Relativistic Quantum Mechanics

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- **Textbook**
  Luciano Maiani & Omar Benhar:
  Relativistic Qantum Mechanics. An Introduction to Relativistic Quantum Fields.
  Suggestions for further readings can be found in the Bibliography.
- **Background and Additional Material**
  Notes on selected subjects will be available at
  http://chimera.roma1.infn.it/OMAR/RQM/notes.html

Syllabus

1. Recollection of Relativity and Classical Field Theory. Symmetries and Nöther's Theorem. Energy-Momentum Tensor. Angular Momentum Tensor. (Chapts. 1 and 2; Chapt. 3, Sects. 3.1, and 3.4–3.6)

2. Klein-Gordon Equation. Quantisation of the Real and Complex Scalar Fields. Creation and Annihilation Operators. Commutation Rules. Conserved Charge. Antiparticles. (Chapt. 4, Sects. 4.1 and 4.3)

3. Covariant Form of Maxwell's Equations. Gauge Invariance. Quantisation of the Electromagnetic Field in Vacuum in the Coulomb gauge. Energy and Momentum of the Electromagnetic Field. The spin of the photon (Chapt. 5, Sects. 5.1, 5.5 and 5.6)

4. Dirac's Equation. Spin. Relativistic Invariance. Properties of γ-matrices. Solution of Dirac's Equation in Free Space. Anomalous Magnetic Moment of the Electron. Quantisation of Dirac's Field. Fermi-Dirac Statistics (Chapt. 6, Sects. 6.1 and 6.3; Chapt. 7, Sects. 7.1, 7.2, 7.5 and 7.6)

5. Free Field Propagators. Scalar, Electromagnetic and Dirac's Fields. (Chapt. 8)

6. Electromagnetic Interactions. Minimal Substitutions. Geuge Invariance. Quantum-Electro-Dynamics (QED) (Chapt. 9, Sect. 9.1))

7. Time Evolution of Quantum Systems. Interaction Picture. S-Matrix and Dyson's Equation. Scattering Processes. Cross Section. (Chapts. 10, 11)

8. Wick's theorem and Feynman rules of QED. Calculation of Electromagnetic Processes: Mott and Rutherford Cross Sections; $e^+e^- \to \mu^+\mu^-$ Annihilation (Chapt. 14, Sects. 14.1 and 14.7). Compton Scattering and Gauge Invariance (Chapt. 14, Sect. 14.4).