UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

## Computational Physics Laboratory

**2223-1-F1701Q119**

### Aims

Study and implementation of techniques for computing path integrals.

### Contents

Elementary numerical integration, Monte Carlo methods, numerical simulation of simple quantum and statistical systems.

### Detailed program

ELEMENTARY NUMERICAL INTEGRATION:

Formulae of Newton-Cotes, Gaussian quadratures, composite integration.

MONTE CARLO METHODS:

Central limit theorem, Monte Carlo, importance sampling, Markov chains, Metropolis algorithm.

NUMERICAL SIMULATIONS:

Implementation of the Metropolis algorithm for the computation of ratios of path integrals for elementary quantum systems.

Definition of the Quantum Chromodynamics (QCD) on the lattice. Numerical computation of the leading contribution

to the eta' mass due to the chiral anomaly.

## Prerequisites

Mechanics, Quantum mechanics.

## Teaching form

Theoretical and programming lectures at the "Marco Comi" Computational Physics Laboratory.

## Textbook and teaching resource

Numerical Recipes, W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery.

W. Feller, An introduction to probability theory and its application.

M. Creutz, Quarks, gluons and lattices.

M. Creutz, B. Freedman, A statistical approach to quantum mechanics, Annals of Physics 132 (1981) 427.

I. Montvay, and G. Münster, Quantum Fields on a Lattice, Cambridge University Press (1997).

C.B. Lang, and C. Gattringer, Quantum Chromodynamics on the Lattice. An Introductory Presentation (Lecture Notes in Physics 788), Springer-Verlag Berlin Heidelberg (2010).

## Semester

First and second semester.

## Assessment method

The students must prepare a written report which summarizes the theoretical material of the course and contains a presentation of the results of the numerical simulations. The report will be discussed in an oral exam, during which the general knowledge of the course programme will be verified.

## Office hours

Students may come to my office any time, preferably Friday 14:00-16:00 . If needed, send an e-mail to fix an

appointment.

## Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE