

Quantum Field Theory I (PHYS645000)

Outline of Lectures

Instructor: Professor Chong-Sun Chu, GB II.P519.
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Time and Location: 10:00 - 12:30 (with one 5 minutes break); Lecture room 521, General Building II.

Office Hour: By appointment by email

Resources:

I. Books

- **L. Ryder, Quantum Field Theory, CUP**
Good basic introduction to the Lagrangian QFT, with emphasis on applications to particle physics
- **Cheng and Li, Gauge theory of elementary particle physics**
Very readable account of QFT to particle physics.
- **N.D. Birrel, P.C.W Davies, Quantum Fields in Curved Space, CUP**
Standard introduction to the subject of QFT in curved space, up to development before the 80's.

II. Others

- **S. Coleman, Aspects of Symmetry, CUP.**
Very informative account on advanced topics in QFT.
- You may also find many links and useful information from the website:
<http://www.blau.itp.unibe.ch/QFTCST>

Course Outline by Topical Areas: The course will be dealing with the following main areas:

- Basic Introduction:
 - Relativistic wave equation
 - Lagrangian field theory and symmetries
 - Quantum theory of field, particle interpretation.
 - Perturbative S-matrix
 - Spontaneous symmetry breaking
- Advanced Topics:
 - Chiral Anomaly and anomaly cancellation
 - QFT in curved spacetime, Inflation and CMB spectrum
 - Entanglement entropy in QFT

Evaluation: Homework counts 30 %, Final reports counts 70 %. 2 people will form a group and submit a final report on a topic of choice. Deadline of submission: Jan 5th, 2020. Possible topics are:

- Higgs mechanism in gauge theory [CL chap 8]
- Fadeev-Popov quantization of gauge theory [CL chap 9.1, 9.2]
- Magnetic monopole in gauge theory [CL chap 15]

- Instanton in Yang-Mills [CL chap 16]
- Conformal anomaly and adiabatic regularization [arXiv:1011.4772]
- Problems of quantum gravity
- Holographic principle of quantum gravity

Week	Main topics
(9/14)	Relativistic wave equations
(9/21)	Lagrangian field theory, Noether theorem, e.g. energy momentum tensor, charge and current of $U(1)$ theory
(9/28)	holiday
(10/5)	Free field quantization: Quantization of scalar field theory, Fock space and particle interpretation, normal ordering, zero point energy; Quantization of Dirac spinor theory, Pauli exclusion principle, Casimir effect etc
(10/12)	Free field quantization
(10/19)	Free field quantization
(10/26)	Time ordering, propagator and S-matrix expansion of the Evolution Operator, Feynman diagrams etc
(11/2)	Spontaneous symmetry breaking, Nambu Goldstone theorem
(11/9)	Yang-Mills gauge theory: Higgs mechanism, instanton, monopoles etc
(11/16)	Chiral anomaly
(11/23)	Chiral anomaly
(11/30)	Chiral anomaly/QFT in curved spacetime
(12/7)	QFT in curved spacetime
(12/14)	QFT in curved spacetime
(12/21)	Entanglement entropy in QFT
(12/28)	Entanglement entropy in QFT