

## Ultracold Quantum Gases

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Monday, 12:00-14:00, Room D

First lecture: 04 March, 2019

### Syllabus

1. Statistical physics: quantum gases at  $T = 0$ , Bose-Einstein condensation (BEC).
2. Matter-light interaction: laser cooling.
3. Interaction of ultracold atoms.
4. Second quantization and many-body Hamiltonian for BEC, correlation functions, Penrose-Onsager definition of a BEC.
5. Gross-Pitaevskii equation and Thomas-Fermi approximation.
6. Solitons in BEC
7. Linearization of Gross-Pitaevskii equation and Bogoliubov approximation.
8. Superfluidity.
9. Quantum many-body effects in BEC; BEC interference; BEC in a double-well; Josephson effects for BEC
10. Spinor condensates.
11. Dipolar condensates.
12. Optical lattices: Bose-Hubbard model and Mott Insulator – Super fluid transition.
13. Fermions: Thomas-Fermi approximation for fermions, long-range order.
14. Ginzburg-Landau theory.
15. BCS theory and BCS-BEC crossover.