Doctoral Dissertation
博士論文

Title
(日本語題目)

A Dissertation Submitted for the Degree of Doctor of Philosophy
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令和５年１２月博士(理学)申請

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My Name
姓 名

ABSTRACT

This is a LaTeXtemplate for doctoral theses, based on the classicthesis (https://bitbucket.org/amiede/classicthesis/) template and customized to meet the formatting requirements of the Graduate School of Science, The University of Tokyo.

classic thesis (https://ctan.org/pkg/classicthesis) を元にした学位論文用LaTeXテンプレートです。東京大学理学系研究科の博士論文様式に合うように調整しています。

ACKNOWLEDGEMENTS

This thesis was typeset using the typographical look-and-feel CLASSICTHESIS (https://bitbucket.org/amiede/classicthesis/) developed by André Miede and Ivo Pletikosić.

PUBLICATIONS

This thesis has used the materials of the following publications.

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LISTINGS

ACRONYMS

JASMINE	Japan Astrometry Satellite Mission for INfrared Exploration
KLD	Kullback-Leibler divergence
LMC	Large Magellanic Cloud
LSR	local standard of rest
MW	Milky Way
OLR	outer Lindblad resonance

Part I

THESIS

1 INTRODUCTION

1.1 STRUCTURE OF THE MILKY WAY

1.1.1 *Milky Way as a disc galaxy*

The Milky Way (MW) has fascinated us throughout human history. Fig. 1.1 displays an all-sky image of the MW obtained by the *Gaia* satellite. It is a portrait of our home galaxy as seen from the solar system. Although we cannot observe our galaxy from the outside, we know that it is a barred spiral galaxy. This section provides a brief history of our understanding of the MW's structure and summarises our current knowledge. Throughout this section, we refer to the following books and papers: Binney & Merrifield (1998), Binney & Tremaine (2008), Bland-Hawthorn & Gerhard (2016), Sofue (2017), Sofue et al. (2018) and van der Kruit (2019).

William Herschel was a pioneer in mapping the MW based on scientific observations and measurements (Herschel 1785). He estimated the shape of the MW by counting the number of stars at over 600 different directions in the sky assisted by his sister Caroline. The number count is proportional to D^3, where D is the distance to the edge. This estimation relied on the following assumptions: (1) stars are uniformly distributed in the MW, (2) all stars have the same intrinsic luminosity and (3) the telescope is powerful enough to see through the MW to its edge. Fig. 1.2 presents the estimated map of the MW, which corresponds to the edge-on slice of the MW disc. The large star near the centre of the map indicates the position of the Sun. It is surprising that Herschel could estimate the flat disc-like shape of the MW with such a simple method and rough assumptions although he mapped the Sun at the wrong place.

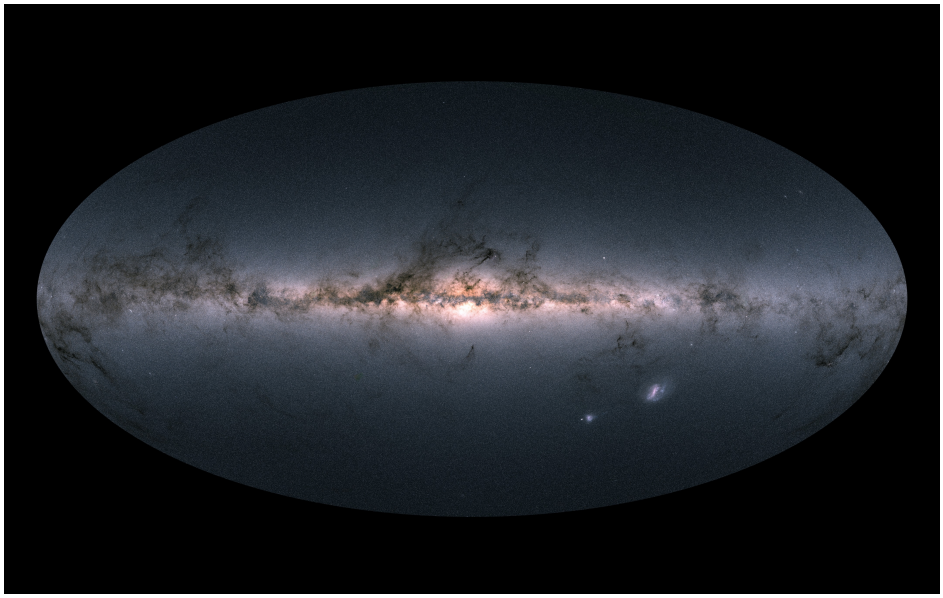


Figure 1.1: Optical image of the MW obtained by the *Gaia* satellite. Credit: ESA/Gaia/DPAC.

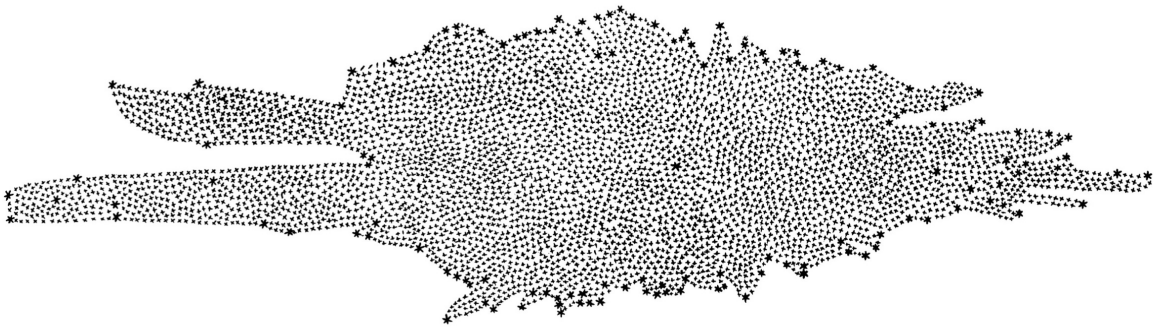


Figure 1.2: Herschel's MW map. The large star near the centre of the map indicates the position of the Sun. This figure is made from a copy of Herschel (1785) available at https://www.jstor.org/stable/106755.

2.1 YYY

xxx yyy zzz.

Part II

APPENDICES

A

INTRODUCTION FOR CLASSIC THESIS

This bundle for LaTeX has two goals:

1. Provide students with an easy-to-use template for their Master's or PhD thesis. (Though it might also be used by other types of authors for reports, books, etc.)

2. Provide a classic, high-quality typographic style that is inspired by Bringhurst's "*The Elements of Typographic Style*" (Bringhurst 2013).

Title Ver. 1.0

The bundle is configured to run with a *full* MiKTeX or TeXLive[1] installation right away and, therefore, it uses only freely available fonts. (Minion fans can easily adjust the style to their needs.)

People interested only in the nice style and not the whole bundle can now use the style stand-alone via the file `classicthesis.sty`. This works now also with "plain" LaTeX.

As of version 3.0, `classicthesis` can also be easily used with LyX[2] thanks to Nicholas Mariette and Ivo Pletikosić. The LyX version of this manual will contain more information on the details.

This should enable anyone with a basic knowledge of LaTeX 2_ε or LyX to produce beautiful documents without too much effort. In the end, this is my overall goal: more beautiful documents, especially theses, as I am tired of seeing so many ugly ones.

The whole template and the used style is released under the GNU General Public License.

If you like the style then I would appreciate a postcard:

André Miede
Detmolder Straße 32
31737 Rinteln
Germany

The postcards I received so far are available at:

`http://postcards.miede.de`

A well-balanced line width improves the legibility of the text. That's what typography is all about, right?

So far, many theses, some books, and several other publications have been typeset successfully with it. If you are interested in some typographic details behind it, enjoy Robert Bringhurst's wonderful book.

IMPORTANT NOTE: Some things of this style might look unusual at first glance, many people feel so in the beginning. However, all things are intentionally designed to be as they are, especially these:

- No bold fonts are used. Italics or spaced small caps do the job quite well.
- The size of the text body is intentionally shaped like it is. It supports both legibility and allows a reasonable amount of information to be on a page. And, no: the lines are not too short.
- The tables intentionally do not use vertical or double rules. See the documentation for the `booktabs` package for a nice discussion of this topic.[3]
- And last but not least, to provide the reader with a way easier access to page numbers in the table of contents, the page numbers are right behind the titles. Yes, they are *not* neatly aligned at the right side and they are *not* connected with dots that help the eye to bridge a distance that is not necessary. If you are still not convinced: is your reader interested in the page number or does she want to sum the numbers up?

Therefore, please do not break the beauty of the style by changing these things unless you really know what you are doing! Please.

1 See the file `LISTOFFILES` for needed packages. Furthermore, `classicthesis` works with most other distributions and, thus, with most systems LaTeX is available for.
2 `http://www.lyx.org`
3 To be found online at `http://mirror.ctan.org/macros/latex/contrib/booktabs/`.

YET ANOTHER IMPORTANT NOTE: Since `classicthesis`' first release in 2006, many things have changed in the LaTeX world. Trying to keep up-to-date, `classicthesis` grew and evolved into many directions, trying to stay (some kind of) stable and be compatible with its port to LyX. However, there are still many remains from older times in the code, many dirty workarounds here and there, and several other things I am absolutely not proud of (for example my unwise combination of KOMA and `titlesec` etc.).

An outlook into the future of `classicthesis`.

Currently, I am looking into how to completely re-design and re-implement `classicthesis` making it easier to maintain and to use. As a general idea, `classicthesis.sty` should be developed and distributed separately from the template bundle itself. Excellent spin-offs such as `arsclassica` could also be integrated (with permission by their authors) as format configurations. Also, current trends of `microtype`, `fontspec`, etc. should be included as well. As I am not really into deep LaTeX programming, I will reach out to the LaTeX community for their expertise and help.

A.1 ORGANIZATION

A very important factor for successful thesis writing is the organization of the material. This template suggests a structure as the following:

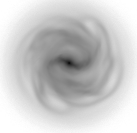
You can use these margins for summaries of the text body...

- `Chapters/` is where all the "real" content goes in separate files such as `Chapter01.tex` etc.
- `FrontBackMatter/` is where all the stuff goes that surrounds the "real" content, such as the acknowledgments, dedication, etc.
- `gfx/` is where you put all the graphics you use in the thesis. Maybe they should be organized into subfolders depending on the chapter they are used in, if you have a lot of graphics.
- `Bibliography.bib`: the BibTeX database to organize all the references you might want to cite.
- `classicthesis.sty`: the style definition to get this awesome look and feel. Does not only work with this thesis template but also on its own (see folder `Examples`). Bonus: works with both LaTeX and pdfLaTeX... and LyX. Great tool and it's free!
- `ClassicThesis.tex`: the main file of your thesis where all gets bundled together.
- `classicthesis-config.tex`: a central place to load all nifty packages that are used.

  Make your changes and adjustments here. This means that you specify here the options you want to load `classicthesis.sty` with. You also adjust the title of your thesis, your name, and all similar information here. Refer to Section A.3 for more information.

  This had to change as of version 3.0 in order to enable an easy transition from the "basic" style to LyX.

In total, this should get you started in no time.



A.2 STYLE OPTIONS

There are a couple of options for `classicthesis.sty` that allow for a bit of freedom concerning the layout:

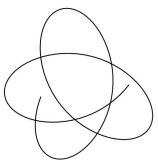
. . . or your supervisor might use the margins for some comments of her own while reading.

- General:
  - `drafting`: prints the date and time at the bottom of each page, so you always know which version you are dealing with. Might come in handy not to give your Prof. that old draft.
- Parts and Chapters:
  - `parts`: use this option if you *use* Part divisions in your document. This is necessary to get the spacing of the Table of Contents right. (Cannot be used together with `nochapters`.)
  - `linedheaders`: changes the look of the chapter headings a bit by adding a horizontal line above the chapter title. The chapter number will also be moved to the top of the page, above the chapter title.
- Typography:
  - `style`: this offers a comfortable way of changing the look and feel easily. Default style is `classicthesis`.

    As a new feature, Lorenzo Pantieri's `arsclassica` is available as well. As Lorenzo's package is discontinued and with his permission, `classicthesis-arsclassica.sty` is now part of `classicthesis` and will be maintained here.
  - `palatino`: Hermann Zapf's classic font is the free standard font for this style. Robert Bringhurst's book uses Adobe's commercial font Minion Pro. However, there are other free alternatives also available. Deactivate this option for loading such alternatives and see `classicthesis-config.tex` for some suggestions.
  - `eulerchapternumbers`: use figures from Hermann Zapf's Euler math font for the chapter numbers. By default, old style figures from the Palatino font are used.
  - `beramono`: loads Bera Mono as typewriter font. (Default setting is using the standard CM typewriter font.)
  - `eulermath`: loads the awesome Euler fonts for math. Palatino is used as default font.

Options are enabled via `option=true`

- Table of Contents:
  - `tocaligned`: aligns the whole table of contents on the left side. Some people like that, some don't.
  - `dottedtoc`: sets pagenumbers flushed right in the table of contents.
  - `manychapters`: if you need more than nine chapters for your document, you might not be happy with the spacing between the chapter number and the chapter title in the Table of Contents. This option allows for additional space in this context. However, it does not look as "perfect" if you use `\parts` for structuring your document.
- Floats:
  - `floatperchapter`: activates numbering per chapter for all floats such as figures, tables, and listings (if used).
- Tweaking colors and fonts – please use this with great care!:
  - `\ct@altfont`: comfortable hook to alter the basic look and feel of everything that uses spaced caps or spaced small caps. For example, for `arsclassica` we used `\renewcommand*{\ct@altfont}{\sffamily}`. Coloring is also possible this way.
  - `CTsemi`: Change the semi gray color used, e. g., for the chapter number. Default is: `\definecolor{CTsemi}{gray}{0.55}`
  - `CTtitle`: Change the red color used, e. g., for the title. Default is: `\definecolor{CTtitle}{named}{Maroon}`



Furthermore, pre-defined margins for different paper sizes are available, e. g., a4paper, a5paper, b5paper, and letterpaper. These are based on your chosen option of \documentclass.

The best way to figure these options out is to try the different possibilities and see what you and your supervisor like best.

In order to make things easier, classicthesis-config.tex contains some useful commands that might help you.

A.3 CUSTOMIZATION

This section will show you some hints how to adapt classicthesis to your needs.

The file classicthesis.sty contains the core functionality of the style and in most cases will be left intact, whereas the file classicthesis-config.tex is used for some common user customizations.

The first customization you are about to make is to alter the document title, author name, and other thesis details. In order to do this, replace the data in the following lines of classicthesis-config.tex:

Modifications in classicthesis-config.tex

```
% ********************************************
% 2. Personal data and user ad-hoc commands
% ********************************************
\newcommand{\myTitle}{A Classic Thesis Style}
\newcommand{\mySubtitle}{An Homage to...}
```

Further customization can be made in classicthesis-config.tex by choosing the options to classicthesis.sty (see Section A.2) in a line that looks like this:

```
\PassOptionsToPackage{
  drafting=true,
  tocaligned=false,
  dottedtoc=false,
  eulerchapternumbers=true,
  linedheaders=false,
  floatperchapter=true,
  eulermath=false,
  beramono=true,
  palatino=true,
  style=classicthesis
}{classicthesis}
```

Many other customizations in classicthesis-config.tex are possible, but you should be careful making changes there, since some changes could cause errors.

A.4 ISSUES

This section will list some information about problems using classicthesis in general or using it with other packages.

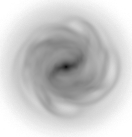
Beta versions of classicthesis can be found at Bitbucket:

https://bitbucket.org/amiede/classicthesis/

There, you can also post serious bugs and problems you encounter.

A.5 FUTURE WORK

So far, this is a quite stable version that served a couple of people well during their thesis time. However, some things are still not as they should be. Proper documentation in the standard format is still missing. In the long run, the style should probably be published separately, with the template bundle being only an application of the style. Alas, there is no time for that at the moment... it could be a nice task for a small group of LaTeXnicians.



Please do not send me email with questions concerning LaTeX or the template, as I do not have time for an answer. But if you have comments, suggestions, or improvements for the style or the template in general, do not hesitate to write them on that postcard of yours.

A.6 BEYOND A THESIS

The layout of `classicthesis.sty` can be easily used without the framework of this template. A few examples where it was used to typeset an article, a book or a curriculum vitae can be found in the folder `Examples`. The examples have been tested with `latex` and `pdflatex` and are easy to compile. To encourage you even more, PDFs built from the sources can be found in the same folder.

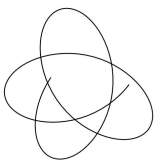
A.7 LICENSE

CLASSICHTHESIS AUTHORS' NOTE: There have been some discussions about the GPL's implications on using `classicthesis` for theses etc. Details can be found here:

`https://bitbucket.org/amiede/classicthesis/issues/123/`

We chose (and currently stick with) the GPL because we would not like to compete with proprietary modified versions of our own work. However, the whole template is free as free beer and free speech. We will not demand the sources for theses, books, CVs, etc. that were created using `classicthesis`.

Postcards are still highly appreciated.



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