**FYS5120 – Advanced quantum field theory** (Spring 2024)

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**Literature**

[PS] M. Peskin and D. Schroeder, *An Introduction to Quantum Field Theory*, Westview Press (1995).

[S] M. D. .Schwartz, *Quantum Field Theory and the Standard Model*, Cambridge University Press (2022).

I will to a large extent base the lecture on the standard textbook by Peskin & Schroeder (and thus, mostly, use their conventions and notation as well), switching more and more to that by Schwartz in the second half of the course. This will be complemented with other material, so the course content is ultimately simply defined by what is covered in the lecture and exercises. Being an advanced course, there is also a significant focus on self-study to fill in aspects only cursory mentioned in the lecture. In this context it is worth noting that all treatments of quantum field theory have a somewhat different 'philosophy'; PS, e.g., put more emphasis on being able to perform QFT calculations in practice, as well as on physical intuition, than on advanced formal aspects of the theory (while still presenting all elementary aspects in full detail). For a deeper understanding of QFT, it is thus anyway indispensable to complement the reading of PS. Textbooks worth looking at include those by Weinberg; Itzykson & Zuber; or Ryder.

# *Very preliminary course syllabus*

[**updated on 11-12-2023**]

| **Date** | **Subject** |
|---|---|
| week 4 (from Jan 22) | Recap: Canonical Quantization |
| week 5-6 (from Jan 29) | Path integral quantization [PS 9] |
| week 7-8 (from Feb 12) | Gauge invariance & some group theory [PS 15] |
| week 9 (from Feb 26) | Quantization of Non-Abelian Gauge Theories [PS 16.1–16.2] |
| week 10-11 (from Mar 4) | Higgs mechanism & electroweak theory [PS 11.1, 20.1, 20.2,...] |
| week 12 (from Mar 18) | **Midterm exam** (written, on 20.03. 9am) *Q&A on 19.03.* |
| week 13 (from Mar 25) | **Easter** *no lectures* |
| week 14 (from Apr 2) | Quantization of broken Yang-Mills theories [PS 21.1, 21.2]<br>Alternatives: *i)* Optical theorem *ii)* Ward identity |
| week 15-17 (from Apr 8) | Perturbative renormalization [S19, S21, S22.6, S22.7] |
| week 18 (from Apr 29) | Effective field theories [S22] |
| week 19-20 (from May 6) | The renormalization group [S23] |
| week 21 (May 20) | QCD and asymptotic freedom |
| June | **Final exam** (oral) |