

Mikhail Baranov (IQOQI, Innsbruck, Austria): *Fermions*

This lecture course discusses properties of many-body fermionic systems, both ideal and interacting. The consideration is mostly based on the second quantization formalism. First I consider an ideal Fermi gas and discuss the characteristic properties of its ground state and excitations, as well as their specific experimental “signatures”. Then the effects of a short-range interparticle interaction, both repulsive and attractive, will be addressed. In the repulsive case, I will discuss, in particular, the basic concepts of the Landau Fermi-liquid theory and the appearance of a collective mode – Landau zero sound. In the attractive case, the main topics will be the BCS pairing leading to superfluidity.

Literature suggestions: The topics of the lecture course are widely presented in the text books. Below are just few suggestions for a kind of “refreshment” and for more advances reading.

- Second quantization: All necessary information about the second quantization formalism for fermions can be found, for example, in Wikipedia article “Second quantization”
- Fermionic systems: Theory of ideal Fermi systems can be found in any text book on statistical mechanics. A very nice and compact introduction to fermionic and bosonic gases including many additional topics can be in the PhD Thesis “High-temperature superfluidity in an ultracold Fermi gas” by M. Zwierlein available at <https://dspace.mit.edu/handle/1721.1/39290>
- For more advances reading I would suggest, for example, the 9-th volume of the Course of Theoretical Physics by L.D. Landau and E.M. Lifshitz, as well as the books “Landau Fermi-liquid theory” by G. Baym and C. Pethick and the book “Quantum Many-Particle Systems” by J.W. Negele and H Orland.