Topics in Quantum Many Body Theory

Questions for the oral exam (tentative) :

- 1) Feynman path integral.
- 2) Coherent state functional integral.
- 3) Wick theorem.
- 4) Perturbation theory for the partition function, linked cluster theorem.
- 5) Perturbation theory for the imaginary time Green's function.
- 6) Ground state energy of the electron gas. Random phase approximation.
- 7) From microscopic Hamiltonian to Landau free energy: case of magnetic transitions for interacting fermions on a lattice.
- 8) Derive the Hubbard model from the many-body Schroedinger Hamiltonian. Discuss terms which are taken into account and which are neglected.
- **9)** Discuss U(1) global gauge symmetry, SU(2) spin symmetry, and particle-hole (geometric) symme- try of the Hubbard model.
- **10)** Discuss solutions of the Hubbard model in the non-interacting and in the atomic limits.
- **11)** Discuss the exact solution of the Hubbard model for two lattice sites.
- **12)** Discuss three theorems about the Hubbard model and their physical significance (no proofs).
- **13)** Present the main steps in deriving the dynamical mean-field theory equations. Why it is an exact solution in the infinite dimension?