

# Topics - 2018

## **Second Quantization and model Hamiltonians**

Quantum mechanics of one particle, Quantum mechanics of many particles, Quantum mechanics of many identical particles, Field operators, Hamiltonian in second quantization, Fano model, Hubbard model, Heisenberg model, Crystals and Bloch theorem, Holstein model, Peierls distortion, Polarons.

## **Contour formulation**

Evolution operator, Equations of motion for Heisenberg operators, Time dependent quantum averages with the contour, Time dependent ensemble averages with the contour, Equations of motion for operator correlators on the contour.

## **MBPT formulations**

Martin-Schwinger hierarchy and Wick theorem, Konstantinov-Perel formalism, Keldysh formalism, Matsubara formalism, Zero-temperature formalism.

## **MBPT for G**

Feynman diagrams, loop rule, Cancellation of disconnected diagrams, topologically inequivalent diagrams, self-energy and Dyson equation, G-skeleton diagrams, W-skeleton diagrams, Feynman rules in arbitrary basis

## **Kadanoff-Baym equations (KBE)**

Keldysh components and Langreth rules, KBE, KBE for open systems

## **Noninteracting G**

Matsubara, lesser, greater, retarded and advanced components. Fluctuation-dissipation theorem, impurity density in the Fano model from Matsubara G, time-dependent impurity density in the Fano model from KBE

## **Interacting G**

Galitskii-Migdal formula, photoemission current, Meir-Wingreen formula for quantum transport, fluctuation-dissipation and other exact properties of  $G<$ , spectral function and physical interpretation

## **Approximations**

Hartree, Hartree-Fock, GW.

Hartree approximation: Self-interaction error, Gross-Pitaevskii equation, homogeneous gas and instability for attractive interactions