1 Many-Body Green Functions

1.1 Reminder: Time evolution pictures in Quantum Mechanics

Lecture 3 – 14.04.2022

Schrödinger picture: time evolution goes with the wave function, which is governed by the Schrödinger equation

$$i\hbar\partial_t |\Psi(t)\rangle = H |\Psi(t)\rangle \ . \tag{1.1}$$

The time evolution of expectation values is

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1.2 Green Functions for Many-Body Systems

The fundamental idea of Green functions can be thought of as the process of putting a particle into a system, letting it propagate and then taking it out again. Because the particle is interacting with the full many-body system, this propagation encodes then information about this system.

As an introduction, we look at a single particle system with a Hamilton operator H. We want to understand the following process: an initial state $|\phi_\alpha\rangle$ at time $t_0 = 0$ is prepared, then a measurement of an observable A is taken at time t. The expectation value for the measurement is then:

$$\langle A\rangle_t = \left\langle \phi_\alpha \right| e^{iHt} A e^{-iHt} \left| \phi_\alpha \right\rangle \tag{1.2}$$

$$= \langle\phi_\alpha| e^{iHt} (\sum_\beta |\phi_\beta\rangle \langle\phi_\beta|) A (\sum_{\beta'} |\phi_{\beta'}\rangle \langle\phi_{\beta'}|) e^{-iHt} |\phi_\alpha\rangle \tag{1.3}$$

$$= \tag{1.4}$$