Projet numérique: **Effet Ramsauer-Townsend**

Physique moderne
Pré ing 2 MI-03 groupe 3E
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SOMMAIRE

- Résolution analytique pour les états stationnaires
- Comparaison et étude des prédictions graphiques avec celles des états stationnaires
- Comparaison et étude pour les paquets d’ondes

Équation de Schrödinger stationnaire

$$-\hbar^2 / (2m) * d^2\psi(x)/dx^2 + V(x)\psi(x) = E\psi(x)$$

$$\Rightarrow d^2\psi(x)/dx^2 + (2m/\hbar^2)(E - V(x))\psi(x) = 0$$

$$k_1 = \sqrt{(2mE)} / \hbar$$

$$k_2 = \sqrt{(2m(E + V_0))} / \hbar$$

Région I : $x < -a/2$, $V(x) = 0$

Équation : $d^2\psi_1(x)/dx^2 + k_1^2\psi_1(x) = 0$

Solution : $\psi_1(x) = A\, e^{ik_1x} + B\, e^{-ik_1x}$

Région II : $-a/2 < x < a/2$, $V(x) = -V_0$

Équation : $d^2\psi_2(x)/dx^2 + k_2^2\psi_2(x) = 0$

Solution : $\psi_2(x) = C\, e^{ik_2x} + D\, e^{-ik_2x}$

Région III : $x > a/2$, $V(x) = 0$

Solution : $\psi_3(x) = F\, e^{ik_1x}$

On pose x = a/2

$$C \exp(i k_2 a/2) + D \exp(-i k_2 a/2) = F \exp(i k_1 a/2)$$

$$k_2 \left(C \exp(i k_2 a/2) - D \exp(-i k_2 a/2) \right) = k_1 F \exp(i k_1 a/2)$$

On pose x = -a/2

$$A \exp(-i k_1 a/2) + B \exp(i k_1 a/2) = C \exp(-i k_2 a/2) + D \exp(i k_2 a/2)$$

$$k_1 \left(A \exp(-i k_1 a/2) - D \exp(i k_1 a/2) \right) = k_2 \left(C \exp(-i k_2 a/2) - D \exp(i k_2 a/2) \right)$$

Par résolution de système on trouvera:

$$\frac{C}{2} = F \exp(i (k_1 - k_2) a/2)\left(1 + \frac{k_1}{k_2}\right)$$

$$A = \frac{F}{4} \exp(i k_1 a) \left[\exp(-i k_2 a)\left(2 + \frac{k_2}{k_1} + \frac{k_1}{k_2}\right) + \exp(i k_2 a)\left(2 - \frac{k_2}{k_1} - \frac{k_1}{k_2}\right) \right]$$

$$D = \frac{F}{2} \exp(i (k_2 + k_1) a/2)\left(1 - \frac{k_1}{k_2}\right)$$

$$B = \frac{F}{4} \left[\exp(-i k_2 a)\left(-\frac{k_2}{k_1} + \frac{k_1}{k_2}\right) + \exp(i k_2 a)\left(\frac{k_2}{k_1} - \frac{k_1}{k_2}\right) \right]$$

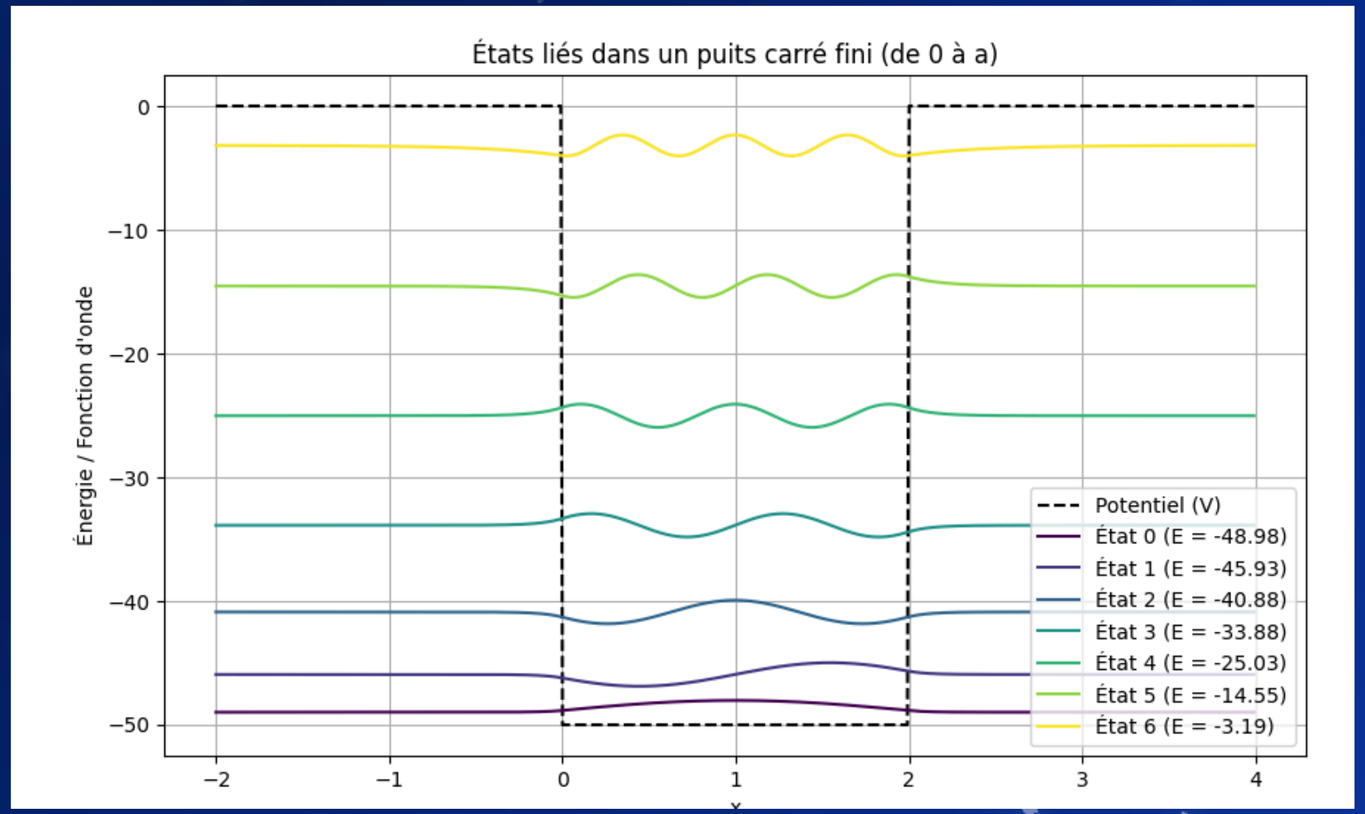
→

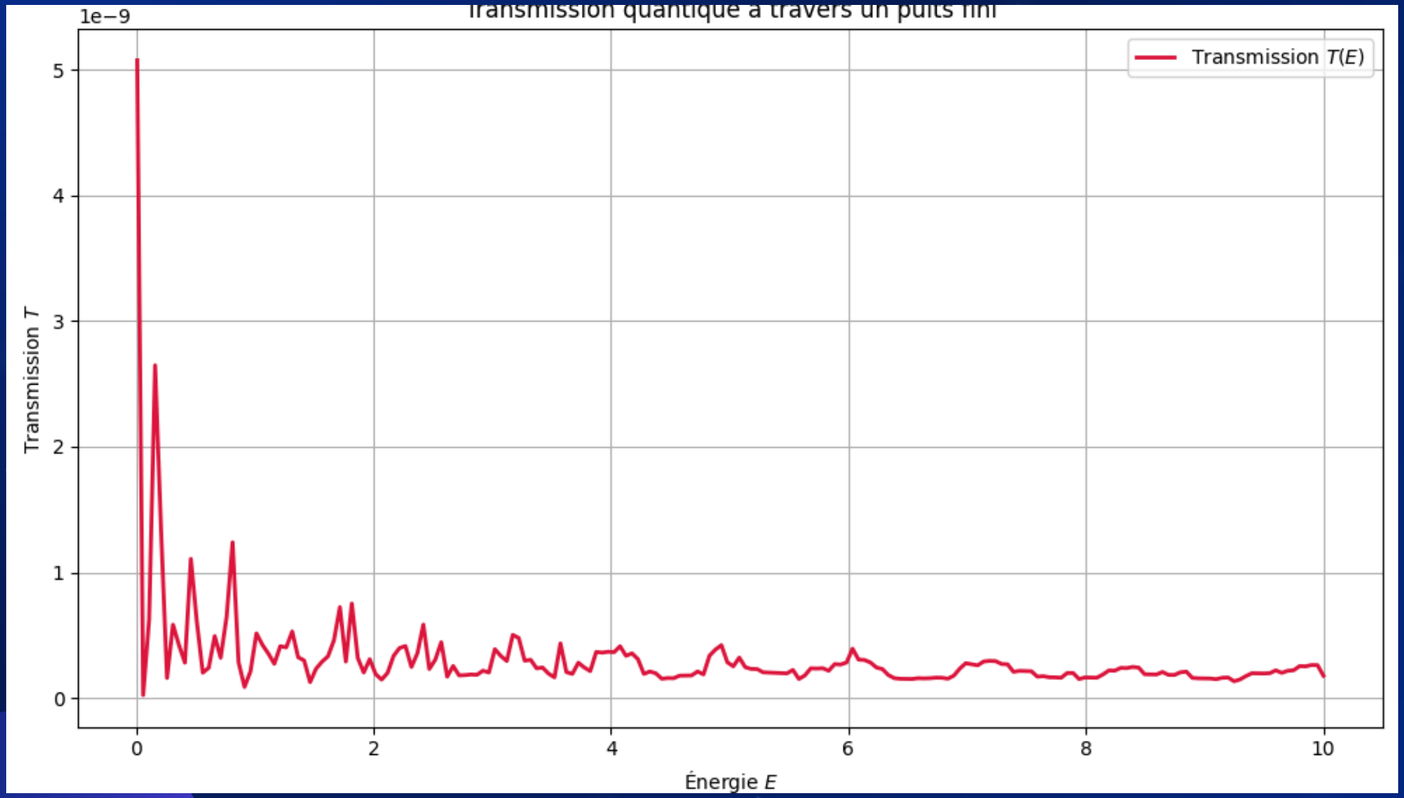
Coefficient de transmission et de réflexion

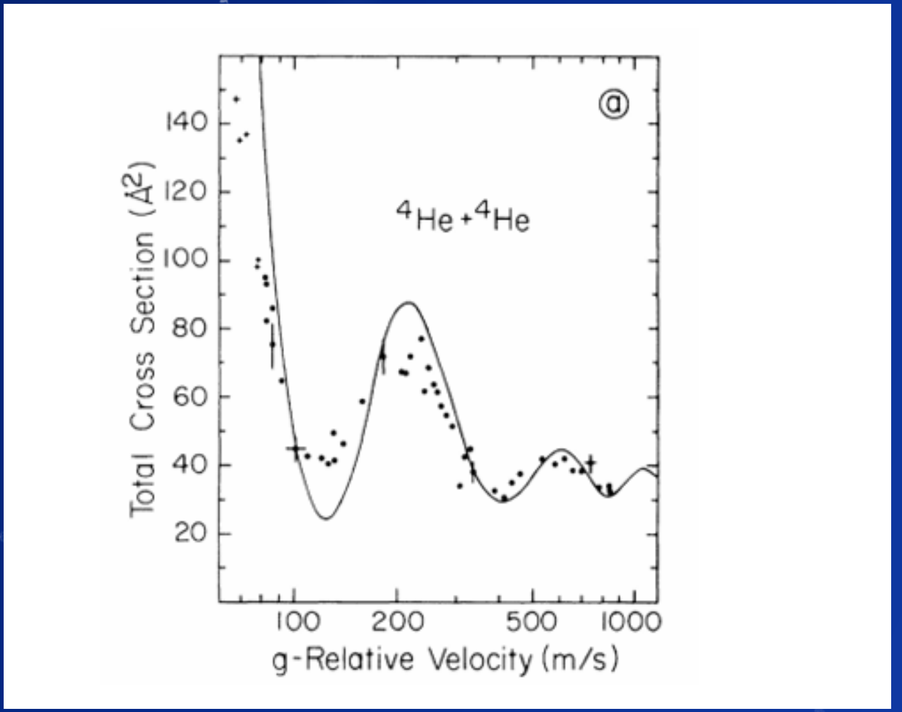
$$T = \frac{|F|^2}{|A|^2} = \frac{4}{4\cos^2(k_2 a) + \frac{(k_2^2 + k_1^2)}{(k_1 k_2)^2} \sin^2(k_2 a)}$$

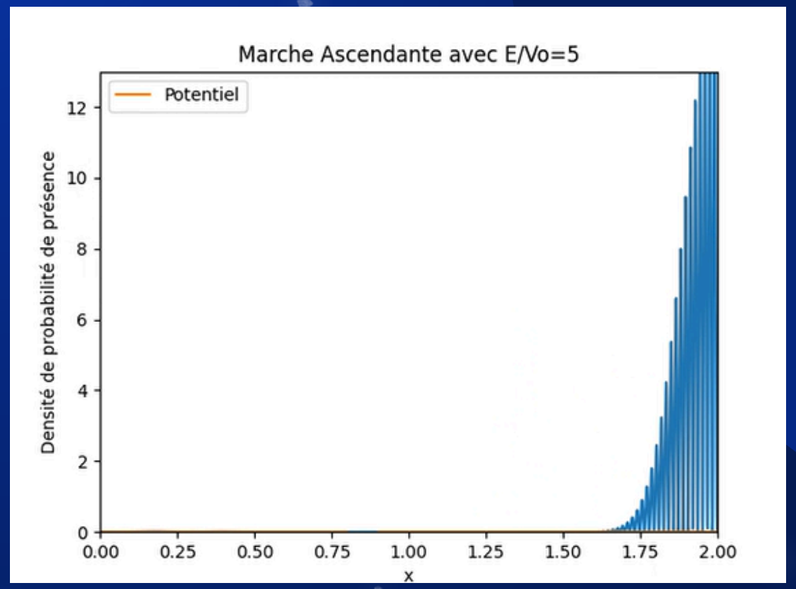
$$R = \frac{|B|^2}{|A|^2} = \frac{\frac{(k_2^2 - k_1^2)^2}{(k_1 k_2)^2} \sin^2(k_2 a)}{4\cos^2(k_2 a) + \frac{(k_2^2 + k_1^2)}{(k_1 k_2)^2} \sin^2(k_2 a)}$$

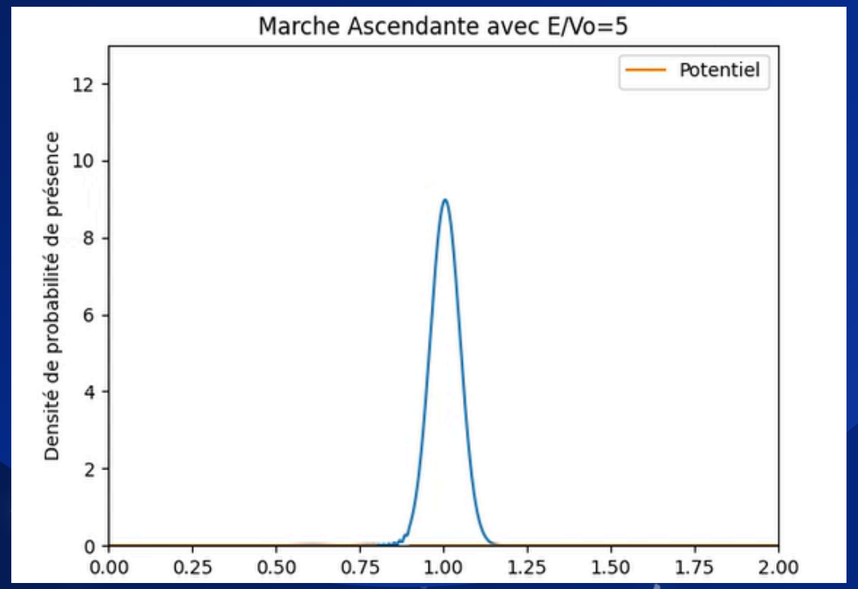
Etude des états stationnaires

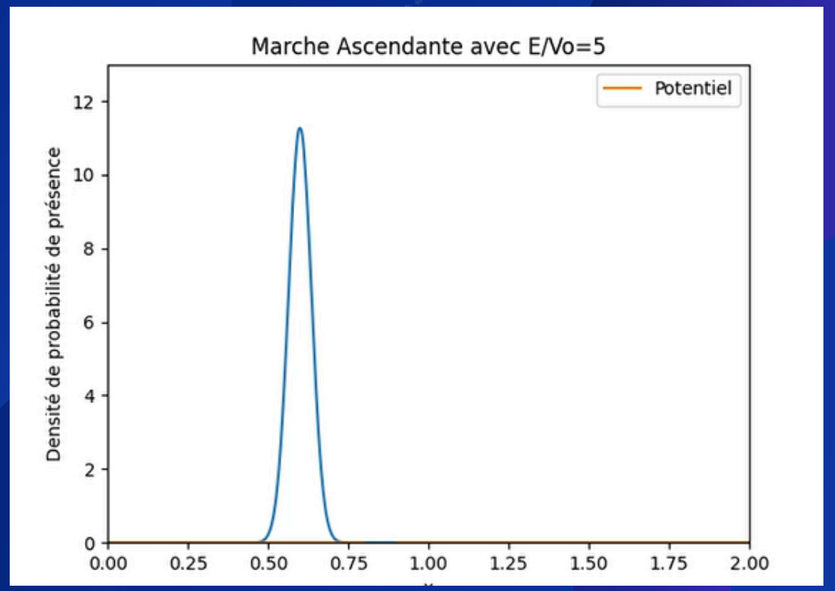


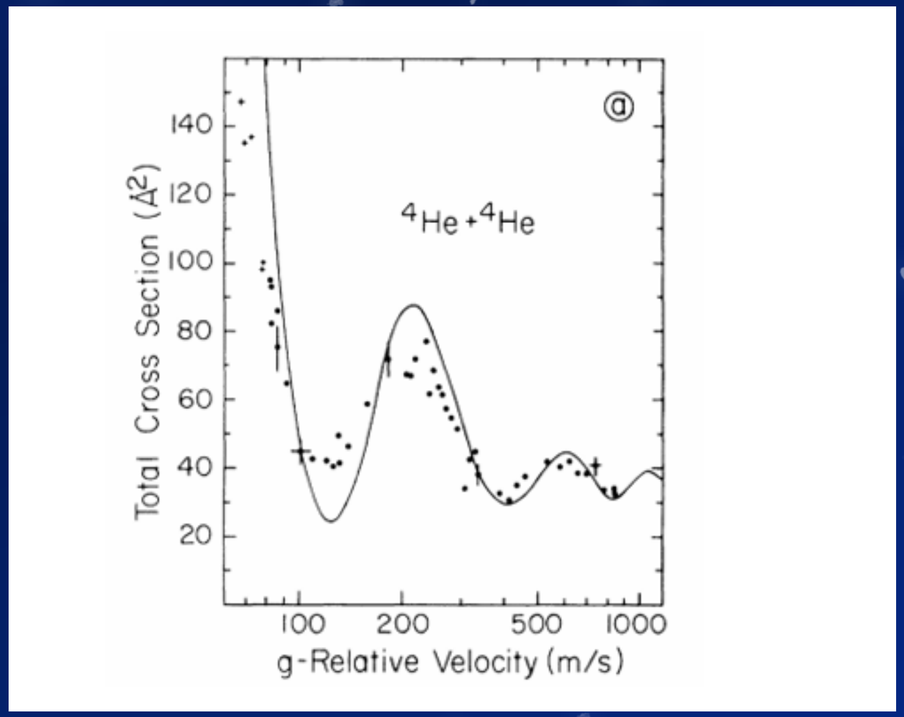

Transmission quantique à travers un puits fini
1e−9
Transmission $T(E)$
Transmission T
Énergie E
0
1
2
3
4
5
0
2
4
6
8
10


@
$^4He + ^4He$
Total Cross Section (Å^2)
g-Relative Velocity (m/s)
20
40
60
80
100
120
140
100
200
500
1000









Etude du paquet d'onde