Hauptseminar Quantenfeldtheorie SS2013 - Vorträge

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Termin: Dienstag, 9:45
Erster Vortrag: 16. April 2013

Vorträge 3 wird als Vorlesung gehalten.

Deadlines

2 Monate vor dem Vortrag: Kontakt mit dem Tutor aufnehmen / In das Thema einarbeiten.

1 Monat vor dem Vortrag: Intensiv mit dem Thema beschäftigen.

2 Wochen vor dem Vortrag: Dem Tutor ein Outline des Vortrags vorlegen.

1 Woche vor dem Vortrag: Probevortrag und Hand-out.

1 Monat nach dem Vortrag: Tex-File der Ausarbeitung.

Die Ausarbeitungen werden in einem kleinen Buch auf der Webseite veröffentlicht.

Talks

1. **Introduction/Basics** [1]
   - Poincare Group / Relativity
   - Klein-Gordon / Dirac Equation
   - Necessity for Field Viewpoint
   - Classical Field Theory Introduction
   - Noether Theorem
   - Klein-Gordon / Dirac Field
2. **Canonical Quantization I - Matter** [3, 4, 1]
   - Canonical Commutator
   - Mode expansion (Harmonic Oscillators)
   - Antiparticle Interpretation
   - Propagators
   - Number Representation of Fermions
   - Spin-Statistic Theorem

3. **Canonical Quantization II - Abelian Gauge Fields** [3, 4, 1]

    - Introduction to Lie Groups
    - General Gauge Invariance
    - Derivation of Electromagnetism from Local Symmetry
    - Problems with Quantization of Gauge Invariant Theories
    - Gauge Fixing and Covariant Quantization
    - Frozen Degrees of Freedom

4. **Feynman Diagrams** [5, 3, 4, 1]

    - S-Matrix Expansion
    - Dyson Series
    - Wick Theorem
    - First Order Terms and Rules for QED

5. **Path Integrals I** [2, 6, 1]

    - Gaussian Integrals
    - General Concept of Path Integrals
    - Propagators in Path Integral Language
    - Dyson Series and Wick Theorem Equivalents for Path Integrals
    - Feynman Rules

6. **Path Integrals II** [2, 6, 1]

    - Path Integrals for Fermions
    - Path Integrals for Gauge Fields
    - Gauge Fixing in Path Integral Formalism (Faddeev-Popov-Formalism)

7. **Radiative Corrections** [5, 3, 1]

    - Second Order Feynman Rules
    - Photon/Electron Self Energy Contribution
    - External Lines
    - Vertex Contribution
    - Ward Identities (Why QED works so well)
    - Applications (Electron Spin, Lamb Shift)

8. **Formal Renormalization** [5, 3, 6, 4, 1]

    - Cut-Off Formalism

- Dimensional Regularization
- Conditions
- Running of Coupling Constants (Unification)

9. **Non-Abelian Gauge Theory** [3, 6, 4, 1]

   - Non-Abelian Groups
   - Yang-Mills Hamiltonian
   - Propagators for Non-Abelian Gauge Particles

10. **Quantization of Non-Abelian Gauge Theory** [3, 6, 4, 1]

    - Faddeev-Popov Lagrangian
    - Asymptotic Freedom
    - Feynman Rules for Non-Abelian Gauge Fields
    - $U(1) \otimes SU(2)$ Electroweak Theory
    - Weinberg Salam Theory of Electroweak Interaction (first Unification)

11. **Spontaneous Symmetry Breaking and Higgs Mechanism** [3, 6, 4, 1]

    - Global Symmetry Breaking
    - Local Symmetry Breaking
    - Goldstone-Mode and Mass Generation (Higgs Mechanism)
    - Non-Abelian Case

12. **Standard Model of Particle Physics** [2, 3, 1]

    - General Overview over Particle Zoo
    - P blackicting the Higgs-Particle
    - Introduction to QCD and $U(1) \otimes SU(2) \otimes SU(3)$-Unification
    - Lagrangian for the Standard Model

13. **Beyond the Standard Model**

    - Problems of the Standard Model
    - Overview over Possible Solutions
    - Supersymmetry
    - Grand Unification
    - String Theory

Literatur

[1] D. V. Schroeder, *An Introduction To Quantum Field Theory*. Levant Books, 2005.

[2] A. Zee, *Quantum Field Theory in a Nutshell: (Second Edition) (Google eBook)*. Princeton University Press, 2010.

[3] F. Mandl and G. Shaw, *Quantum Field Theory*. John Wiley & Sons, 2010.

[4] L. H. Ryder, *Quantum Field Theory*. Cambridge University Press, 1996.

[5] C. Itzykson and J. B. Zuber, *Quantum Field Theory*. Dover Publications, 2005.

[6] M. Srednicki, *Quantum Field Theory (Google eBook)*. Cambridge University Press, 2007.