QM II; FS 2013; Adrian Signer

Literature

[**BJ**] Quantum Mechanics, B.H. Bransden and C.J. Joachain, Pearson

[**SN**] Modern Quantum Mechanics, J.J. Sakurai and J. Napolitano, Addison-Wesley/Pearson

[**Sc**] Quantum Mechanics, F. Schwabl, Springer

[**S***] Advanced Quantum Mechanics, J.J. Sakurai, Addison-Wesley

[**Sc***] Advanced Quantum Mechanics, F. Schwabl, Springer

and many, many more

Syllabus

1. Approximation methods for stationary problems (week 1,2)

   1.1 Time-independent PT, non-degenerate case [BJ 8.1] [SN 5.1]
   1.2 Time-independent PT, degenerate case [BJ 8.3] [SN 5.12]
   1.3 Variational principle [BJ 8.3] [SN 5.4]
   1.4 WKB, semi-classical approximation [BJ 8.4]

2. The hydrogen atom (week 2,3)

   2.1 Basics from QM I [BJ 7.2,7.5] [SN 3.7]
   2.2 Relativistic corrections [BJ 8.2] [SN 5.3] [Sc 12.1]
   2.3 Spin-orbit term [BJ 8.2] [SN 5.3] [Sc 12.2]
   2.4 Darwin term [BJ 8.2] [Sc 12.3]
   2.5 Fine structure of hydrogen [BJ 8.2] [SN 5.3]
   2.6 Corrections beyond fine structure [Sc 12.4]

3. Many-electron atoms (week 3,4)

   3.1 Identical particles [BJ 10.2] [SN 7.1,7.2] [Sc 13.1]
   3.2 Thomas-Fermi approximation [Sc 13.4]
   3.3 Hartree approximation [Sc 13.3]
   3.4 Hartree-Fock approximation [Sc 13.3]
   3.5 The periodic table and Hund's rules [Sc 13.5]

4. Approximation methods for time-dependent problems (week 4,5)

   4.1 Time-dependent perturbation theory [BJ 9.1] [SN 5.7]
   4.2 Constant perturbation [BJ 9.2]
   4.3 Harmonic perturbation [BJ 9.3] [SN 5.7]
   4.4 The interaction picture [Sc 16.3] [SN 5.5]
   4.5 The adiabatic approximation [BJ 9.4] [SN 5.6]

5. Interaction with (classical) radiation

   5.1 Basics from EM and QM I [BJ 11.1] [Sc 16.4]
   5.2 Induced emission and absorption [BJ 11.2-3] [SN 5.8]
   5.3 Dipole approximation and selection rules [BJ 11.4]

6. Potential scattering

   6.1 Scattering and cross sections [BJ 13.1-2]
   6.2 Partial-wave analysis [BJ 13.3-4] [SN 6.4] [Sc 18.3]
   6.3 Coulomb scattering [BJ 13.7] [Sc 18.11]
   6.4 The Lippmann-Schwinger equation and Green function [BJ 13.5] [SN 6.2]
   6.5 The Born approximation [BJ 13.6] [SN 6.3]

7. General scattering theory

   7.1 Dynamics of scattering
   7.2 Moller and scattering operator

8. Quantization of radiation field

   8.1 Quantization of free photon field [SN 7.6] [S* 2.1,2.3] [Sc* 14.1-4]
   8.2 Fock space [S* 2.2] [Sc* 1.3]
   8.3 Photon emission and absorption [S* 2.4]
   8.4 Scattering of photons by atoms [S* 2.5]

9. Relativistic quantum mechanics

   9.1 The Klein-Gordon equation [BJ 15.1] [SN 8.1] [Sc* 5.1-2]
   9.2 The Dirac equation [BJ 15.2-3] [SN 8.2] [S* 3.2] [Sc* 5.3]
   9.3 Covariance of the Dirac equation [BJ 15.3] [SN 8.3] [S* 3.4] [Sc* 6.2]
   9.4 Solutions of the Dirac equation [BJ 15.4] [S* 3.3] [Sc* 6.3]
   9.5 The non-relativistic limit [BJ 15.6] [S* 3.3] [Sc* 5.3]

10. Second quantization

   10.1 Creation and annihilation operators for bosons and fermions [Sc* 1.3-4]
   10.2 Field operators [Sc* 1.5]
   10.3 Observables in second quantization [Sc* 1.6]
   10.4 Quantization of relativistic fields [Sc* 12.2-3,13.1,13.3] [S* 3.10]