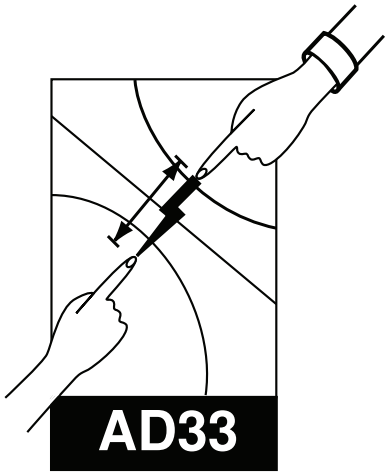
Document Preparation



NTC after JJB August 2011

1 Abstract

This short document provides a brief introduction to the LaTeX typesetting system, which you may use to produce beautiful reports. Having read it, if you're tempted, you may want to devour *The Not So Short Introduction to LaTeX 2ε*[3] next.

2 Introduction

LaTeX is a dialect of the TeX typesetting language that was developed in the 1970s by the computing guru Donald E. Knuth of Stanford University. TeX is an extremely powerful tool that allows one to produce on a personal computer technical books that are typeset to the very highest standards. LaTeX makes some of the power of TeX available to people who lack the time or inclination to master TeX properly. The astrophysics, condensed-matter physics and high-energy physics communities regard LaTeX as a standard tool for the exchange of information. In particular, contributors to the proceedings of conferences in these areas are invariably required to submit their contributions as LaTeX documents, and the major journals all encourage the submission of manuscripts in LaTeX. If you hope to work at a postgraduate level in astrophysics, condensed-matter physics or high-energy physics, you may as well learn LaTeX now as later. TeX and LaTeX can be downloaded gratis from the Web for a machine that runs pretty much any operating system (see appendix B). If you do download LaTeX, you will probably obtain significant documentation in the package. The file `usrdoc.dvi` is well worth reading. The standard book for LaTeX is Lamport[1] whilst Kopka[4] comprehensively covers LaTeX and a wide range of the more commonly used packages/classes. You may also wish to refer to the LaTeX Wikibook[2]. The current version of LaTeX is LaTeX 2ε , written unstylized as "LaTeX 2e" (avoid the previous version, LaTeX 2.09, which you may find on some neglected machines). Extensive documentation for LaTeX packages can be found in the Comprehensive TeX Archive Network (CTAN[1]).

3 Coding in LaTeX

When you use TeX, you don't really write the document you will eventually publish: you write a computer program that tells TeX how to write it. Non-scientists find this a bit off putting, but it comes naturally to physicists. Consider the text of figure 1.

Humpty Dumpty
Requests the pleasure of your company
on Dead Man's Walk
on Friday April 13, at 5 p.m.

RSVP The eggbox, Merton Street

Figure 1: An example of boxmaking.

[1] `http://www.ctan.org/`

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The code for this reads

```
\begin{figure}
\begin{center}
Humpty Dumpty\\
Requests the pleasure of your company\\
on Dead Man's Walk\\
on Friday April 13, at 5 p.m.
\end{center}
\begin{flushright}
\parbox{2.7cm}{\small\it%
RSVP The eggbox, Merton Street}
\end{flushright}
\caption{An example of boxmaking.
\label{fig:humptyfig}}
\end{figure}
```

When laying out an invitation, the necessity of saying in words how everything should be laid out on paper can be frustrating and is less easy than moving each block of text to the required place with a mouse. The strength of TEX's approach emerges when doing headings and writing complicated equations. For example, the code for the abstract above is

```
\begin{abstract}
The use of \LaTeX\ to format scientific
documents is briefly described.....
\end{abstract}
```

while the last section head was produced by typing simply

```
\section{Coding in \LaTeX}
```

From these examples you will see that words that start with \ are not to be printed: they are commands to the typesetting program. Notice also the `\begin` and `\end` pairs. Each such pair delimits a LATEX 'environment' in which special formatting rules apply. Besides the `center` and `abstract` environments, there are `flushright`, `equation`, `tabular`, `list` and many other environments. In fact, one's whole document has to lie between

```
\begin{document}
```

and

```
\end{document}
```

Notice that the number 3 in the last section heading was added by LATEX. It's time for a subsection, so we type

```
\subsection{Mathematical typesetting}
```

and get (notice again the automatic generation of the section number):

3.1 Mathematical typesetting

You tell LaTeX how to set an equation by reading the equation out. So to set

$$\log x = \int_1^x \frac{\mathrm{d}x}{x}$$

we type

```
\[
\log x=\int_1^x{\frac{{\dif x}{x}}
\]
```

There are several things to notice here. First, `\[` and `\]` respectively start and finish a 'displayed' equation – one on a line by itself.[2] Second, the underscore character, `_`, makes the following letter a subscript and the hat character, `^`, generates a superscript. Notice also the use of `\dif` for dx instead of the lazy and incorrect approach of typing dx which would use an italic d making it essentially indistinguishable from an equation variable (this requires the use of the `commath` package).

Finally, the use of `\frac{a}{b}` generates a fraction "$\frac{a}{b}$"; this requires use of the `amsmath` package. Another example of LaTeX's use of { and } to form groups is the code for x_{min}:

```
$x_{min}$
```

The squigglies ensure that all three letters go into the subscript.

Notice the use of dollar signs in the last example: the first begins and the second finishes in-line maths. So we could obtain $\log x = \int_1^x \frac{\mathrm{d}x}{x}$ by typing

```
$\log x=\int_1^x{\frac{\dif x}{x}}$
```

in line with our text.

When it's setting maths, either in-line or as a display, LaTeX ignores spaces, so the code given above is identical to

```
$\log x = \int _1 ^x {\frac{\dif d x}{x}}$
```

In maths mode letters are by default italic. In the best typesetting, only variables are italic. LaTeX provides commands that make it easier to observe this rule. For example, it provides `\log` to ensure that log appears in Roman letters, and `\sin`, `\asin`, `\min`, etc for other common functions. You have to make subscripts, as in x_{min}, Roman yourself: above we ought to have typed

```
$x_\mathrm{min}$
```

LaTeX allows one to use all sorts of exotic symbols. The Greek alphabet is accessed by spelling out the letters. For example typing

```
$\alpha,\pi,\theta,\vartheta,\omega,\Omega$
```

yields $\alpha, \pi, \theta, \vartheta, \omega, \Omega$. Notice the dollar signs: LaTeX assumes that Greek letters will be required only in maths mode and will produce an error message if it encounters one unprotected by dollars and not in a

[2] `\[` is actually short-hand for `\begin{equation}`

displayed equation. Since dollars have a special significance in LaTeX, people interested in money have to type `\$` to get a $ and `\pounds` to get £.

LaTeX classifies some symbols, such as $=, >, :, \neq$ (typed `\ne`) as relational operators and puts extra space around them. This fact enables one quickly to spot incompetents: when such people refer to the expectation value, $\langle x \rangle$, of the variable x, they write $< x >$, which looks silly; the correct expression is obtained by typing `\langle x\rangle`. Similarly, if x is much smaller than y, we obtain $x \ll y$ by typing `x\ll y` rather than putting up with $x << y$ as an incompetent would.

If you refer to lots of expectation values, you are likely to get tired of typing `\langle`. To avoid tedium you could type at the head of your file

```
\newcommand{\av}[1]{\left\langle#1\right\rangle}
```

Then, you get $\langle x \rangle$ simply by typing `\av x`. This command takes only one argument (the symbol being averaged). A command might take two arguments, for example `\dotprod[1][2]{...}`. Incidentally, using `\left` and `\right` in the definition of `\av` ensures that the brackets grow in stature with the averaged quantity, and we can easily get

$$\left\langle \frac{\Omega}{Y} \right\rangle$$

Mathematics often requires us to arrange one thing on another. So we write the matrix[3]

$$\sigma_y = \begin{pmatrix} 0 & -\mathrm{i} \\ \mathrm{i} & 0 \end{pmatrix}$$

by typing

```
\[
\sigma_y=\begin{pmatrix} 0&-\mathrm{i}\\
\mathrm{i}&0\end{pmatrix}
\]
```

If we have a set of equations that should be arrayed together, we use the `eqnarray` environment. For example, to obtain

$$\begin{aligned} \ddot{x} - \omega\dot{y} &= -\nabla_x \Phi \quad (1) \\ \ddot{y} + \omega\dot{x} &= -\nabla_y \Phi \quad (2) \end{aligned}$$

we type

```
\begin{eqnarray}
\ddot x-\omega\dot y&=&-\nabla_x\Phi\\
\ddot y+\omega\dot x&=&-\nabla_y\Phi
\end{eqnarray}
```

The role of the ampersands is to align the equals signs. By moving the ampersands in the second equation to either side of the plus sign, we get instead

$$\begin{aligned} \ddot{x} - \omega\dot{y} &= -\nabla_x \Phi \quad (3) \\ \ddot{y} + \omega\dot{x} &= -\nabla_y \Phi \quad (4) \end{aligned}$$

[3] In σ_y $\mathrm{i} = \sqrt{-1}$ is not a variable, so it has to be Roman.

4 LaTeX files

LaTeX code must be in plain ASCII (the ordinary characters you see on a keyboard, which are all represented in a computer by bytes in which the most significant bit is 0) and stored in a file with extension `.tex`. By way of an example, you can download the code that generated this document from the file `writeups.tex` on the Practical Course webpage. In principle, any text editor can be used to create such a file, but with packages such as MS-Word care has to be taken to ensure that the file is saved 'unformatted' as a plain ASCII file. The World's best plain-text editor, Emacs, is available gratis for every platform from any number of Web sites. Emacs will even check your spelling and LaTeX syntax for you. Alternatively your TeX installation might provide a specific editing environment instead (for example, TeXshop, part of MacTeX).

The code for a report document could begin

```
\documentclass{report}
\usepackage{graphicx}
\begin{document}
\title{Typesetting a Report}
\author{A. Physicist}
\maketitle
```

The `\documentclass{report}` command tells LaTeX what page layout to use. Other possible `documentclasses` include `article`, `letter`, and `slides`, which is for making overheads (though there are many more[4]).

The `\usepackage{graphicx}` command makes it possible to include in the document figures encoded with the PDF page-layout language, which is a standard vector page layout language (it can also handle other formats, such as PNG bitmaps, amongst others). More on this in §5 below (CTAN also has a searchable archive of packages.).

Once your code is safely stored in the file `myfile.tex`, you submit it to LaTeX's scrutiny by typing

```
pdflatex myfile
```

If all goes well, a PDF (Portable Document Format) file, `myfile.pdf`, will be produced. You will want first to view this on the screen. You do that using any PDF viewer.

All of the pre-packaged LaTeX software distributions (outlined in appendix B) have an associated PDF file viewer (or you can use your favourite operating system provided or third party PDF file viewer).

5 Including figures

The traditional practice of appending figures at the end of a document is now to be strongly discouraged. One should be able to see a figure as one reads the relevant text. Competent graphics packages can export your figures, whether graphs or pictures, as PostScript files that contain `%%BoundingBox` statements. We recommend that you export (or convert) these to PDF files. Such files are trivially integrated into a LaTeX document. For example, figure 2, which was in the file `Fig2.pdf`, was inserted by typing

```
\begin{figure}
\centering
\includegraphics[width=0.4\textwidth]{Fig2.pdf}
\caption{The elliptical orbit of a planet around
the Sun can be approximately represented by
a superposition of a circular orbit around the
```

[4] Visit `http://www.tug.org/ctan.html`.

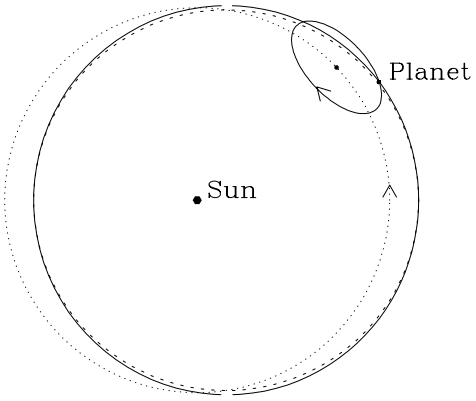


Figure 2: The elliptical orbit of a planet around the Sun can be approximately represented by a superposition of a circular orbit around the Sun of a guiding center, around which the planet executes small elliptical epicycles.

Model	α	flat
Simple	12.1	no
Complex	100	yes

Table 1: Parameters and flatness of the models

```
Sun of a guiding center, around which the
planet executes small elliptical epicycles.}
\label{fig:planetfig}
\end{figure}
```

The figure is automatically positioned at a convenient point in the text and scaled to the given width (in this case 40% of the text width). If your figure won't fit over a single column, replace `figure` with `figure*` in the `\begin` and `\end` commands and it will be allocated space across both columns.

The code above pushes the figure to the left edge of the reserved space. You may prefer to have the figure centred. If so, precede `\begin{figure}` with `\begin{center}` and follow `\end{figure}` with `\end{center}`.

Note the command `\label{planetfig}` in the code associated with the figure. LaTeX automatically numbers the figures (and the equations and the tables etc) and the `\label` command enables one to refer to one of these objects without knowing what its number will be in the final document: you give the object an appropriate name such as `planetfig` and then refer in the text to `figure~\ref{fig:planetfig}` (the tilde "tie" avoids ugly line breaking of the reference number from the word "figure"). Since it is `\caption` that numbers the figure, the `\label` command goes into its argument (no matter where).

6 Constructing tables

Tables are generally handled by analogy with figures: they 'float' to a convenient spot at the head of the paper. As an example, consider table 1. This was set by typing

```
\begin{table}
\begin{center}
\begin{tabular}{l|cr}
Model & $\alpha$ & flat\\
\hline
```

```
Simple & 12.1 & no\\
Complex & 100 & yes\\
\hline
\end{tabular}
\end{center}
\caption{Parameters and flatness of the
models\label{firstT}}
\end{table}
```

If the table had been wider than a column, the code would have started with `\begin{table*}` rather than with `\begin{table}`, and with corresponding modification of `\end{table}`. The table itself starts with `\begin{tabular}`, whose arguments `l|cr` indicate that the left column should be pushed leftwards, then there should be a vertical line, followed by the second column centred and the third column pushed to the right. Each row of code that follows specifies a row of the table, with the exception of those that consist of `\hline`: these generate the horizontal black lines.

7 Practice makes perfect

[13/07/2021 - check "report" links etc - JF] One of the easiest ways to get up to speed with LaTeX is to examine other authors' documents. Obtain the LaTeX source files and play with them; it won't bite. You could try our sample report document[5] and its corresponding LaTeX file[6] as templates for your initial documents.

The Art of Problem Solving Wiki[7] provides plenty of LaTeX examples complete with the source files used to generate them.

8 Conclusions

LaTeX is a document markup language, part of the TeX documentation preparation system which is widely used throughout academia, scientific and technical publishing, in particular. You can use it to create beautiful reports and theses, concentrating on the content (the physics), leaving LaTeX to handle the page layout. If you plan to pursue a career in the sciences and/or one that includes any aspect of technical publishing, you will most likely find it advantageous to familiarise yourself with it.

A References

The bibliography below was produced by typing

```
\begin{thebibliography}{9}
\bibitem{lamport} L.\ Lamport, \emph{LaTeX: A document preparation system,
User's guide and reference manual},
2nd edition, Addison-Wesley Professional, 1994.
\end{thebibliography}
```

The second argument of the `\begin{thebibliography}` command, here `99`, is any text that is no narrower than the widest label [1] etc in the reference list. Each reference is introduced by a `\bibitem` command, whose first argument is a label by which you can refer to this reference in the text. Thus, on the first page the [1] was generated by typing `\cite{lamport}`.

[5] `http://www-teaching.physics.ox.ac.uk/practical_course/CO5x_report.pdf`
[6] `http://www-teaching.physics.ox.ac.uk/practical_course/CO5x_report.tex`
[7] `http://www.artofproblemsolving.com/Wiki/index.php/LaTeX:Examples`

B Downloading LaTeX for your machine

For Mac OS X, obtain the latest MacTeX package from `http://tug.org/mactex/`. We recommend using the TeXshop front end for editing. This is the environment installed on all the teaching course Apple Mac desktops for your use.

LaTeX will be available pre-installed (or at least pre-packaged) with any modern Linux distribution (e.g. Ubuntu, SUSE, Fedora, etc). Simply search for it with the appropriate package management software.

For all versions of Windows we suggest you use the latest, stable, version of MiKTeX. You can obtain this pre-packaged from `http://miktex.org/` where you will find full installation instructions.

C Typography

In preparing any document an eye should be kept on the typography and style required. Refer to the document AD30 — *typography* which provides an introduction and some help in this matter.

Bibliography

[1] L. Lamport, *LaTeX: A document preparation system, User's guide and reference manual*, 2nd edition, Addison-Wesley Professional, 1994.

[2] Wikibooks contributors, *LaTeX*, `https://upload.wikimedia.org/wikipedia/commons/2/2d/LaTeX.pdf`

[3] T. Oetiker, *The Not So Short Introduction to LaTeX 2ε*, `http://tobi.oetiker.ch/lshort/lshort.pdf`

[4] H. Kopka, P. W. Daly, *Guide to LaTeX*, 4th edition, Addison-Wesley Professional, 2003.