Università degli Studi di Torino
Scuola di Dottorato

Eventuale figura

Titolo titolo titolo titolo titolo titolo titolo titolo

Nome e cognome del dottorando

Università degli Studi di Torino
Scuola di Dottorato

Dottorato in Fisica

Titolo titolo titolo titolo titolo titolo titolo

Nome e cognome del dottorando

Tutor: Nome e cognome del relatore

The amazing quote
that I chose as inspiration
for this work

Author, *Title*

Abstract

Here goes the abstract: This thesis will cover a brief introduction of lattice gauge theories and how they are still actively used in investigating confinement in QCD. Within this framework I will also mention the link between lattice gauge theories and spin systems. The main topic of this thesis is the investigation using lattice QCD of inclusive semileptonic decays of heavy meson. I will start by discussing what lattice QCD is and the sate of the art simulation for Twisted Mass fermions (and Domain Wall fermions). Then I will present the main challenge of this type of calculations, namely solving the ill-posed inverse problem which is required for the inclusive calculation. we will certainly cite this work: [1]

Italian abstract

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Contents

Chapter 1

Introduction and overview

1.1 Choose your stile

Since no style reference has been provided, we are quite free: you have first of all to choose the style and change some lines in the file `thesis.tex`. When two options are available, one of the two is commented starting the line with %. To change it, comment what you don't need and de-comment the other option:

1.1.1 Single- or Double-sided

I like better the Single-sided, but if you want to go double-sided remove at line 14

```
\documentclass[12pt,a4paper,openright,oneside]{book} %%One sided
```

and de-comment line 15

```
\documentclass[12pt,a4paper,openright,twoside]{book} %%Double sided
```

1.1.2 Headers and footers

Lines 22-42 are going to use

1.1.3 PDF settings

Insert the information about you and the thesis in lines 56-61. They will be included in the PDF information

```
\hypersetup{
    pdfauthor={AuthorName},
    pdftitle={shortTitle},
    pdfsubject={subject},
    pdfkeywords={keyword1, keyword2}
}
```

1.1.4 Language

The main language is the last, so for a thesis in english line 69 is

```
\usepackage[italian,english]{babel}
```

Swap ita with eng fi you are writing in italian as main language

1.2 Chapters, sections and subsections

A thesis has three parts: head, body and tail. Three correspondent folders are containing the source files for these parts.

Any of this source files is imported in the `thesis.tex` file, which is the only one to get compiled. This is realised using the command

```
\input{subfolder/filename.tex}
```

To exclude a section from the compiling process, comment or remove the correspondent line. If no subfolder is specified, LaTeX looks for it in the same folder of `thesis.tex`

E.g. the introduction source file is in the body subfolder, and is included using the command

```
\input{body/introduction.tex}
```

1.2.1 Front page

Two front pages are provided:

1. `frontPage.tex` for thesis with a single Relatore
2. `frontPage-cr.tex` for thesis with Relatore and Correlatore

choose what is needed adapting lines 94-95.

1.2.2 Dedication

Dedication is the initial inspirational quote. Can be edited in the file `dedication.tex` or removed.

1.2.3 Chapter names

Chapter and section names are in this form:

```
\chapter[Name in the index]{Name on the title}
```

To exclude them from the numbering, use the *; If no name for the index is specified, will be assumed the same. For example:

```
\chapter*{Name on the title}
```

won't be numbered and will have the same name in the title and in the index.

1.3 Bulleting

Bullet list example

- first point
- second point
- third point

Enumeration example

1. first point
2. second point
3. third point

Description example

first descr first point

second descr second point

third descr third point

. . . but you can also build nested lists

- first point
  - first point
  - second point
- second point
- third point

1.4 Floating objects

Floating objects are tables, figures and so on.

1.4.1 Position, captions and cross-referencing

To force the position of an object use the options, for example:

```
\begin{figure}[htb]
```

where [htb] means that the priority of positioning is `h` = here, `t` = top, `b` = bottom. Also `p` can be used and means that the object is placed in a page on itself.

Captions are managed automatically using the command

```
\caption{The title of my object}
```

to cross reference to the object use the

```
\label{labelName}
```

to assign a name to the object and

```
\ref{labelName}
```

to refer to that.

1.4.2 Figures

Insert a figure using the code

```
\begin{figure}[htb]
\centering
\includegraphics[scale=0.15]{pictures/logo.png}
\caption{the logo of UniTo}
\label{myFigure}
\end{figure}
```

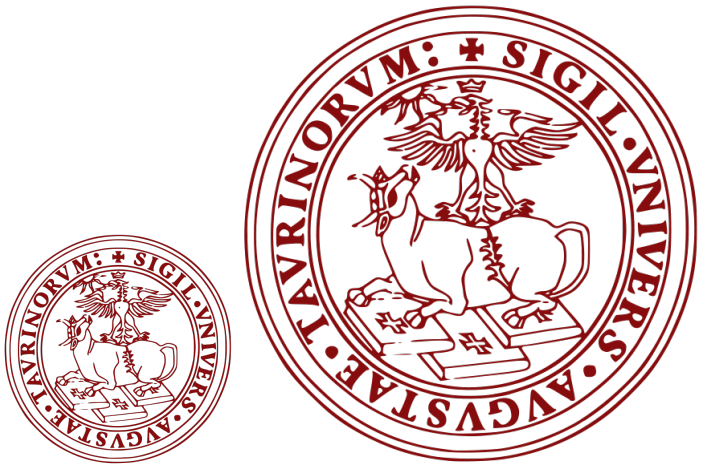
then you can cross-reference to it. In this case the discussion is about Fig. **??**. Where the number of the figure has been gotten using

```
\ref{myFigure}
```

Figure 1.1: the logo of UniTo

1.4.3 Subfigures

1.4.4 Tables



(a) title of first subfigure

(b) title of second subfigure

Figure 1.2: Two logos of UniTo of different sizes

Chapter 2

Lattice Gauge Theory

Lorem ipsum dolor sit amet[1], consectetur adipiscing elit. Sed dui sem, aliquam id ultricies sit amet, fermentum at magna. Aenean vitae rhoncus leo. Fusce gravida consequat lacus, a porta risus bibendum semper. Morbi eget auctor velit. Pellentesque eu lacinia nisi. Maecenas sed orci eu erat porta imperdiet ac non dui. Pellentesque a odio ac quam euismod tempor. Nulla in dapibus mauris, a sodales ex. In imperdiet enim sed ornare sollicitudin. Pellentesque[2] habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Donec vehicula metus eu nisi ornare euismod. Proin at ex non ex iaculis porta.

2.1 Lattice Gauge Theories at non-zero temperature

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Here I want to test[2] some[3] quote[4]

2.1.1 Relation between LGT and spin-systems

Nulla interdum molestie bibendum. Quisque condimentum justo quis lectus pretium, eget porttitor odio elementum. In dignissim sed justo et congue. In pulvinar feugiat odio eu vehicula. In ut malesuada est, sit amet porttitor dolor. Donec ullamcorper libero eros, vitae blandit nibh pellentesque quis. Aliquam aliquet ex id sapien lobortis, at molestie sem commodo. Donec quis accumsan lectus. Sed eget turpis id mi iaculis accumsan. Maecenas eget rutrum leo. Nam eu purus vitae lorem semper vestibulum. Phasellus mattis euismod faucibus. Vestibulum ornare sem a mattis placerat. Donec

[1] first foot note

[2] another foot note

interdum blandit erat, eu iaculis risus cursus sed. Donec magna sem, finibus nec scelerisque nec, auctor in turpis.

2.1.2 LGT and Effective String Theory

stuff

Chapter 3

Lattice QCD

3.1 Twisted Mass Action

something

3.1.1 light quarks

other stuff

3.1.2 heavy quarks

some other stuff

3.2 Axial and vector currents

words

3.3 Improvments to the fermion and gluon actions

final stuff

Chapter 4

Heavy meson decays

something

4.1 Inclusive B_s decays

something else

4.2 Inclusive decays on the lattice

stuff

Chapter 5

The Inverse Problem

something

5.1 Euclidean correlators and the inverse problem

something else

5.2 Inclusive calculations and inverse problem

bla bla bla

Chapter 6

Lattice QCD inclusive calculation

something

Chapter 7

Conclusions and outlook

final words

List of Figures

List of Tables

Bibliography

[1] P. Gambino, S. Hashimoto, S. Mächler, M. Panero, F. Sanfilippo, S. Simula, A. Smecca, and N. Tantalo, "Lattice QCD study of inclusive semileptonic decays of heavy mesons," *JHEP* **07** (2022) 083, `arXiv:2203.11762 [hep-lat]`.

[2] A. Einstein, "Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]," *Annalen der Physik* **322** no. 10, (1905) 891–921.

[3] M. Goossens, F. Mittelbach, and A. Samarin, *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[4] D. Knuth, "Knuth: Computers and typesetting." `http://www-cs-faculty.stanford.edu/~{}uno/abcde.html`.