Advanced Quantum Physics Notes

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Abstract

Abstract of this course

1 Revision

2 Perturbation Theory

2.1 Time-Independent Perturbation Theory

2.2 First-order Perturbation Theory

2.3 Second-order Perturbation Theory

Example: Infinite square well with central bump

...

Example: Infinite square well in an electric field

...

Example: Harmonic Oscillator + Linear perturbation

...

Example: Van der Waals Interaction

...

2.4 Degenerate Perturbation Theory

Example: Perturbed 2D infinite square well

...

2.5 Variation Method

Example: Hydrogen atom ground state energy

...

2.5.1 Rayleigh-Ritz Method

Example: Hydrogen atom with finite proton mass

...

3 Electromagnetism

3.1 Aharanov-Bohm Effect

3.2 Gauge Invariance

3.2.1 Couloumb Gauge

3.2.2 Symmetric Gauge

3.3 Orbital Magnetic moment

In Hamiltonian, the $L \cdot B$ term can be written as: $\hat{H} = -\hat{\mu}_L \cdot B$ *Definition Orbital magnetic moment operator:*

$$-\hat{\mu}_L = \frac{q}{2m}\hat{L}\gamma_L$$

...
Definition Gyromagnetic ratio, γ_L:

$$\gamma_L = \frac{q}{2m}$$

...
For an electron (q=-e), the orbital magnetic moment operator is

3.4 Magnetic Moments

3.4.1 Electron

3.4.2 Muon

3.4.3 p, n, nuclei

3.5 Spin

3.5.1 Particle magnetic moment: spin-half

3.5.2 Spin Precession

3.5.3 Spin-half

3.5.4 Energy Eigenstates

3.5.5 Wave-function Evolution

3.6 Stern-Gerlach

3.7 Landau Levels

3.7.1 Landau Gauge

Example: 2D Electron Gas

4 Real Hydrogen Atom

4.1 Relativistic Corrections

4.2 Fine Structure

4.3 Hyperfine Structure

5 Symmetries

5.1 Symmetry Transformation

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6 Identical Particles

6.1 Spin and statistics(fermions and bosons)

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8 Zeeman effect/Stark effect/Molecules: H_2^+ and H_2