

### Lecture 23: The Bogoliubov quasiparticles

The variation problem with the BCS trial wavefunction was solved as a homework problem. Instead we develop a more general solution using the Bogoliubov quasiparticle operators. We show that this can be considered an extension of Hartree Fock theory where the four fermion terms are replaced by the best fermion bilinear. Once the off-diagonal order parameter is identified, it is natural to consider the third way of decoupling the four fermion terms using the pairing order parameter

$$\Delta = V_0 \langle \psi_{\uparrow}(\mathbf{r}) \psi_{\downarrow}(\mathbf{r}) \rangle .$$

The equation of motion leads to a  $2 \times 2$  matrix which is diagonalized to yield the excitation spectrum

$$E_k = \sqrt{\xi_k^2 + |\Delta|^2} .$$

The self-consistent equation is derived and solved for  $T_c$  and  $\Delta$ .

**Reading:** Marder 27.3.5