MATH431

Modern Particle Physics

2020–2021

Semester 2

General objectives

- The main objective is to **introduce** the basic mathematical structures that underlie our contemporary undestanding of fundamental particle physics.
- The modern formalism of elementary particle physics uses the concept of symmetries and their relation with conservations laws. Starting with the Lorentz and Poincare spacetime symmetries, and continuing with the internal gauge symmetries of the Standard Model of particle physics, we will see how modern physics utilises groups and algebras to construct the models that account for all observational subatomic data to date. Building on the traditions of Galileo and Newton we will see how mathematics provide the language to describe natural phenomena.

Who am I & how to reach me?

- Lecturer: Alon Faraggi
  - Theoretical particle physics
- How to reach me?
  - email: alon.faraggi@liv.ac.uk
  - Canvas discussion board / inbox
  - **Remote** office hours (e.g. Zoom or Teams)
    - **Wednesdays 12–1 pm**
    - **Fridays 11 am–12:00 pm**

    Feel free to reach out via your preferred channel (e.g. Canvas inbox, email...)

Preparing for lectures

- The lecture notes are provided online. I am in the process of typing them up, but part of them may still be hand written. The lectures are self contained and do not rely on a particular reference. The lectures are delivered by videos, three of which will be delivered each week. It is important that you go through and understand the lecture notes. You should ask about any points that remain unclear in the synchronous sessions.
- Each lectures covers roughly 4 hand written lecture notes. The lectures will be accompanied by slides, with a set of slides per lectures and will labeled as such on Canvas.

Excercises

- I will provide a set of exercises for each week
  - It is important that you do these to exercises for the exercise delivery and tests; these are however not marked
- It is important to do the exercises; it is the most important part; You can only learn a subject in math by doing exercises
- You can ask questions about these in the weekly Zoom session, or in Canvas board. I will check the Canvas questions (at least) twice a week

Zoom sessions

- Two hours synchronous session on Wednesdays 12 pm and Thursdays 11 am
- Link in your timetables
  - New link every week
- Possibility for Q&A
- We will also go through some exercises (a bit like online tutorial)
  - The solutions to the exercises will be posted one week after they are assinged.
  - The homework sets will not be marked but the problems on the exam will be similar to the problems on the problem sets. It is important that you understand and know how to work out the problems.

Canvas discussion boards

- This is the preferred way of communication when F2F not possible!
  - Sending emails is of course fine too, but it's easier to keep the relevant discussions organised in Canvas
- I pinned a couple initial discussion threads (General stuff, Typos/errors, Feedback) but please start new ones!
  - Feel free to also answer / comment, no need to wait for me to reply!

Grading

- Mid term test in week 7 or 8 (50 %)
- Final exam after the end of S2 (50 %)

Contents

References

1. Quarks and leptons : an introductory course in modern particle physics, Francis Halzen, Alan D. Martin, New York ; Chichester : Wiley, 1984.
2. A Modern Introduction to Quantum Field Theory, Michele Maggiore, Oxford University Press, 2005.
3. Modern Particle Physics, Mark Thomson, Cambridge University Press, 2013.
4. The foundations of quantum theory , Sol Wieder, New York :Academic Press, [1973]
5. Journeys beyond the standard model,, Pierre Ramond, Perseus Books, 1999.
6. Gauge theory of elementary particle physics, Ta-Pei Cheng and Ling-Fong Li, Clarendon Press, 1984