

tdpt.

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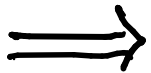
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(Schwinger-Tomonaga equation)

Assume $\lim_{t \rightarrow -\infty} \tilde{V}(t) = 0$

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$$\tilde{\Psi}(t) = \tilde{\Psi}^{(0)} + \int_{-\infty}^t dt' \frac{\partial \Psi(t')}{\partial t'}$$

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$$\tilde{\Psi}(t) = \tilde{\Psi}^{(0)} - i \int_{-\infty}^t dt' \tilde{V}(t') \tilde{\Psi}(t')$$

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$$\begin{aligned}\tilde{\Psi}(t) &= \tilde{\Psi}^{(0)} - i \int_{-\infty}^t dt' \tilde{V}(t') \tilde{\Psi}^{(0)} \\ &\quad + i^2 \int_{-\infty}^t dt' \tilde{V}(t') \int_{-\infty}^{t'} dt'' \tilde{V}(t'') \tilde{\Psi}^{(0)}\end{aligned}$$

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consider $V(t) = \sum_{\beta} f_{\beta}(t) \hat{V}_{\beta}$

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interaction w/ E-field

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interaction w/ B-field

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p.t. expansion

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$$X(t) = X^{(0)} + \sum_{\beta} \int_{-\infty}^{\infty} dt' f_{\beta}(t') \left. \frac{dX(t)}{df_{\beta}(t')} \right|_{f=0}$$

p.t. expansion

$$X(t) = X^{(0)}$$

$$+ \sum_{\beta} \int_{-\infty}^{\infty} dt' f_{\beta}(t') \left. \frac{dX(t)}{df_{\beta}(t')} \right|_{f=0}$$

$$+ \frac{1}{2} \sum_{\beta\gamma} \int_{-\infty}^{\infty} dt' \int_{-\infty}^{\infty} dt'' f_{\beta}(t') f_{\gamma}(t'') \left. \frac{d^2 X(t)}{df_{\beta}(t') df_{\gamma}(t'')} \right|_{f=0}$$

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+ ...

response functions:

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$$\chi(t) = \langle \Psi(t) | W(t) | \Psi(t) \rangle$$

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wavefunction response:

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$$\frac{d\tilde{\Psi}(t)}{df_A(t')} \Big|_0$$

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$$\left. \frac{d \tilde{\Psi}(t)}{d f_{\beta}(t')} \right|_0 = -i \frac{d}{d f_{\beta}(t')} \int_{-\infty}^t dt'' \tilde{V}(t'') \tilde{\Psi}^{(0)} \Big|_0$$

wavefunction response:

$$\begin{aligned} \left. \frac{d \tilde{\Psi}(t)}{d f_{\beta}(t')} \right|_0 &= -i \frac{d}{d f_{\beta}(t')} \int_{-\infty}^t dt'' \tilde{V}(t'') \tilde{\Psi}^{(0)} \Big|_0 \\ &= -i \Theta(t-t') \tilde{V}_{\beta}(t') \tilde{\Psi}^{(0)} \end{aligned}$$

$$\langle\langle \tilde{W}(t); \tilde{V}_A(t') \rangle\rangle$$

$$\langle\langle \tilde{W}(t); \tilde{V}_A(t') \rangle\rangle = \frac{d}{dt_A(t')} \langle \tilde{\Psi}(t) | \tilde{W}(t) | \tilde{\Psi}(t) \rangle |_0$$

$$\langle\langle \tilde{W}(t); \tilde{V}_\rho(t') \rangle\rangle = \frac{d}{dt_\rho(t')} \langle \tilde{\Psi}(t) | \tilde{W}(t) | \tilde{\Psi}(t) \rangle \Big|_0$$

$$= -i \Theta(t-t') \langle \tilde{\Psi}^{(0)} | [\tilde{W}(t), \tilde{V}_\rho(t')] | \tilde{\Psi}^{(0)} \rangle$$

the end.