

# *An introduction to LaTeX*

*- a document  
preparation language*

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(adapted from a lecture by Cedric Lacey)

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• You can find these notes and some LaTeX examples on my web page:

[http://astro.dur.ac.uk/~cole/Intro\\_LaTeX\\_PG](http://astro.dur.ac.uk/~cole/Intro_LaTeX_PG)

# *What is LaTeX?*

- A document preparation system in which the source file contains both text and markup commands
- Create source file using normal text editor
- Run LaTeX program to see result
- LaTeX program decides details of word spacing, line breaks, page breaks, position of figures & tables etc according to instructions in source file



# *Why use LaTeX?*

- Produces high-quality output with **uniform style**, e.g. for journals, conference proceedings
- **Style** can be changed simply by **global commands** or by loading different **macro packages**
- Lets you concentrate on **content** rather than **formatting/layout**
- Very good for **mathematics & equations**
- **Automatic numbering & cross-referencing** of sections, equations, figures, tables etc
- Free! Runs on all operating systems
- **THE STANDARD** for publications in physics, astronomy, maths

# *Useful books*

## **Guide to LATEX**

by H. Kopka & P. Daly

- describes standard features & some additional ones –  
HIGHLY RECOMMENDED!

## **The LATEX Companion**

by Goossens, Mittelbach & Samarin

- describes lots more optional/additional features
- both in the Astronomy reading room

# *Useful websites:*

A very brief overview to get you started:

<http://www.tug.org/begin.html>

A much more detailed introduction:

[ftp://tug.ctan.org/pub/texarchive/info/  
beginlatex/html/beginlatex.html](ftp://tug.ctan.org/pub/texarchive/info/beginlatex/html/beginlatex.html)

Another general introduction:

<http://amath.colorado.edu/documentation/> LaTeX



## *More websites:*

A primer for typesetting equations in LaTeX:

<http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/>

some hints about including graphics:

<http://merkel.zoneo.net/Latex/index.php?lang=en>

Latex beamer

<http://gking.harvadr.edu/files/beamerusrguidef.pdf>

how to cite references using natbib package:

<http://merkel.zoneo.net/Latex/natbib.php>

references using BibTeX:

<http://www.bibtex.org>

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# *Macros & tips for PhD theses in LaTeX*

Durham PhD thesis macros:

<http://www-old.cs.st-andrews.ac.uk/~eb/thesisclass.php>

another example, with useful hints:

<http://amath.colorado.edu/documentation/LaTeX/thesis/sample/>





# LaTeX & TeX

- The LaTeX program is actually written in a lower-level typesetting language TeX
  - If you want to install LaTeX on your own computer, have to install TeX first (or install TeX & LaTeX together)
  - But normal user can use LaTeX without knowing anything about TeX
  - Can use some TeX commands in LaTeX documents – but better to use LaTeX equivalents (added functionality, usually clearer & simpler)
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# *How to install TeX & LaTeX*

•If you want to install TeX & LaTeX on your own laptop:

•**Linux:** download teTeX distribution from

[www.tug.org/tetex](http://www.tug.org/tetex)

•**Windows:** try MiKTeX from

[www.miktex.org](http://www.miktex.org)

or TeXnicCenter from

[sourceforge.net/projects/texniccenter](http://sourceforge.net/projects/texniccenter)

•**Mac OS X:**

try gwTeX from

[ii2.sourceforge.net/tex-index.html](http://ii2.sourceforge.net/tex-index.html)

or TeXShop distribution (includes GUI) from

# *How to run LaTeX under Linux/Unix*

- Create a LaTeX source file with suffix '.tex', e.g. **mypaper.tex**, using a text editor

- Use an **editor** which provides special features for LaTeX files e.g. **emacs**

- Run LaTeX program:

```
> latex mypaper.tex
```

OR >

```
latex mypaper (suffix .tex assumed!)
```

- Producing a file **mypaper.dvi**

- Can **view on screen** (if EPS figures) using

```
> xdvi mypaper.dvi (OR > xdvi mypaper)
```

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# *Producing Postscript output*

- **Postscript (PS)** files, suffix **'*.ps*'**, are designed to be printed, but can be viewed on screen, e.g. Using **gv** (ghostview)
- To produce **.ps** from **.dvi**:  
**> dvips -o mypaper.ps mypaper.dvi**
- For this to work, included **figures/graphics** must be **Encapsulated Postscript (EPS)** files, suffix **'*.eps*'**
- Then print: **> lpr mypaper.ps**
- Or view on screen: e.g. **> gv mypaper.ps**



# *Producing PDF output*

- Portable Document Format (PDF) files are designed to be viewed on screen, e.g. using **acroread**, but can be printed from a PDF viewer

- Three ways to make from LaTeX:

- (1) from **.ps** file (output: **mypaper.pdf**)

- > **ps2pdf mypaper.ps**

- (2) from **.dvi** file

- > **dvipdf mypaper.dvi**

- (3) directly from **.tex** file (output: **mypaper.pdf**)

- > **pdflatex mypaper.tex**

- For (3) to work, included **figures/graphics** must be either **PNG (.png)** or **PDF (.pdf)** (or **JPEG (.jpeg,**

- .jpg)** in some versions)

## *Some other things....*

- There are programs which can **convert** your **figures/graphics** between different formats, e.g, **.eps** to **.png** e.g. in **Linux** can use **display** or **convert**, on **MAC** use **preview**
- There are also programs which can convert your **LaTeX** files directly to **HTML** for web pages



# *How to run LaTeX under Windows*

- Basic procedure same as in Linux, i.e.

`file.tex` (latex) -> `file.dvi` (dvips) ->  
`file.ps` OR

`file.tex` (pdflatex) -> `file.pdf`

- Much easier if install **editor** with built-in features for LaTeX, e.g.

- **WinShell** (free) from

[www.winshell.de](http://www.winshell.de)

- **WinEdt** (costs US\$30 for students) from

[www.winedt.com](http://www.winedt.com)

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# *How to run LaTeX under Mac OS X*

- Basic procedure same as in Linux, i.e.

`file.tex (latex) -> file.dvi (dvips) -> file.ps`

OR

`file.tex (pdflatex) -> file.pdf`

- More convenient to work with PDF rather than PS on Macs
- If you like a graphical front-end, try **TeXShop** from <http://www.uoregon.edu/~koch/texshop>



## *Now a simple example*

•LaTeX `demodoc.tex`, with included figure `fig.jpg`



# ❓ *Structure of a LaTeX file*

```
\documentclass[options]{class_name}  
% documentclass determines overall structure
```

*preamble – global commands which affect whole document*

```
\begin{document}
```

*text*

*+ instructions for including figures*

```
\end{document}
```

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# *Standard document classes*

- **article** : document has sections, subsections, sub-subsections, e.g. For paper in journal or conference proceeding

`\documentclass{article}`

- **report** : also has chapters, title page, table of contents, e.g. For L4 or PhD thesis

- **book** : similar to report, but extra features for publication-quality book

- **letter** : for writing letter – letterhead but no sections



## *Other document classes*

- Many people have created modified versions of standard classes. For these, you need class file, e.g. **thesis.cls** (modified report.cls), then

- `\documentclass{thesis}`

- Each journal has its own style. Download .cls file from journal webpage

- **MNRAS:** mn2e.cls (modified article.cls)

- `\documentclass{mn2e}`

- **ApJ, AJ:** aastex.cls

- `\documentclass{aastex}`



# *Document class for L4 dissertation*

- Many people have created modified versions of standard classes, e.g. for writing PhD theses
- For these, you need class file, e.g. **duthesis.cls** (modified report.cls) produces layout for Durham PhD thesis, which you can also use for **L4 thesis**
- Download **duthesis.cls** from <http://www-old.cs.st-andrews.ac.uk/~eb/thesisclass.php>
- Then begin document with

```
\documentclass{duthesis}
```
- See my example **thesis\_example.tex**, also **thesis\_template.tex**



# *Loading packages*

- **Packages** are used to add additional features, or to modify standard features of class
- Need `\usepackage` command in preamble, e.g.  
`\usepackage{amssymb}`  
which adds extra math symbols
- Needs file `amssymb.sty` to be in current directory or elsewhere in LaTeX search path



# *Splitting a document into different files*

- For long documents (e.g. PhD thesis) better to split into several files
- e.g. File **main.tex** could contain:

```
\documentclass{report}
```

```
\begin{document}
```

```
\input{chap1}
```

```
\input{chap2}
```

```
\end{document}
```

- Inputs **chap1.tex**, **chap2.tex**
- Effect is same as cutting & pasting chap1.tex etc into

# *Special characters for commands*

- These characters are used in a LaTeX file in markup commands: `\ % # $ & ~ _ ^ { }`
- `\` begins a command name
- `%` begins a comment
- `{ }` delimit the arguments to commands and the range within which some commands act
- `$` starts/ends math mode
- If you want `%`, `&`, `$` to appear in document, need to type `\%`, `\&`, `\$` in .tex file etc





# Font sizes & styles

- Can change overall **fontsize** using optional argument in **\documentclass**, e.g.

**\documentclass[12pt]{article}**

- For **italics** use **\em**, e.g.

**Some text {\em**

**some text in italics} more text**

- For **boldface** use **\bf**, e.g.

**Some text {\bf text in**

**bold} more text**

- **Greek** characters available in **math mode**, e.g.

**The  $\alpha$ -elements**

# *Defining your own commands*

- Use `\newcommand` e.g.

```
\newcommand{\etal}{ {\em et al.} }
```

- Effect is equivalent to replacing every appearance of `\etal` in file with `{\em et al.}`

- Can also define commands with arguments

```
\newcommand\Bold[1]{ {\bf #1} }
```

- Then `\Bold{this text}` is equivalent to `{\bf this text}`



# Chapters, sections, etc

•e.g.

```
\chapter{The model}
```

```
\section{Dark
```

```
matter halos}
```

```
\subsection{Density profiles}
```

```
\subsubsection{Some  
irritating details}
```

•Heading will be printed using text in {}

•Chapters, sections etc will be **numbered automatically**

e.g. Chapter 1, Section 1.2, Subsubsection 1.2.5, etc

# *Lists*

•LaTeX can make various kinds of lists, e.g.

```
\begin{itemize}
```

```
\item
```

apples

```
\item oranges
```

```
\item bananas
```

```
\end{itemize}
```

will list items

preceded by bullet-points

```
\begin{enumerate} etc will make list with items
```

# Equations

- In **math mode**, can have
- **Greek characters**, e.g. `\alpha`
- Other math symbols, e.g. `\leq`
- Fractions, integrals etc
- **Subscripts**, e.g. `x_n`
- **Superscripts**, e.g. `y^2`
- **AMS-LaTeX** package **amsmath** gives even more possibilities

```
\usepackage{amsmath}
```



# *Text & displayed equations*

• **Text equations** are embedded in normal text and start and end with  $\$,$  e.g.

We define

$y=x^2$ .....

• **No equation numbers** for text equations

• **Displayed equations** appear on a separate line, and can have numbers, e.g.

$\begin{equation}$

$$y = x^2$$

---

$\end{equation}$

# Equations: Example 1

• You type:

```
\begin{equation}  
P_{\rm gal}(k)=\frac{1+Qk^2}{1+Ak}P_{\rm lin}(k),  
\end{equation}
```

• You get:

$$P_{\rm gal}(k) = \frac{1 + Qk^2}{1 + Ak} P_{\rm lin}(k), \quad (3.1)$$

## Equations: Example 2

• You type:

```
\begin{eqnarray}
1 - n_{\rm s} &=& 2\epsilon_1 + \epsilon_2 \\
r &=& 16\epsilon_1.
\end{eqnarray}
```

• You get:

$$1 - n_s = 2\epsilon_1 + \epsilon_2 \quad (3.3)$$

$$r = 16\epsilon_1. \quad (3.4)$$



# *Including graphics*

- Modern way to include graphics from file uses **graphicx** package: **preamble** must include

`\usepackage[dvips]{graphicx}` (for dvips)

OR `\usepackage[pdftex]{graphicx}` (for pdflatex)

- Then to include a graphics file

`\includegraphics[key=value,...]{file_name}`

- e.g.

`\includegraphics[width=8.5cm]{myplot}`

Will load `manutone` (for dvips) or `myplot.eps` or

# *Floating figures*

- `\includegraphics` command will try to insert figure at that point if space on page, otherwise on next page, leaving blank space on current page
- Better to let figure “float”, using `figure` environment, e.g.

```
\begin{figure}
```

```
\includegraphics[scale=0.6]{lumfun}
```

```
\caption{The luminosity function}
```

```
\end{figure}
```

- This also gives the figure a `caption` and a `number`

- **WARNING:** may need to tune figure placement

# Tables

- Make tables using `\tabular` environment, e.g.

```
\begin{tabular}{lcc}
```

galaxy &

magnitude & redshift \\

NGC 891 & 15.5 & 0.02 \\

M87 & 14.8 & 0.01

```
\end{tabular}
```

- Which left-justifies 1<sup>st</sup> column and centres 2<sup>nd</sup> and 3<sup>rd</sup> columns

- `&` separates columns and `\\` separates lines

# Tables: Example

• You type:

```
\begin{tabular}[t]{cc}
\hline\hline
Parameter          & Allowed range \\
\hline\hline
 $\Omega_k$           &  $-\$0.3 -- 0.3$  \\
 $\omega_{\rm dm}$       &  $0.01 -- 0.99$  \\
 $\omega_{\rm b}$         &  $0.005 -- 0.1$  \\
 $f_{\rm \nu}$           &  $0 -- 0.5$  \\
 $w_{\rm DE}$           &  $-\$2. -- 0$  \\
 $\tau$                 &  $0 -- 0.8$  \\
 $n_{\rm s}$             &  $0.5 -- 1.5$  \\
 $\log_{10}(10^{10}A_{\rm s})$  &  $2.7 -- 4.0$  \\
 $r$                   &  $0 -- 1$  \\
 $b$                   & marginalized \\
 $\Theta$              &  $0.5 -- 10$  \\
\hline\hline
\end{tabular}
```

# *Tables: Example (continued)*

• You get:



# *Floating tables*

- Usually make tables “float” (like figures) using **table** environment, e.g.

```

\begin{table}
  \caption{Galaxy magnitudes and redshifts}
  \begin{tabular}{rlcc}
    .....
  \end{tabular}
\end{table}
```

- Which also gives the table a **caption** and a **number**

# Cross-referencing

- Can cross-reference sections in a paper, equations, figures, tables using `\label` to create labels, and `\ref` to refer forward or back to them

- e.g. to label a section:

```
\section{Dark  
halos}
```

```
\label{sec:halos}
```

- Then to refer to it:

```
We discuss  
the structure of dark halos in Section  
\ref{sec:halos}
```

- ~~LaTeX will insert actual section number~~

Cross-referencing info written to aux file

# Cross-referencing figures & tables

- Works similarly for figures & tables, e.g.

```
\begin{figure}
```

.....

```
\caption{The luminosity function}
```

```
\label{fig:lumfun}
```

```
\end{figure}
```

- NB `\label` inside `figure` environment after `\caption`

- Then to refer to it:

---

We show in



# Cross-referencing equations

- Similarly for equations, e.g.

```
\begin{equation}
```

$$P_a = \frac{y_3}{x^2}$$

```
\label{eq:p_a}
```

```
\end{equation}
```

- Then to refer to it:

$P_a$  is

defined in eqn.(\ref{eq:p\_a}).....

The brackets () here enclose the equation number in

# *Bibliographic references – simple approach*

- Use the **natbib** package:

```
\usepackage{natbib}
```

- Create your bibliography (in alphabetical order):

```
\begin{thebibliography} { }
```

.....

	<pre>\bibitem[Smith \&amp; Jones</pre>
(1990)][Smi90]	Smith, A., \& Jones, B.,
1990, ApJ 231, 506	.....

---

```
\end{thebibliography}
```

# *Referring to a paper in the bibliography (using natbib)*

- Then to refer to a paper in the text, use `\citet` or `\citep` or `\citeauthor` or `\citeyear`, e.g.
  - `\citet{Smi90}` produces “Smith & Jones (1990)”
  - `\citep{Smi90}` produces “(Smith & Jones 1990)”
  - `\citeauthor{Smi90}` produces “Smith & Jones”
  - `\citep[see][chap 6]{BT}` produces “(see Binney & Tremaine, chap 6)”
  - `\citep{Smi90,Cole12}` produces “(Smith & Jones 1990; Cole 2012)”
  - See documentation on **natbib** for more possibilities
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# *Bibliography with BibTeX*

- A more sophisticated approach is to store all your bibliographic data in a separate (or multiple) **BibTeX** file(s)
  - You then have to run the **BibTeX** program along with **LaTeX**
  - But different **LaTeX** documents can share the same **BibTeX** files, so you only ever need to enter references in the database once
  - See [www.bibtex.org](http://www.bibtex.org) or “**Guide to LaTeX**” (Kopka & Daly) for more details
  - Compatible with **natbib** citation package
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## *Example BibTeX entry*

- You create bibliographic database file, e.g. **refs.bib**

- example entry:

```
@ARTICLE{Almeida2007a
  author = {Almeida, C., Baugh, C.M. and Lacey,
            C.G.},
  title = {The structural properties of galaxies in CDM},
  journal = MNRAS,
  year = 2007,
  volume = 376,
  pages = {1711-1726}
}
```

- File begins...ends with

```
\begin{thebibliography}...\end{the bibliography}
```

- **ADS** will create entries in BibTeX format for you

# *Running BibTeX with LaTeX*

- Main LaTeX file (e.g. **paper.tex**) must specify (somewhere) bibliographic style, e.g.

**`\bibliographystyle{mn2e}`**

- loads file **mn2e.bst**

- And specify where bibliography to appear & which databases to load, e.g.

**`\bibliography{refs}`**

- loads file **refs.bib**

- Need to run LaTeX (e.g. **latex paper**), then BibTeX (**bibtex paper**) (creates file **refs.bbl**), then LaTeX again (TWICE)



# *latexdiff*

- Perl script for highlighting the differences between two versions of a LaTeX file

- `latexdiff oldfile.tex newfile.tex > diff_file.tex`

- `latex diff_file`

- The resulting pdf/ps file shows the deleted text in red with a line through it and the inserted text in blue and underlined with a wavy line.



*The End*

