An introduction to LaTeX

- a document preparation language

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(from an original lecture by Cedric Lacey)

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

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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 of these in Astronomy reading room

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LATEX: A document preparation system
 by Leslie Lamport
- describes basic features, but not many examples
- somewhat out of date

The LATEX Companion
by Goossens, Mittelbach & Samarin
- describes lots more optional/additional features

Useful websites:

A very brief overview to get you started:
http://www.tug.org/begin.html

A much more detailed introduction:
http://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.harvard.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

Macros & tips for PhD theses in LaTeX

Durham PhD thesis macros:
http://www.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)

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
- Windows: try MiKTeX from
     www.miktex.org   (in Russian?)
   or TeXnicCenter from
     sourceforge.net/projects/texniccenter
- Mac OS X: try gwTeX from
     ii2.sourceforge.net/tex-index.html
   or TeXShop distribution (includes GUI) from
     http://www.uoregon.edu/~koch/texshop

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)

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: > lp 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
- WinEdt (costs US$30 for students) from
www.winedt.com

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.eps

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}

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.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 main.tex at position of \input command

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 α-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

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, Subsection 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 numbered 1,2,3 etc

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}
- For multi-line equations, use \begin{eqnarray} etc

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:

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

Equations: Example 2

- You type:

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

- You get:

$$1 - n_{\rm s} = 2\epsilon_1 + \epsilon_2 \tag{3.3}$$

$$r = 16\epsilon_1. \tag{3.4}$$

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 myplot.eps (for dvips) or myplot.png or myplot.pdf (for pdflatex) and rescale to width of 8.5cm

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 manually

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 1st column and centres 2nd and 3rd columns
- & separates columns and \\ separates lines

Tables: Example

- You type:

```latex
\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:

Parameter	Allowed range
Ω_k	$-0.3 - 0.3$
ω_{dm}	$0.01 - 0.99$
ω_{b}	$0.005 - 0.1$
f_ν	$0 - 0.5$
w_{DE}	$-2. - 0$
τ	$0 - 0.8$
n_{s}	$0.5 - 1.5$
$\log_{10}(10^{10} A_{\mathrm{s}})$	$2.7 - 4.0$
r	$0 - 1$
b	marginalized
Θ	$0.5 - 10$

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
- Must run LaTeX **TWICE** to get final document

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 Fig.~\ref{fig:lumfun} that....
  ```
- \ref{...} gets replaced by actual figure number in document

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 brackets, e.g. eqn.(3.2)

Bibliographic references – simple approach

- Use the **natbib** package:
    \usepackage{natbib}
- Create your bibliography (in alphabetical order):

- \begin{thebibliography}{}
    ....
 \bibitem[Smith \& Jones (1990)]{Smi90}   Smith,
    A., \& Jones, B., 1990, ApJ 231, 506   ....

    \end{thebibliography}
- One \bibitem for each article or book referred to
- LaTeX will typeset your bibliography

Refering to a paper in the bibliography (using natbib)

- Then to refer to a paper in the text, use \citet or \citep or \citeauthor or \cityear, e.g.
- \citet{Smi90} produces "Smith & Jones (1990)"
- \citep{Smi90} produces "(Smith & Jones 1990)"
- \citeauthor{Smi90} produces "Smith & Jones"
- See documentation on **natbib** for more possibilities

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 or "Guide to LaTeX" (Kopka & Daly) for more details
- Compatable with natbib citation package

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)