



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Mathematical Methods for Physics

2425-1-F1701Q098

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#### Aims

Group theory and its applications to theoretical physics.

#### Contents

Lie groups, Lie algebras; their representations.

#### Detailed program

##### Basic definitions

- Definition of a group; subgroups, homomorphisms, representations.
- conjugate, invariant subgroups; quotient group;

##### Finite Groups

- Cyclic group, dihedral group, group of permutations

##### Representations

- Unitary representations, their classification, orthonormality and completeness, Regular representation. Irreps of  $SO(3)$

##### Lie groups

- Manifolds, Lie groups, Lie algebras, generators, exponential map.
- Examples of Lie groups: orthogonal, unitary, Lorentz, Poincaré.  $SU(2)$  and  $SO(3)$

### Lie algebras

- Definition, simple and semi-simple algebras. Killing form.

### Classification of Lie Algebras

- Cartan subalgebra, Root systems, Dynkin diagrams.

### Prerequisites

Undergraduate degree in math or physics

### Teaching form

Lessons (6 CFU), This course will be taught in English.

### Textbook and teaching resource

Lecture notes uploaded on the course webpage.

Group Theory:

- Wu-Ki Tung, *Group Theory in Physics*
- Georgi, *Lie Algebras in Particle Physics*.
- Keski-Vakkuri-Montonen-Panero, *Mathematical Methods for Physics - An Introduction to Group Theory, Topology and Geometry*
- Fulton-Harris, *Representation theory*, Springer.

Further readings:

- Gilmore, *Lie Groups Lie Algebras and some of their applications*, Dover.
- Gilmore, *Lie Groups, Physics and Geometry*, Cambridge.
- Cornwell, *Group Theory in Physics*, Academic Press.

### Semester

First semester

## **Assessment method**

Oral exam. Open questions on all course's topics covered during the lectures.

## **Office hours**

By appointment, by sending an e-mail to *mattia.bruno@unimib.it*

## **Sustainable Development Goals**

QUALITY EDUCATION

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