Lecture at National Research Nuclear University (MEPhI) Moscow,
Academic year 2016/2017

Modern Problems in Nuclear Physics

D. Blaschke (U. Wroclaw, Poland; JINR Dubna; MEPhI)
G. Röpke (U Rostock, Germany)
A. Sedrakian (Frankfurt Institute for Advanced Studies – FIAS, Germany)

Contents:

I) Functional Integral and Green's Functions Methods (Winter semester 2016/17)

1. Path Integral approach to the partition function

2. Ideal quantum gases

- neutral and charged scalar field, Bose condensation
- Fermionic fields
- gauge fields & blackbody radiation

3. Basic Green's functions approximations

- Ideal gas
- Hartree-Fock approximation
- Polarization function (RPA)

4. Strongly interacting matter: Models

- Walecka model for nuclear matter: liquid-gas transition
- NJL model for quark matter: χSB, CSC, ...
- Bound states & Mott effect: pions, kaons, nucleons
- Beth-Uhlenbeck equation of state

5. Strong correlationsin the Green's function approach

- Bound states
- Cluster expansion
- Pairing

II) Applications in Nuclear Physics, Heavy Ion Collisions (HIC), Astrophysics (Summer 2017)

1. Physics of Neutron Stars I - Phenomenology, EoS and Structure (3 lectures)

2. Statistical Model and HIC I – RHIC and CERN experiments, chemical freeze-out (2)

3. Statistical Model and HIC II – MAL (NSE), clusters in nuclei, HIC & femtonova (3)

4. Superfluidity in Nuclear Matter I – BEC-BCS crossover, NSR theory (2)

5. Superfluidity in Nuclear Matter II – Nuclear, Quark Matter and Atoms in traps (3)

6. Physics of Neutron Stars II – Cooling and superfluidity, nuclear vs. quark matter (2)