Noninteracting Fermions

Consider Hamiltonian

$$H = \sum_{n,\sigma} c^\dagger_{k\sigma}(\varepsilon_k - \mu)c_{k\sigma} = \sum_{k,\sigma} \xi_k c^\dagger_{ka} c_{k\sigma},$$

with $T = 0$

$$|\mathrm{gs}\rangle = \prod_{|k|<k_\mathrm{F}} c^\dagger_{k\sigma}|0\rangle\,.$$

And we know very well single-particle exitations. Let's add a pericle $k > k_\mathrm{F}$

$$\delta E_k = \frac{1}{2m}\left(k^2 - k_\mathrm{F}^2\right) = \frac{1}{2m}\left((k_\mathrm{F} + \delta k)^2 - k_\mathrm{F}^2\right) \approx v_\mathrm{F}\cdot\delta k.$$

with $\delta k = |k - k_\mathrm{F}| \ll k_\mathrm{F}$ and $v_\mathrm{F} = k_\mathrm{F}/m$. If we remove a particle $k < k_\mathrm{F}$

$$\delta E_k = \frac{1}{2m}\left(k_\mathrm{F}^2 - (k_\mathrm{F} - \delta k)^2\right) = v_\mathrm{F}\cdot\delta k.$$

We could define Wilson ration as

$$R_W = \frac{\pi^2 k_\mathrm{B}^2}{3\mu_\mathrm{B}^2}\frac{\chi}{\gamma} = 1,$$

for free fermions despite the band structure.

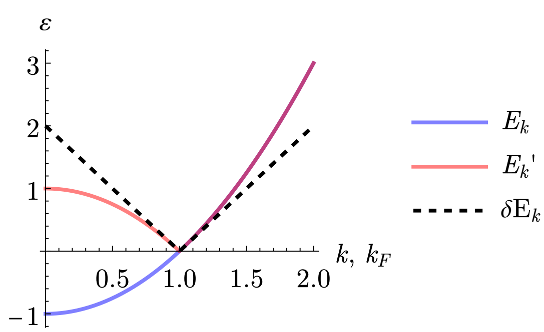

Рис. 1: Single-particle exitations