PHYSICS 622: NUCLEAR PHYSICS

Spring 2008

Witold Nazarewicz and Nicolas Schunck

1. **Introduction**
2. **Lipkin model (exactly soluble many-body Hamiltonian; will illustrate fundamental concepts of many-body physics)**
    a. **Group structure**
    b. **Exact solutions, quantum numbers**
    c. **Numerical implementation**
3. **The Fock Space for Fermions**
4. **Second quantization representation**
5. **Occupation number representation**
6. **Wick's theorem, contractions**
7. **Wick's Theorem. evaluation of matrix elements**
8. **Product states**
9. **Qusiparticle spaces**
10. **Matrix Bogoliubov transformation**
11. **Bogoliubov transformations in the Fock spoace**
12. **Improper Bogoliubov transformations**
13. **Ring and Schuck theorem and Thouless theorem**
14. **Density matrices and the generalized density matrix**
15. **Hartree-Fock method**
    a. **General considerations**
    b. **Lipkin model and Hartree-Fock method. Coherent SU(2) states**
16. **Hartree-Fock stability conditions**
17. **Self-consistent Hartree-Fock symmetries**
18. **Spontaneous symmetry breaking**
    a. **General considerations**
    b. **Parity doublet in the Lipkin model**
19. **Hartree-Fock-Bogoliubov**
20. **Gauge space and particle number symmetry**
21. **Random phase approximation**
22. **Generator Coordinate Method (GCM)**
    a. **General considerations**
    b. **GCM in the Lipkin model**
23. **Nuclear adiabatic motions: problems and perspectives**

Recommended textbook:

"Nuclear Many Body Problem"
Ring & Schuck, 3rd printing, 2004 Springer, ISBN: 3-540-212

Recommended textbook in Polish (but equations are universal!)

"Theory of Nuclear Systems", Jacek Dobaczewski
Can be downloaded from http://www.fuw.edu.pl/~dobaczew/Czesc055f.ps.gz

Supplementary texts:

"An Advanced Course in Modern Nuclear Physics", Ed. Arias and Lozano,
(Lecture notes in physics, vol. 581), Springer 2001
ISBN: 3-540-42409-1

"Frontiers in Nuclear Physics", Ed. S. Kuyucak, World Scientific 1999
http://www.wspc.com/books/physics/4136.html