Théorie des perturbation dépendante du temps

$$H = H_0 + W(t)$$
$$W(t) = \begin{cases} 0 & t < 0 \\ W(t) & t \geq 0 \end{cases}$$

$$H \left|\varphi_n\right\rangle = E_n \left|\varphi_n\right\rangle$$

$$p_{i\to f}(t) = \left|\langle|\varphi)f\left|\psi(t)\right\rangle\right|^2 = \left\|\left\langle\varphi_f U_{I(t)}\left|\varphi_i\right\rangle\right|\right\|^2$$

$$\frac{\mathrm{d}U_I}{\mathrm{d}t} = W_I(T)U_I$$

$$W_I(t) = U_o^\dagger w(t)U_0$$

$$U_I(t) = \mathbb{1} + \sum_{n=1}^{\infty} U_I^{(n)}(t)$$

$$U_I^{(n)}(t) = \left(\frac{1}{i\hbar}\right)^n \int_0^t \mathrm{d}t_1 \cdots \int_9^{t_{n-1}} \mathrm{d}t_n \mathrm{d}t_n W_I(t_1) \cdots W_I(t_n)$$

$$\mathcal{P}_{i\to f} = \left|\left\langle_f\right| \sum_n U_I^{(n)}(t) \left|\varphi_1\right\rangle\right|^2$$

Perturbation oscillantes :

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

$$\partial\mathcal{P}(\mathbf{P}_I, t) = \int_{D_f} \left|\langle P, \Omega|\psi(t)\rangle\right|^2 p^2 \mathrm{d}p\mathrm{d}\Omega$$

On a au premier ordre

$$\left|\psi(t)\right\rangle = \frac{1}{i\hbar} int_0^t W_I(t')$$

On peut réécrire la probabilité comme

$$\partial P(\mathbf{p}_f, t) = \frac{1}{hbar^2}\int_{Df}\left|\langle p, \Omega| \int_0^t e^{i(\omega_{fi}-\omega)t'}\mathrm{d}t' \frac{W^\dagger}{2}\left|\varphi_i\right\rangle\right|^2 \rho(E)\mathrm{d}E\mathrm{d}\Omega$$

$$= 1\frac{1}{4\hbar^2}\int_{Df}|\langle p,\Omega|\,E\,|\varphi_i\rangle|^2$$

$$\partial\mathcal{P}(\mathbf{p}_f,t)=\frac{\pi t}{2\hbar}\int_{Df}=|\langle p_f,\Omega_f|\,E\,|\varphi)i\rangle|\partial(E_f-E_i-\hbar\omega)\rho(E_f)\mathrm{d}E_f\mathrm{d}\Omega_f$$

$$=\frac{\pi t}{2\hbar}\left|\left\langle p_{f,\Omega_f}W\middle|\varphi_i\right\rangle\right|^2\rho(E_i+\hbar\omega)\mathrm{d}\Omega_f$$

Taux de transition :

$$\frac{\partial\mathcal{P}}{\partial t\partial\Omega_f}=\frac{\pi t}{2\hbar}\left|\left\langle p_{f,\Omega_f}W\middle|\varphi_i\right\rangle\right|^2\rho(E_i+\hbar\omega)$$

<u>Effet photoéléctrique</u>

$$H=\frac{(\mathbf{P}-q\mathbf{A}^2}{2m}+V(R)=\frac{\mathbf{p}^2}{2m}\frac{q}{m}\mathbf{P}\cdot\mathbf{A}+\underbrace{\mathcal{O}(A^2)}_{\approx 0}+V(R)$$