Diffusion élastique

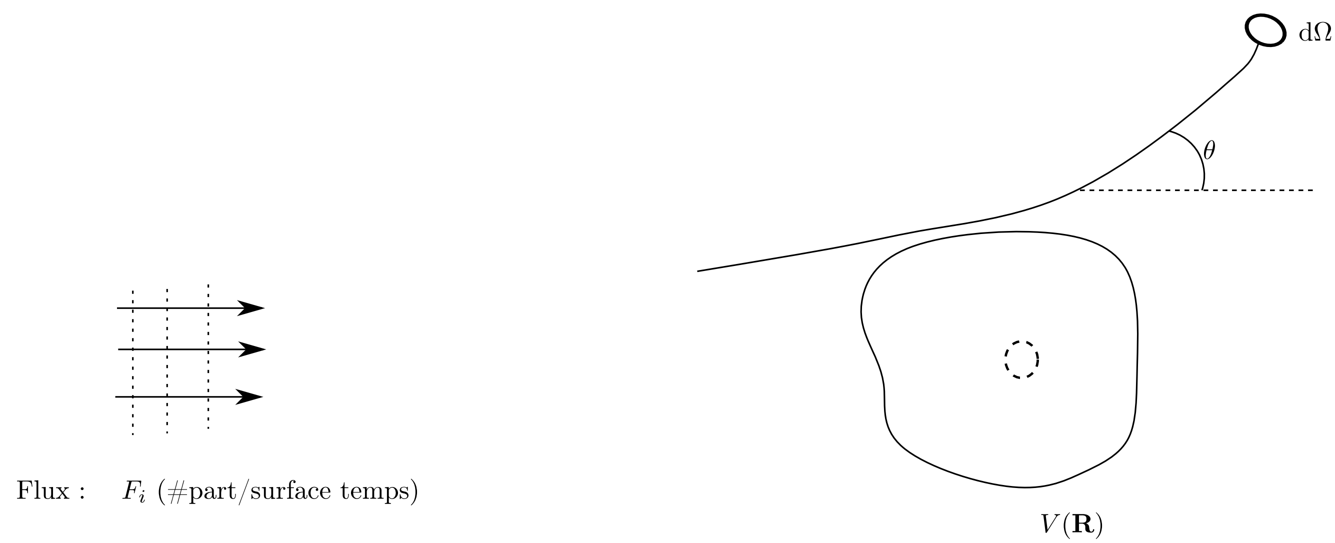

Figure 1 – diffusion

$$\mathrm{d}n = F_i \mathrm{d} \underbrace{\sigma(\theta, \varphi)}_{\text{section efficasse}} \Omega$$

Les unitées de la section efficasse sont

$$[\sigma] = \text{surface (ban} = 10^{-24}\text{cm}^2)$$

L'énérgie est conservé

$$\frac{\hbar^2 k^2}{2m} = E_k$$

Argument physiques pour l'amplitude de diffusion

$$u_r \sim \left(e^{ikz} + f_l(\theta, \varphi) \frac{e^{e^{ikr}}}{r} \right)$$

$$\sigma(\theta, \varphi) \iff {}^{?} f_k(\theta, \varphi)$$

Courrant de probabilité de incident (i) et diffusé (d)

$$\mathbf{J}_{i,d} = \frac{1}{\mu} \operatorname{Re} \left[\varphi^*_{i,d}(\mathbf{r}) \frac{\hbar}{i} \boldsymbol{\nabla} \varphi_{i,d} \right]$$

$$|\mathbf{J}_i| = \frac{|A|^2 i\hbar k}{\mu}$$

Si $\varphi = Ae^{ikz}$

$$\mathbf{J}_d = \frac{i}{\mu}\frac{|A|^2}{2\mu}|f_k(\theta,\varphi)|^2 \left[\frac{e^{-ikr}}{r}\frac{\hbar k i}{i}\frac{e^{ikr}}{r} - \cancel{\frac{e^{-ikr}}{r}\frac{hbar}{i}\frac{e^{ikr}}{r^2}} + \text{c.c.}\right]\hat{r}$$

$$(\mathbf{J}_d)_r = \frac{|A|^2\hbar k}{\mu}\frac{1}{r^2}\left|f_{k(\theta,\varphi)}\right|^2$$

$$\implies \mathrm{d}n = C\frac{|A|^2\hbar k}{\mu}\frac{1}{\cancel{r^2}}|f_k|^2\cancel{r^2}\mathrm{d}\Omega$$

$$\sigma(\theta\varphi) =$$

$$f_k(\theta,\varphi) \to \begin{cases} \text{Théorie des perturbations } \to \text{approximation (règle d'or de Fermi) de Born} \\ \text{déphassages (ondes partielles)} \end{cases}$$

Théorie des perturbation (Approximation de Born)

$$\|\mathbf{P}_i\| = \|\mathbf{P}_f\| \quad \text{Élastique}$$

$$\partial\mathcal{P}_{i\to f} = \int_{DF} \mathrm{d}^3 P_F |\langle\mathbf{P}_i|\psi(t)\rangle|^2$$

$$\mathcal{P}_{i\to f}(t) = \underbrace{\int_{Df} P_f^2 \mathrm{d}P_f \mathrm{d}\Omega}_{\int\rho(E_F)\mathrm{d}E_f\mathrm{d}\Omega} |\langle\mathbf{P}_f|Psi(t)\rangle|^2$$

$$\boxed{\rho(E_f)\mathrm{d}E_f\mathrm{d}\Omega}$$

$$\partial\mathcal{P}_{i\to f} \approx \int_{Df}\rho(E_f)\mathrm{d}E_f\mathrm{d}\Omega \times \frac{1}{\hbar^2}\left|\int_0^t e^{i\omega_{fi}t'}W_{fi}(t')\mathrm{d}t'\right|^2$$

$$W(t) = \frac{W}{2}e^{i\omega t} + \frac{W^\dagger}{2}e^{-i\omega t}$$

$$|\langle P_f|\psi(t)\rangle|^2 = \frac{|\langle\mathbf{P}_f|\,W\,|\mathbf{P}_i\rangle|^2}{4\hbar^2}\left|e^{i(\omega_{fi}-\omega)\frac{t}{2}}\frac{\partial m\,(\omega_{fi}-\omega)\,\frac{t}{2}}{(\omega_{fi}-\omega)\,/2} + e^{i(\omega_{fi}+\omega)\frac{t}{2}}\frac{\partial m\,(\omega_{fi}+\omega)\,\frac{t}{2}}{(\omega_{fi}+\omega)\,/2}\right|^2$$

$$= \frac{\langle \mathbf{P}_f | \, W \, | \mathbf{P_i} \rangle}{\hbar^2} \frac{\partial m^2 \omega_{fi} \frac{t}{2}}{(\omega_f i)^2 / 2^2}$$

$$\cdots ??????$$

$$\langle \mathbf{P_f} | \, V(\mathbf{R}) \, | \mathbf{P_i} \rangle = \int \langle \mathbf{P}_f | \mathbf{r} \rangle \langle \mathbf{r} | \, V(\mathbf{r}) \, | \mathbf{P}_i \rangle \, \mathrm{d}^3 r = \int \frac{e^{i \mathbf{P}_f \cdot \mathbf{r} / \hbar}}{(2\pi\hbar)^{3/2}} V(\mathbf{r}) \frac{e^{i \mathbf{P_i} \cdot \mathbf{R} / \hbar}}{(2\pi\hbar)^{2/3}} \mathrm{d}^3 r$$

$$\int \frac{e^{-i \frac{P_f - P_i}{\hbar} \cdot \mathbf{r}}}{(2\pi\hbar)^3} V(\mathbf{r}) \mathrm{d}^3 r = \frac{1}{(2\pi\hbar)^3} \int \mathrm{d}^3 r e^{-i \mathbf{q} \cdot \mathbf{r}} V(\mathbf{r}) \quad \text{Tansformé de fourier du potentiel}$$

$$\frac{\mathbf{P}_f - \mathbf{P}_i}{\hbar} = \mathbf{K_f} - \mathbf{K}_i \equiv \mathbf{q}$$

$$\sigma(\theta, \varphi) = \frac{\#??\text{diffusées/temps} \partial \Omega}{\# ??? \text{ incidents/temps} ???}$$

$$\mathbf{J}_i = \frac{1}{\mu (2\pi\hbar)^3} \hbar k \hat{z} = \frac{1}{(2\pi\hbar)^3} \underbrace{\frac{\sqrt{2}}{\mu}}_{\frac{\sqrt{2}\sqrt{E}}{\sqrt{\mu}}} \hat{z}$$

$$\boxed{\frac{\partial \mathcal{P}_{i \to f}(t)}{\partial t \partial \Omega} / |\mathbf{J}_i| = \sigma(\theta \varphi) = \frac{\mu^2}{(2\pi)^2 \hbar^4} \left| \int \mathrm{d}^3 r e^{-i \mathbf{q} \cdot \mathbf{r}} V(\mathbf{r}) \right|^2}$$

$$\mathbf{q}^2 = \cdots 4K^2 \sin^2 \frac{\theta}{2}$$

<u>Diffusion nucléons-nucléons (pos de Yukawa)</u>

si $\sigma(\theta\varphi) = \| f_k(\theta, \varphi) \|^2$

$\langle allo | meme \rangle$