$$H = \frac{p^2}{2m} - \frac{e^2}{r}$$

$$e^2 = \frac{q^2 4\pi}{\epsilon_0}$$

$$R(r) = a_0^{-3/2} f(p)$$

$$f(\rho) = \frac{1}{\rho^2 + b^2}, \rho = \frac{r}{a_0}$$

$$p \sim \frac{\hbar}{a_0 b} \qquad r \sim a_0 b$$

$$E(b) =^? = \alpha_1 \frac{\hbar^2}{m a_0^2 b^2} - \alpha_2 \frac{e^2}{a_0 b}$$

$$\Psi(r, \theta, \varphi) = \frac{1}{\sqrt{4\pi}} \mathcal{N} R(r)$$

$$\langle \Psi | \Psi \rangle = \mathcal{N}^2 \int_0^\infty R^2(r) r^2 \mathrm{d}x$$

$$= \mathcal{N}^2 \int_0^\infty \frac{r^2}{\left(\left(\frac{r}{a_0} \right)^2 + b^2 \right)^2} \mathrm{d}r$$

$$\boxed{r = b\tilde{r}}$$

$$= \mathcal{N}^2 \underbrace{\int_0^\infty \frac{b^3 \tilde{r}^3 \mathrm{d}\tilde{r}}{b^4 \left(\left(\frac{\tilde{r}}{a_0} \right)^2 \right)^2}}_{\text{cste} \times \frac{1}{b}} = \mathcal{N}^2 \frac{1}{?b}$$

$$E(b) = \langle \Psi | H | \Psi \rangle = \frac{\hbar^2}{4 m a_0^2 b^2} - \frac{2e^2}{\pi a_0 b}$$

$$\frac{\partial E}{\partial b} = -2 \frac{\hbar^2}{4 m a_0^2 b^2} + \frac{2e^2}{\pi a_0 b^2} = 0$$

$$\frac{i}{b_0} = \frac{4 e^2 m a_0}{\pi \hbar^2}$$

$$E(b_0) = -4me^4 = \text{Il a tout effacé :)}$$

Particules identiques

$$\varphi_n(x) = \sqrt{\frac{2}{a}}\sin\Big(\frac{nx\pi}{a}\Big)$$

$$E_n = \frac{\hbar k_n^2}{2m}$$

$$k_n = \frac{n\pi}{a}$$

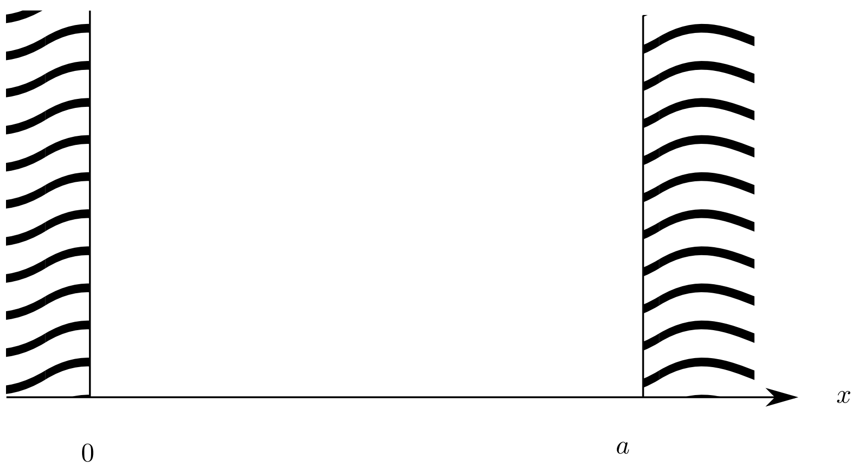

Figure 1 – Puit de potentiel

$$|\Psi_b\rangle = |\varphi_1\rangle \otimes |\varphi_1\rangle$$

$$|\Psi_f\rangle = \frac{1}{\sqrt{2}}\left[|\varphi_1\rangle \otimes |\varphi_2\rangle - |\varphi_2\rangle \otimes |\varphi_1\rangle\right]$$

Hamiltonien total

$$H = H_1 + H_2$$

$$E_b = \langle \Psi_b | H | \Psi_b \rangle = \langle \varphi_1 | H_1 | \varphi_1 \rangle \langle \varphi_1 | \varphi_1 \rangle + \langle \varphi_1 | \varphi_1 \rangle \langle \varphi_1 | H | \varphi_1 \rangle = 2E_1$$

$$E_f = \frac{1}{2} \left(\langle \varphi_1 | \langle \varphi_2 | - \langle \varphi_2 | \langle \varphi_1 | \right) (H_1 + H_2) \left(|\varphi_1\rangle |\varphi_2\rangle + |\varphi_2\rangle |\varphi_1\rangle \right) = \frac{1}{2} (E_1 + E_2 + E_2 + E_1) \text{ Il a encore effacé le tableau :(}$$

Ajout d'une perturbation $W =< alpha < delta(x_1 - x_2)$

$$\Psi_f(x_1, x_2) = -\Psi_f(x_2, x_1) \implies \Psi_f(x_1, x_1) = 0$$

$$E_b^{(1)} = \langle \Psi_b | W | \Psi_b \rangle = \int \mathrm{d}x_1 \mathrm{d}x_2 \Psi_b(x_1, x_2)^* \alpha \delta(x_1 - x_2) \Psi_b(x_1 x_2)$$

$$= \alpha \int \mathrm{d}x_1 |\psi_b(x_1, x_1)|^2 = \frac{3\alpha}{2a}$$