$\rightarrow$ 10-100 eV

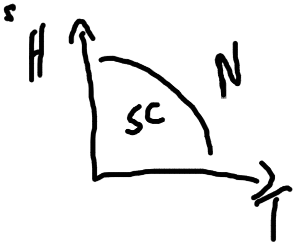
10^{-4} eV $\;>\; 10^{-5} - 10^{-6}$

10^{23}

$\dfrac{\hbar}{1\,\text{eV}} \sim 10^{-15}\,\text{s} \longrightarrow 1\,\text{s}$

$\uparrow \;\; \downarrow \;\; ?$

- Continuité adiabatique
- Symétrie brisée



$$S\left(\prod_{i,j} e^{-|r_i - r_j|^2/2\sigma^2}\right) \qquad \min_{\Psi}\left[\frac{\langle\Psi|H|\Psi\rangle}{\langle\Psi|\Psi\rangle}\right]$$

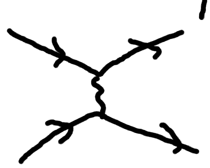
$\langle\rho\rangle \qquad \langle\rho(r_1)\rho(r_2)\rangle$

Self-énergie $\longleftrightarrow \frac{1}{\tau}$ ("viscosité")

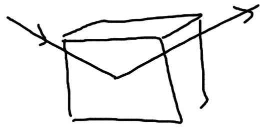
Vertex $\longleftrightarrow$ interaction effective

janv. 11-10:23

Théorie des pert.



8. Fonctions de corrélation



$$H_p + H_{ps}$$

$$\boxed{H_{ps} = g A_p A_s}$$

$$P_{fi} = \frac{2\pi}{\hbar} \left| \langle p_f | \langle s_f | H_{ps} | s_i \rangle | p_i \rangle \right|^2 \delta(E_f - E_i - \hbar\omega)$$

$$E_f + \epsilon_f = E_i + \epsilon_i$$

$$E_f - E_i = \epsilon_i - \epsilon_f = \hbar\omega$$

$$\to P_{fi} = \frac{2\pi}{\hbar} \left| \langle p_f | A_p | p_i \rangle g \right|^2 \times \left| \langle s_f | A_s | s_i \rangle \right|^2 \delta(E_f - E_i - \hbar\omega)$$

$$\sum_{s_f} P_{if} = \left[\frac{|\langle p_f | A_p | p_i \rangle|^2}{\hbar^2} g^2 \right] \sum_{s_f} \langle s_i | A_s^+ | s_f \rangle \langle s_f | A_s | s_i \rangle \int dt\, e^{i\omega t - (E_f - E_i)t/\hbar}$$

$$\int dt\, e^{i\omega t} \sum_{s_f} \langle s_i | e^{iH_s t/\hbar} A_s e^{-iH_s t/\hbar} |s_f\rangle \langle s_f | A_s | s_i \rangle$$

$$\int dt\, e^{i\omega t} \langle s_i | A_s(t) A_s | s_i \rangle$$

$\Longrightarrow$ en équilibre

$$\int \frac{\sum_i e^{-\beta E_i} \langle s_i | A_s(t) A_s | s_i \rangle}{\sum_i e^{-\beta E_i}} e^{i\omega t} dt$$

$$= \int dt\, e^{i\omega t} \frac{\mathrm{Tr}\left[e^{-\beta H_s} A_s(t) A_s \right]}{\mathrm{Tr}\left[e^{-\beta H_s} \right]}$$

$$= \int dt \boxed{\langle A_s(t) A_s \rangle} e^{i\omega t}$$

$$= \boxed{\langle A_s(\omega) A_s(-\omega) \rangle}$$

$$P(x_1, x_2, x_3) \to \int dx_3\, P(x_1, x_2, x_3) = \rho(x_1 x_2)$$

$$\to \langle x_1^2 x_2^3 \rangle = \int dx_1 dx_2 dx_3\, P(x_1, x_2, x_3)\, x_1^2 x_2^3$$

$$\langle 0 | \rho(x,t) \rho(y,0) | 0 \rangle$$