Quantum Theory of Many-Body systems in Condensed Matter (4302112) 2020

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Today's class: *Dyson's equations and self energy*

- Dyson's equation for single particle Green's functions.
- Dyson's equation for time-ordered Green's functions.
- Self-energy: proper and improper.
- Example of diagrams.

Review: Single-particle Green's Functions

$$\begin{cases} \left(E - \hat{H}\right)\psi_E(\vec{r}) = 0 \\ \left(E - \hat{H}_0\right)\psi_E^{(0)}(\vec{r}) = 0 \end{cases}$$

Green's functions

$$\begin{cases} \left(E - \hat{H}\right)G(\vec{r},\vec{r}\,';E) = \delta(\vec{r}-\vec{r}\,') \\ \left(E - \hat{H}_0\right)G_0(\vec{r},\vec{r}\,';E) = \delta(\vec{r}-\vec{r}\,') \end{cases}$$

Integral equations

(Lippmann-Schwinger)

$$\begin{cases} \psi_E(\vec{r}) = \psi_E^{(0)}(\vec{r}) + \int d\vec{r}\,'\, G_0(\vec{r},\vec{r}\,';E)V(\vec{r}\,')\psi_E(\vec{r}\,') \\ \psi_E(\vec{r}) = \psi_E^{(0)}(\vec{r}) + \int d\vec{r}\,'\, G(\vec{r},\vec{r}\,';E)V(\vec{r}\,')\psi_E^{(0)}(\vec{r}\,') \end{cases}$$

Integral equation for G (if we know G_0) (Dyson's equation):

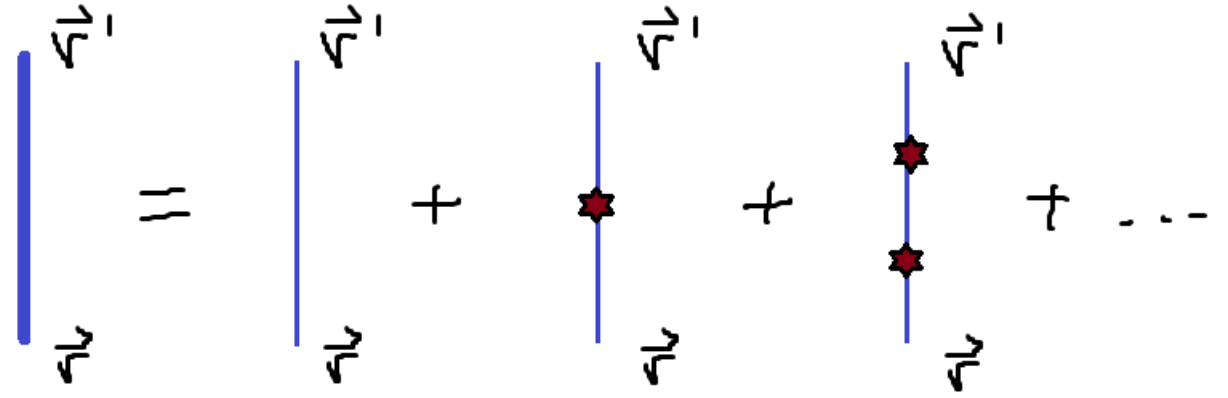
$$G(\vec{r},\vec{r}\,';E) = G_0(\vec{r},\vec{r}\,';E) + \int d\vec{r}_1\, G_0(\vec{r},\vec{r}_1;E)V(\vec{r}_1)G(\vec{r}_1,\vec{r}\,';E)$$

Dyson's equation: "Diagrams"

$$G(\vec{r},\vec{r}\,';E) = G_0(\vec{r},\vec{r}\,';E) + \int d\vec{r}_1\; G_0(\vec{r},\vec{r}_1;E)V(\vec{r}_1)G(\vec{r}_1,\vec{r}\,';E)$$

$$G = G_0 + G_0\, VG$$

$$G = G_0 + G_0\, VG_0 + G_0\, VG_0\, VG_0 + \ldots$$



"Pictoric view" :Diagrams!