Overview

Jinyuan Wu

April 26, 2023

Solid state physics is about the Hamiltonian

$$H = -\sum_i \frac{\nabla_i^2}{2m} - \sum_i \frac{\nabla_i^2}{2M_i} + \sum_{ij} \frac{Ze^2}{|\boldsymbol{r}_i - \boldsymbol{R}_j|} + \sum_{i<j} \frac{e^2}{|\boldsymbol{r}_i - \boldsymbol{r}_j|} + \sum_{i<j} \frac{Z_i Z_j e^2}{|\boldsymbol{R}_i - \boldsymbol{R}_j|}. \tag{1}$$

The free electron gas is just about H_1, but it's already quantum enough. After we add H_4 we get Fermi liquid. With $H_2 + H_5$ we have phonons. With $H_3 + H_4$ we have local magnetism, while $H_1 + H_3 + H_4$ gives us itinerant magnetism. Electron-phonon coupling, polarons, and Kohn anomaly involve $H_1 + H_2 + H_3 + H_5$. BCS involves all the terms.