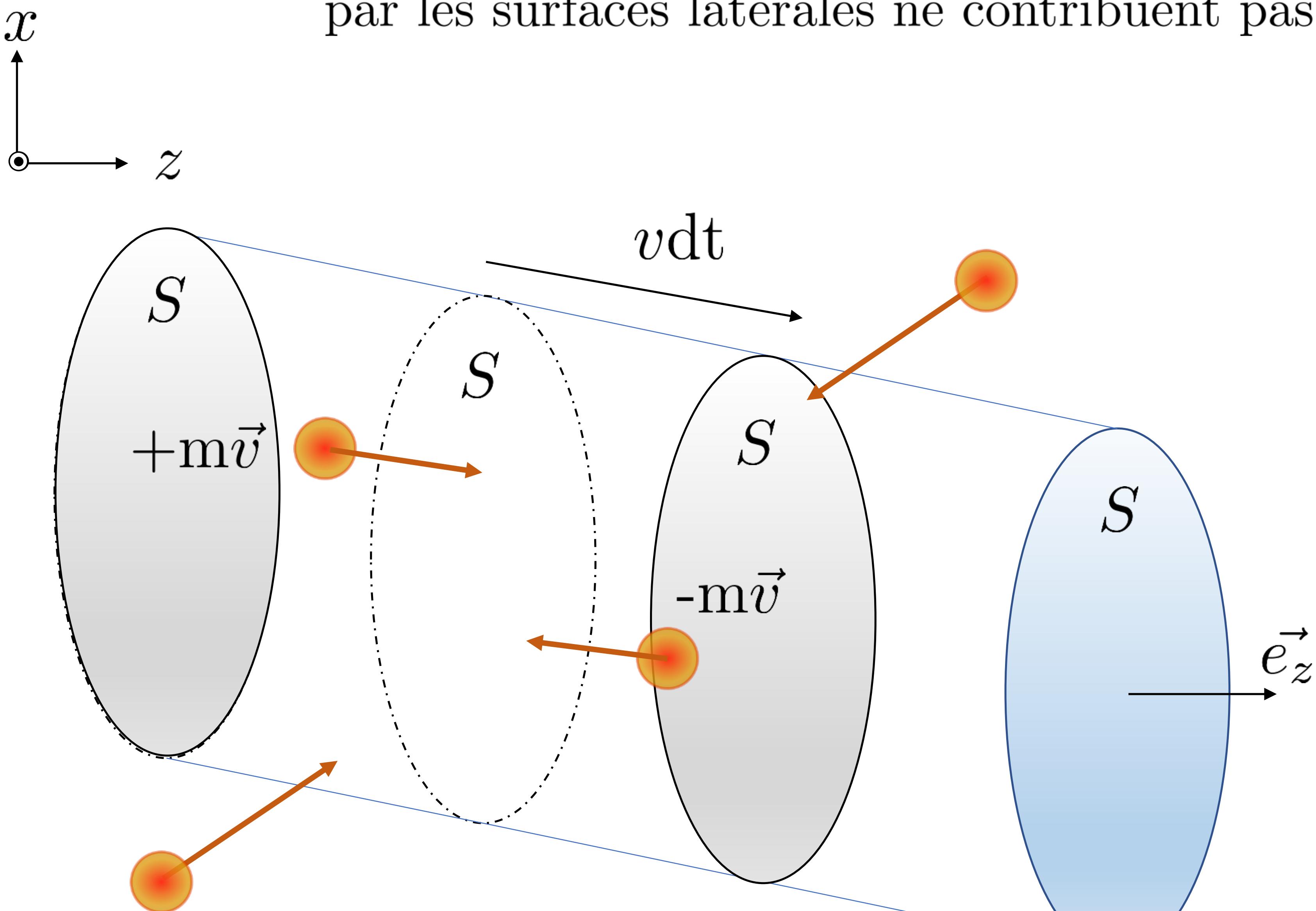
Probabilité que $v \in [v, v + dv]$


p
Liquide
Solide
T
Gaz
T
0


p
Liquide
Solide
C
T
Gaz
0
T


Merci de votre
attention

Monsieur, pourquoi les atomes qui rentrent par les surfaces latérales ne contribuent pas ?



Beattie-Bridgeman Equation of State

$$P = \frac{R_u T}{\overline{v}^2}\left(1 - \frac{c}{\overline{v}T^3}\right)(\overline{v} + B) - \frac{A}{\overline{v}^2}$$

The constants appearing in the above equation are given in Table 3–4 for various substances. The Beattie-Bridgeman equation is known to be reasonably accurate for densities up to about $0.8\rho_{cr}$, where ρ_{cr} is the density of the substance at the critical point.

Benedict-Webb-Rubin Equation of State

$$P = \frac{R_u T}{\overline{v}} + \left(B_0 R_u T - A_0 - \frac{C_0}{T^2}\right)\frac{1}{\overline{v}^2} + \frac{bR_u T - a}{\overline{v}^3} + \frac{a\alpha}{\overline{v}^6} + \frac{c}{\overline{v}^3 T^2}\left(1 + \frac{\gamma}{\overline{v}^2}\right)e^{-\gamma/\overline{v}^2}$$

The values of the constants appearing in this equation are given in Table 3–4. This equation can handle substances at densities up to about $2.5\rho_{cr}$. In 1962, Strobridge further extended this equation by raising the number of constants to 16 (Fig. 3–59).

Distribution de Maxwell Boltzmann des vitesses

$$dP(v) = \left(\frac{m}{2\pi k_B T}\right)^{3/2} e^{-\frac{mv^2}{k_b T}} dv$$

$$\boxed{\langle v_z^2 \rangle = \int_{-\infty}^{+\infty} v_z^2 P(v) dv = \frac{k_B T}{m}}$$

$$\langle v^2 \rangle = \int_{-\infty}^{+\infty} v^2 P(v) dv = \frac{3k_B T}{m}$$