Syllabus for Quantum Physics (Fall 2022)

I. Some missing topics in quantum physics (I), Spring 2022

- Reading assignment: One (only) of the following:
  - **[Ga]:** Ch 7-8, $8A_{supplement,}$ $8B_{supplement}$, 10, $10A_{supplement}$
  - **[Gr]:** $Ch5_3$, Ch9

1. Degenerate Fermi system and the structure of matter
- White dwarf stars, Chandrasekhar limit and neutron stars
- Electrons in metals: periodic potentials, Bloch waves, band structure, metal-insulator-semiconductor.Schrödinger equation in 3D with a central potential

2. Semi--classical approximation (WKB approximation)
- The classical region
- Tunneling
- The connection formulas

II. Charge particles in a magnetic field

- Reading assignment: One (only) of the following:
  - **[Ga]:** Ch 16,
  - **[Gr]:** Ch $4_{4,5}$

1. Canonical quantization
2. The classical particle interacting with EM field
3. Electron moving in a constant magnetic field
4. The degeneracy of Landau levels
5. Integer Quantum Hall effect Time dependent perturbation theory and adiabatic approximation

III. Time Dependent Perturbation Theory and Adiabatic Approximation

- Reading assignment: One (only) of the following:
  - **[Ga]:** Ch 14_7, 15, $16_{6,A}$ 17
  - **[Gr]:** Ch $11_{1,2,3,4,5}$

1. Time-dependent perturbation
   - General formula
   - Harmonic time-varying of the potential
   - Life--time, line widths, and resonances
   - Phase space
2. Radiation
   - Semiclassical treatment of the EM field
   - Quantization of the EM field

- Matrix element and selection rules
- 2p to1s transition
- Spin and intensity rules

3. The adiabatic and Born-Oppenheimer approximation
   - The Born-Oppenheimer approximation and the rotation/vibration of molecules
   - The adiabatic theorem
   - Berry's phase
   - The Aharonov-Born effect

IV. Scattering and Identical particles

- Reading assignment: One (only) of the following:
  - **[Ga]:** Ch 19,
  - **[Gr]:** Ch 10

1. Introduction
2. Partial wave expansion and phase shifts.
3. The Born approximation.
4. Scattering of identical particles
5. Inelastic scattering.

V. Special topics

- Reading assignment: One (only) of the following:
  - **[Ga]:** Ch 16,

1. Entanglement and EPR.
2. Lasers.
3. The two-level/three-level system.
4. Quantum jumps.
5. The Mössbauer effect.

References:

1. [Li]: Introduction to Quantum Mechanics by R. Liboff (QC174.12 L52, 2003)
2. **[Ga]:** ***Quantum Physics*** by S. Gasiorowcz (QC174.12 G37, 2003)
3. **[Gr]:** ***Introduction to Quantum Mechanics*** by D. Griffiths (QC174.12 G855, 2005)
4. **[Sh]:** ***Principles of Quantum Mechanics*** by R. Shankar
5. [**Sa]:** ***Modern Quantum Mechanics*** by J.J. Sakurai, 2nd Ed. You can find this textbook on-line at: ***https://archive.org/details/ModernQuantumMechanicsJ.J.Sakurai/page/n9***