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TEX at CERN

Local guide

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Abstract

This document describes how to use TEXware at CERN. Only the LATEX macro package and its associated tools are actively supported. Other macro packages, like PLAIN, PSIZZL, PHYZZX and PHYS are available and can be used if so desired, but no formal support for these is possible.

On all central computer platforms a **simple** and **uniform** user interface for using LATEX has been provided (see chapter 2). The New Font Selection Scheme (NFSS) has been installed everywhere (see chapter 4). For printing formatted output PostScript and its associated DVI converter `dvips` have been chosen. Chapter 5 explains how to include EPS (EPS) pictures in a document. The complete functionality of AMS-TEX can be used with the `amstex` style option of LATEX(see chapter 9).

The present manual does not describe TEX or LATEX themselves (for more details see *The TEXbook* by D. E. Knuth and *LATEX: A Document Preparation System* by L. Lamport, both published by Addison-Wesley, or one of the many books or tutorials on the subject).

Contributions by David Stungo/AS and the work of Philippe Defert/CN in installing TEX, especially on the Unix platforms, are gratefully acknowledged.

This document is available as a PostScript file `texacern.ps` on all central systems in the PostScript documentation directories (see table 2.2 on page 5 for more details)

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Chapter 1: Introduction

TEX [1, 2] (pronounced `Tekh`) is a text processing system developed by Donald E. Knuth of Stanford University to compose by computer high quality documents, especially those containing many mathematical formulae. Its typographic quality is comparable to the finest works of the printing art. The TEX text formatting system offers several tens of custom-made fonts and over 300 basic and 600 "composed" `PLAIN` commands.

Unlike most desktop publishing systems, TEX does not attempt to show the appearance of the finished document on the screen as it is edited (although screen previewers are available). Instead, the document is "marked up" with codes, which indicate boldface, italics, special characters (e.g., "`\int`" for an integral sign), and the like. Large-scale aspects of design are automated; you just give the title of a chapter, and let the computer take care of numbering the chapter and putting the title in the right place on the page.

TEX is generally considered the most sophisticated computer typesetting system, as well as (for an experienced user) one of the easiest to use. LATEX is a macro package build on top of TEX.

Leslie Lamport, the original author of LATEX, says the following about his system in the preface of [3]

> "LATEX adds to TEX a collection of commands that simplify typesetting by letting the user concentrate on the structure of the text rather than on formatting commands. In turning TEX into LATEX, I have tried to convert a highly-tuned racing car into a comfortable family sedan. The family sedan isn't meant to go as fast as a racing car or be as exciting to drive, but it's comfortable and gets you to the grocery store with no fuss. However, the LATEX sedan has all the power of TEX hidden under its hood, and the more adventurous driver can do everything with it that he can with TEX."

Fundamental to LATEX is the idea of a **document style** which determines exactly how a document will be formatted. LATEX provides standard document styles that describe how standard logical elements should be printed. One may have to supplement these styles by specifying the formatting of logical structures peculiar to a given document, such as mathematical formulae. One can modify the standard document styles or create an entirely new one, though one should possess a basic understanding of typographical design before creating a radically new style.

1.1 Advantages of LATEX

- The layouts were developed by (American) design professionals, and they produce documents which indeed look as though "they were printed".
- It is extremely simple to compose mathematical formulae.
- The user must only know a few easily memorized commands, which control the logical structure of the document, and (almost) does not have to know the technical details about how a document is formatted.
- More complex components such as footnotes, bibliography, table of contents etc. as well as simple pictures can be produced without great difficulty.
- LATEX is the "de facto" standard for scientific publications in Europe and the U.S.A..

1.2 Disadvantages of LATEX

- The computer units (both CP and disk space) needed are higher than with more primitive text processors.
- The document can only be output on display units or printers with graphical (all point addressable) capabilities.
- One can vary a few parameters quite easily within the framework of a given LATEX document layout style. However more basic deviations from the available layouts are only possible with a lot of (re)programming.

1.3 How does LATEX work?

A TEX (LATEX) input file is a "plain" text file prepared with a text editor and in general has the extension `tex` file.

The files describing the document styles or options (extension `sty` file) are stored in a standard public directory. There exist many LATEX styles, but only four standard ones, namely, `report`, `article`, `book` and `letter`. These styles can be further customized by specifying one or more options.

The output from LaTeX is a set of files. One of them (extension `dvi` file) contains a device independent binary representation of the formatted text. This file can be converted into a printable form by a separate program.

A logfile of the (La)TeX run is generated (extension `LIS` file, `log` file or `TEXLOG` file); it contains information which also appeared on the screen (e.g. the names of the files read, the numbers of the pages processed, error messages etc).

The other files contain information about cross-referencing (extension `aux` file), table of contents (extension `toc` file), list of figures (extension `lof` file) and list of tables (extension `lot` file). They are used in a subsequent LaTeX run to produce particular elements of the document.

A file with extension `idx` file contains all indexed items. They can be sorted and included as an `ind` file file.

A file with extension `bbl` file contains the bibliographic references extracted by BIBTeX from the bibliography database.

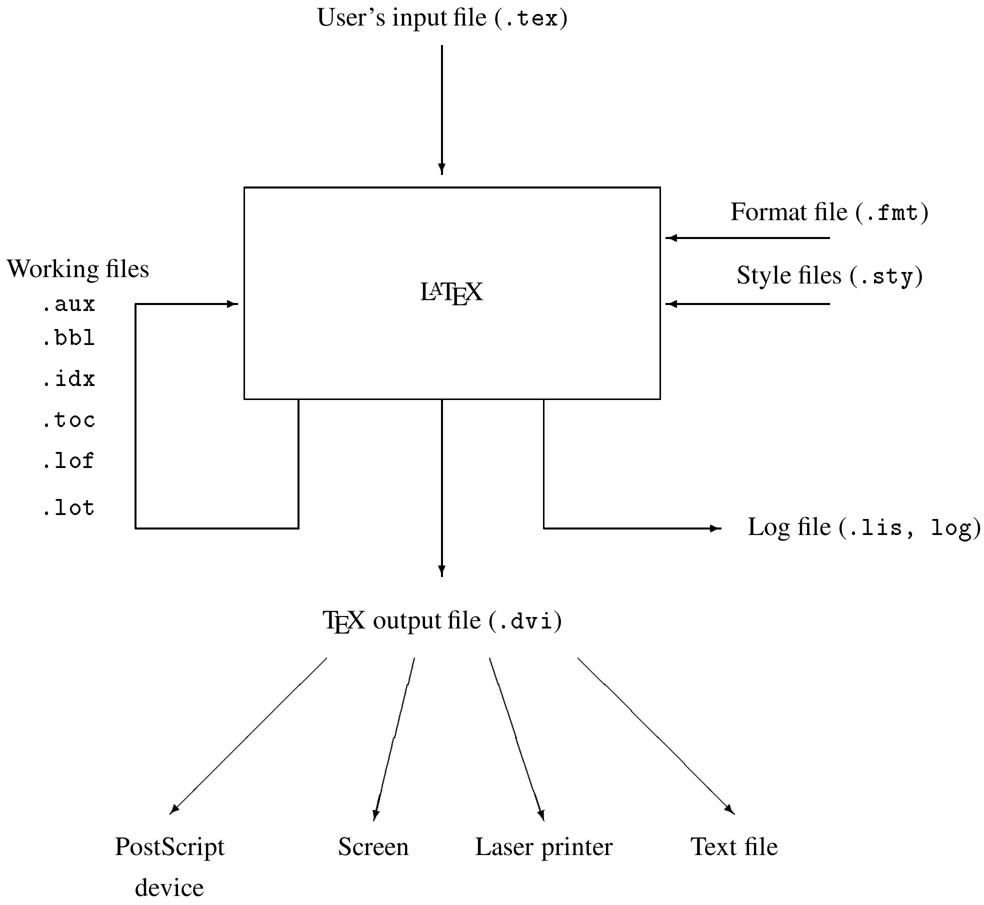


Figure 1.1: Data flow for the files used by LaTeX

1.4 TeX glossary

This section is partly based on a glossary posted to `TEXHAX` by Jacques Goldberg of the Department of Physics, Technion–Israel Institute of Technology, Haifa (Israel).

glyph	A graphical representation of a character, for example **a**, *a* and `a` are three different glyphs for the same character.
font	A set of glyphs corresponding to a character set.
primitives	About three hundred basic commands wired into the TEX program.
macros	More sophisticated or simpler to use commands, built upon the primitives.
Plain TEX	Donald Knuth's TEX augmented by his own set of macros.
LATEX	Donald Knuth's TEX augmented by Leslie Lamport's alternative set of macros.
AMS-TEX	Donald Knuth's TEX plus American Mathematical Society macros. The functionality of this package is now available to LATEX users with the `amstex` style option.
format	A given set of macros, compiled and written into a file of filetype **fmt** once to save repeated compilation time. TEX will restore all definitions by reading such a format file.
TFM	Font Metric files contain *device independent global* information about the space on the output requested for each glyph in the font, as well as other boundary conditions such as relative spacing with neighbouring glyphs (e.g. ligatures). TEX does *not* need to know the detailed shape of a glyph. Filetype is **tfm**.
DVI	A DeVice Independent file (extension **dvi**) is output by TEX. DVI files use the ASCII 255-character set and can be copied between different computers (PC's and mainframes) as *binary (image)* files. They contain the description of the formatted document.
DVI driver	A program which turns the human-unreadable DVI file into ink on paper or light on a display. The DVI driver *must* know exactly how to produce the image of a given glyph. Therefore it needs a *raster* image for each glyph, and this raster is device (printer, display) dependent, at least, but not only, because devices have different resolutions.
previewer	DVI driver to output the DVI file onto a screen.
font file	A set of raster representations for each glyph in a font, clearly printer and magnification-dependent. These files have various filetypes such as **pxl, pk, gf**. The differences in names are historical and technical. **pxl** is obsolete but still used by some old drivers, **pk** is by far the most efficient especially when it comes to saving disk space, **gf** is produced on the way to making fonts by the METAFONT program. DVI drivers are *not* supposed to be able to magnify fonts, but they should not generate a fatal error when a font is not available. DVI drivers expect to find the magnified rasters in a specific directory structure, and the user is responsible for not invoking magnifications for which no raster files exist; again TEX does *not* check that the driver will or will not be able to print out a font at the requested magnification. This is *not* TEX's business.
magnification	A scale factor applied to the original design size for a font. The following magnification factors are accepted: $$0.5, 0.6, \ldots, 1.0, \sqrt{(}1.2), 1.2, (1.2)^2, etc$$ Not all fonts at each magnification will be present on all machines.
METAFONT	A companion program to TEX used to generate new fonts, or existing fonts at new magnifications. The program METAFONT reads a font definition file, actual device parameters, magnification etc., to generate *two* output files per input font file definition. The input is an **mf** file and the two outputs are the corresponding **tfm** and **gf** files. If you wish to make a font at 5 different magnifications you have to run METAFONT 5 times, on almost the same **mf** file. If you wish to create the font for 3 different devices (a dot matrix printer, a laser printer, a display) you again must run METAFONT 3 times, with the correct printer definition. *All these runs will always produce the same **tfm** file* but a *different **gf** file.*
LATEX style	A file which contains the description of or changes to a document layout style. These are the files which are specified in the LATEX command `\documentstyle[minor_style]{major_style}` where `minor_style` is an optional part, which specifies small changes to be made to the mandatory `major_style`.

1.5 Educational material

1.5.1 Public domain TEX and LATEX tutorials

Directory DISK$ET:[TEX.EXAMPLES] (VAX/VMS) or minidisk TEX 712 contain public domain educational material, with among others:

- "*Essential LATEX*" by Jon Warbrick (Plymouth Polytechnic). It is available as essential.ps (english version) and latexdeb.ps (french version) in the PostScript documentation directories.
- "*A Gentle Introduction to TeX* (A Manual for Self-Study)" by Michael Dood (The University of Manitoba). It is available as texintro.ps in the PostScript documentation directories.
- "*An Introduction to TeX/LaTeX Document Production Systems*" by Jingbai Wang (University of Pittsburgh).

Further material is available in PostScript form in the relevant directories described in section 2.2.

1.5.2 Suggested further reading on TEX

Those, who wish to know more about TEX and LATEX, will find a list of books below. Unless stated otherwise in brackets, these books are edited by Addison-Wesley. Knuth's *TEXBook* and Lamport's *LATEX* book can be bought with a stores card from the Computer Documentation Office (Jean Zueras, Bat. 513-1-022).

- *The TEXbook* by D. Knuth
- *LATEX, a Document Preparation System* by L. Lamport
- *TeX for the Impatient* by P.W. Abrahams
- *TEX für Fortgeschrittene* (in German) by W. Appelt
- *LATEX, la perfection dans le traitement de texte* (in French) by F. Borceux (Editions Ciaco, Bruxelles)
- *TEX by Example* by A. Borde (Academic Press)
- *LATEX for Engineers and Scientists* by D.J. Buerger (McGraw-Hill)
- *Publiceren met LATEX* (in Dutch) by R. de Bruin, C.G. van der Laan, J.R. Luyten and H.F. Vogt (C.W.I. Amsterdam)
- *TEX by Topic* by V. Eijkhout
- *LATEX, Eine Einführung* (in German) by H. Kopka
- *LATEX, Erweiterungsmöglichkeiten* (in German) by H. Kopka
- *Le petit Livre de TeX* (in French) by R. Seroul (InterEditions, Paris)
  Translated and adapted by S. Levy as *A beginner's Book of TEX* (Springer-Verlag)
- *Introduction to TeX* (also in Dutch and German) by N. Schwarz
- *Kompaktführer LATEX* (in German) by R. Wonneberger

1.5.3 Electronic TEX magazines

On VM/CMS various electronic magazines about TEX are stored on the minidisk TEX 201.

TEXMAX Electronic magazine published by the Harvey Mudd College Mathematics Department.

TEXHAX Hints, comments, questions, suggestions, etc. about TEX, LATEX, METAFONT and related programs. This digest is a service of the TeX Users Group in cooperation with the University of Washington.

TEXUK UKTeX is the U.K. version of TeXhax, edited by Peter Abbott of Aston University.

Moreover there are files which contain answers to "Frequently asked questions" on TEX in TEX QUESTION, plus a list of FTP sites with TEX goodies in TEXFTP LIST. These files are also accessable on VAX/VMS, e.g. the following command will show the issues of TEXUK of the year 1991 [DCL $] DIR CERNVM::[TEX.201]TEXUK.90*.

Chapter 2: Running LaTeX

The latest versions of TeX, METAFONT and the LaTeX macro package have been installed on all centrally supported computer platforms at CERN. Below we show the basic commands to format a LaTeX document, transform the DVI file into PostScript and print the output. Then each major system will is reviewed in turn.

2.1 Running a Sample File

Before preparing your own documents, you may want to get acquainted with LaTeX by running it on a sample input file. You can copy the file `sample.tex`, which is present in the public directories shown in table 2.1.

System	File name
VM/CMS	`SAMPLE TEX` on the standard TeX minidisk
VAX VMS	`TEX_EXAMPLES:SAMPLE.TEX`
Unix	`/usr/local/lib/tex/macros/sample.tex`

Table 2.1: Location of sample LaTeX file

You can now modify your copy of the file `sample.tex` if you want and then run LaTeX on your file by typing:

```
latex sample
```

When LaTeX has finished, it will have produced the file `sample.dvi` in your current (working) directory. You can print this file by first transforming the information into PostScript using the command `dvips`.

```
dvips sample.dvi
```

In general the extension `.dvi` can be omitted. If `dvips` is configured normally, this will send the output file to your default printer (pointed by the environment variable `PRINTER`) via `lpr` with BSD Unix and via `lp` with System V Unix, or create a file `SAMPLE.PS` (VAX/VMS) or `SAMPLE PS` (VM/CMS). In the latter cases you can print this file as follows:

```
XPRINT/LW/PR=printer_name SAMPLE.PS      -- on VAX/VMS
XPRINT SAMPLE PS (PR printer_name        -- on VM/CMS
```

After your output has been printed, you can delete `sample.dvi` and possibly `sample.ps`.

2.2 Documentation in PostScript form

Table 2.2 shows where CERN users can find ready-to-print documentation about packages or utilities described in this guide as PostScript files, which can be printed on any PostScript printer known to the local system.

```
lpr -Pprinter_name filename.ps           -- on BSD  Unix
lp  -dprinter_name filename.ps           -- on SysV Unix
XPRINT/LW/PR=printer_name FILENAME.PS    -- on VAX/VMS
XPRINT FILENAME PS (PR printer_name      -- on VM/CMS
```

With a default printer defined, one does not have to specify the printer's name. Users without a local PostScript printer can print on the public PostScript printers `513-pub` or `513-lps`, located in the UCO area of building 513.

System	Location of the PostScript files
VM/CMS	`TEX202` minidisk available with `GIME TEX 202`
VAX VMS	The directory defined as `TEX_DOCPS:`
Unix	The directory defined as `/usr/local/lib/tex/docps`

Table 2.2: Location of ready-to-print documentation about LaTeX and its related software

2.3 TeX on CERNVM

On VM/CMS the `TEX` and `LATEX` execs are available on the `P`-disk. These execs automatically access the TeX minidisks.

2.3.1 TeX minidisks

`TEX 802`	Default TeX minidisk, containing the basic TeX system, and LaTeX related files.
`TEX 501`	– The `GOODY1` disk – contains lots of style files and other material, which is not officially supported but is nevertheless interesting. The disk is partially maintained by local experts of SL and TH divisions. This minidisk has also styles for some CERN documents, like `SLREPORT`, `LEPPERF`, `LEPNOTE`. There is also `YELLREPT` for Yellow reports. LaTeX files with the same names contain examples on how to use these styles. The file `GOODIES TEX` contains a description of some other styles.
`TEX 502`	– The `GOODY2` disk – contains mainly special formatting packages used by TH Division at CERN.
`TEX 201`	Information about TeX with recent issues of the electronic magazines (see page 4).
`TEX 202`	PostScript files containing ready-to-print documentation about TeX and LaTeX (see also section 2.2).

2.3.2 Interrupting TeX

If you want to stop TeXing in the middle of execution, perhaps because it is printing a seemingly unending string of uninformative error messages, type <CR>. This will make TeX stop as if it had encountered an ordinary error, and you can return to CMS command level by typing `X`, as described in the TeXbook. If this doesn't work, hitting `PA1` will get you immediately to CP command level, then typing `EXT` and `HX` afterwards puts you back into CMS command level.

A "deadlock" may occur if LaTeX requires a file which is not accessible. The user will be prompted to input the correct file name, if any. If you want to exit from TeX at that point, specify `null` as filename. This is an empty file on the default TeX minidisk.

2.3.3 `dvips` - DVI convertor to PostScript

The `DVIPS` exec can be used to convert a DVI file into a PostScript file. The command format is:

```
DVIPS fn [ft [fm]] ( options
```

`fn ft fm` are the input file characteristics. Default is `fn dvi *`. The most important options are:

`-ofilename`	The output file will be called `filename`. The default is `fn PS A`.
`-n num`	Number of pages printed. Default is 100000.
`-p num`	First page printed. Default is first page in the DVI file.

As an example, `dvips myfile ( -p4 -n2` will generate a PostScript file `MYFILE PS` containing pages numbers 4 and 5 of document `MYFILE`. Other options of `dvips` are discussed in the documentation file `DVIPS PS` on minidisk `TEX202`.

2.3.4 `dvitek` - DVI previewer for Tektronix 4014 terminals

This `DVITEK` exec converts DVI files to the format needed by the Tektronix 4012/4014 terminal. The previewer provides the movable and scalable window (screen) to see the page with the TeX output. Initially the window is adjusted to the left and top margins of the page.

The command format is:

```
DVITEK fn [ft [fm]] ( options
```

`fn ft fm` are the input file characteristics. Default is `fn dvi *`. The most important options are:

`-x #units`	The left margin of the page.

`-y #units`	The top margin of the page
`-o num:num`	The range of the pages to be printed. Default is the whole DVI file.

As an example, `dvitek myfile ( -p4:5` will output the pages 4 and 5 of document `MYFILE`.

The previewer is controlled with a few keystrokes. The user can move the window along the page, reduce or enlarge the window, select the page, etc. On VM keystrokes can be entered **only** after the graphical output is terminated.

Please note that only FALCO terminals accessed through TAGIBM were thoroughly tested.

`dvitek` works rather slowly, but it allows users to see the result of a TEX run without having to print the document with `dvips`. It is thus a nice utility for those VM and VMS users, who do not yet have access to a workstation, where tools like `xdvi` and PostScript previewers like `ghostview` give a much faster representation of the printed pages on the graphics screen.

2.3.5 `dvi2tty` – DVI previewer for on ordinary terminals

This `DVI2TTY` exec converts a DVI file to a format that is appropriate for terminals and line printers. The program is intended to be used for preliminary proofreading of TEX-ed documents. By default the output is directed to the terminal, but it can be directed to a file or a pipe. The command format is:

```
DVI2TTY fn [ft [fm]] ( options
```

`fn ft fm` are the input file characteristics. Default is `fn dvi *`. The most important options are:

`-o file`	Write output to file `file`.
`-p list`	Print the pages chosen by list.
`-w n`	Specify terminal width. Default is 80.

2.3.6 How to get the VM version

Those interested in bringing up TEX at their VM installation can copy all the files on the various `TEX` minidisks freely, since no commercial packages have been installed there. It might however be more advisable to get the CMS distribution tape for TEX and the associated font libraries directly from **Maria Code, DP Services, 1371 Sidney Drive, Sunnyvale, CA 94087 USA**, as described in the back pages of *TUGboat*, the magazine of `TUG`, the TEX Users Group.

2.4 TEX on the VXCRNA VMS system

The version of TEX installed on VXCRNA is based on the DECUS `TEX91` tape collection. To set up the necessary TEX environment variables and symbols, all TEX users must execute the command `CERNTEX` or enter it in their `LOGIN.COM`.

2.4.1 Interrupting TEX

When TEX is running you can interrupt it by typing `control-C`. This will stop TEX as if it had encountered an ordinary error, and you can then return to `DCL` command level by typing `X`, as described in the TEXbook. Note, that the program closes the output files (`.dvi`, `.lis`, etc). Of course, `control-Y` will also stop execution, but the `.dvi` file will be corrupted.

A "deadlock" may occur if LATEX requires a file which is not accessible. The user will be prompted to input the correct file name, if any. If you want to exit from TEX at that point, type `control-Z` or specify `null` as filename. This is an empty file, which is provided in the standard input file directories.

2.4.2 dvidis – DVI previewer for VWS

The dvidis is a program that displays DVI files on a VaxStation running under VWS. A large window will be created, and your text should start to appear in it; depending on the paper size and where you have located your window (by default it starts out centered), you may be able to see the "edge" of the paper as a gray bar. Meanwhile, your keyboard will remain attached to the window you were previously in, and you can enter commands. For a list of commands available to you, hit the HELP key.

The syntax for the dvips command is

```
DVIDIS options file[.dvi]
```

The options of DVIDIS can be found by issuing the command HELP DVIDIS.

2.4.3 xdvi – DVI previewer for DECWindows

The DVI previewer xdvi is a program which runs under the DECwindows system. It has the capability of showing the file shrunken by various (integer) factors, and also has a "magnifying glass" which allows one to see a small part of the unshrunk image momentarily.

Before displaying any page or part thereof, it checks to see if the DVI file has changed since the last time it was displayed. If this is the case, then xdvi will reinitialize itself for the new DVI file. For this reason, exposing parts of the xdvi window while TeX is running should be avoided. This feature allows you to preview many versions of the same file while running xdvi only once.

```
xdvi [+[<page>]] [-s <shrink>] [-density <%>] [-p <pixels>] [-l] [-rv]
[-paper <papertype>] [-mgs[n] <size>] [-altfont <font>]
[-margins <dimen>] [-sidemargin <dimen>] [-topmargin <dimen>]
[-offsets <dimen>] [-xoffset <dimen>] [-yoffset <dimen>] [-keep]
[-hushspecials] [-hushchars] [-hush]
[-fg <color>] [-bg <color>] [-hl <color>] [-bd <color>] [-cr <color>]
[-bw <width>] [-geometry <geometry>] [-icongeometry <geometry>]
[-iconic] [-display <host::display>] [-copy] [-thorough] dvi_file
```

The options, keystrokes and mouse actions of xdvi are described in the manual page obtained by typing help xdvi.

2.4.4 dvips - DVI convertor to PostScript

The DVI driver dvips translates a DVI file into a PostScript file. The latter can be printed on any PostScript printer, e.g. DEC LN03R or lps20, Apple LaserWriter, PrintServer 20 or 40.

The syntax for the dvips command is

```
DVIPS options file[.dvi]
```

The output file is created in the default directory with the same filename as the DVI file and with extension PS. Possible options are:

/OUTPUT=filename	The output file will be called filename.
/NUMBER=num	At most num pages will be printed. Default is 100000.
/START=num	First page printed is the one numbered num. Default is first page in the DVI file.

Other options of DVIPS can be found by issuing the command HELP DVIPS or by reading the documentation in the file TEX_DOCPS:DVIPS.PS.

2.4.5 dvitek - DVI previewer for Tektronix 4014 terminals

This DVITEK exec converts DVI files to the format needed by the Tektronix 4012/4014 terminal. The previewer provides the movable and scalable window (screen) to see the page with the TeX output. Initially the window is adjusted to the left and top margins of the page.

The command format is:

DVITEK [options] file[.dvi]

fn ft fm are the input file characteristics. Default is fn dvi *. The most important options are:

-x #units The left margin of the page.
-y #units The top margin of the page
-o num:num The range of the pages to be printed. Default is the whole DVI file.

As an example, dvitek -o4:5 myfile will output the pages number 4 and 5 of document MYFILE.

Other options of dvitek can be found by issuing the command HELP DVItek.

2.4.6 dvi2tty – DVI previewer for on ordinary terminals

This DVI2TTY driver converts a DVI file to a format that is appropriate for terminals and line printers. The program is intended to be used for preliminary proofreading of TeX-ed documents. By default the output is directed to the terminal, possibly through a pager (depending on how the program was installed), but it can be directed to a file or a pipe.

The command format is:

DVI2TTY [options] file[.dvi]

The most important options are:

-ofile Write output to file file.
-plist Print the pages chosen by list.
-wn Specify terminal width. Default is 80.

2.5 TEX on Unix

TEX3.14 has been compiled for most Unix systems at CERN and the relevant executables, as well as other necessary files, are available on the fileserver asis01. The tex, latex and other relevant commands reside in the /usr/local/bin directory. When you get a latex: not found error from the system, first check whether the above directory is in your command search path by typing echo $PATH. If it is, please type ls /usr/local/bin/latex to check whether the latex file is indeed installed. If it is not, contact your system administrator or, in his absence, Philippe Defert/CN for more information about getting it up and running on your own Unix system. The installation of software from the asis server is described in [4].

Once you get LATEX started, you should get the message:

```
This is TeX, C Version 3.14t3
```

If the command latex is found, but you do not get this far, then you have probably the wrong version of the LATEX format. In this case you should contact the people mentioned above.

2.5.1 Interrupting TEX

When TEX is running you can interrupt it by typing control-C. This will stop TEX as if it had encountered an ordinary error, and you can then return to Unix shell command level by typing X, as described in the TEXbook.

A “deadlock” may occur if LATEX requires a file which is not accessible. The user will be prompted to input the correct file name, if any. If you want to exit from TEX at that point, specify null as filename. This is an empty file, which is provided in the standard input file directories. You should be aware that in some cases TEX only searches its own defaults input directories. Also when a file to be input is not in the same directory as the root-file, **absolute pathnames** have to be used to transmit the file’s actual pathname to TEX. In particular the ˜ character for the home directory is not recognized.

2.5.2 dvips - DVI convertor to PostScript

The DVI driver dvips translates a DVI file into a PostScript file. The latter can be printed on any PostScript printer, usually an Apple LaserWriter.

The syntax for the dvips command is:

```
This is dvips 5.485 Copyright 1986-92 Radical Eye Software
     Usage: dvips [options] filename[.dvi]
 a*  Conserve memory, not time      t s Paper format
 b # Page copies, for posters e.g.  x # Override dvi magnification
 c # Uncollated copies              C # Collated copies
 d # Debugging                      D # Resolution
 e # Maxdrift value                 E*  Try to create EPSF
 f*  Run as filter                  F*  Send control-D at end
 h f Add header file                K*  Pull comments from inclusions
 i*  Separate file per section      M*  Don't make fonts
 k*  Print crop marks               N*  No structured comments
 l # Last page                      O c Set/change paper offset
 m*  Manual feed                    P s Load config.$s
 n # Maximum number of pages        S # Max section size in pages
 o f Output file                    T c Specify desired page size
 p # First page                     U*  Disable string param trick
 q*  Run quietly                    X # Horizontal resolution
 r*  Reverse order of pages         Y # Vertical resolution
 s*  Enclose output in save/restore Z*  Compress bitmap fonts
     # = number   f = file   s = string  * = suffix, `0' to turn off
     c = comma-separated dimension pair (e.g., 3.2in,-32.1cm)
dvips: ! No input filename supplied.
```

The DVI file may in general be specified without the .dvi extension. Fonts used may either be resident in the printer or defined as bitmaps in PK files, or a "virtual" combination of both. dvips will automatically invoke METAFONT to generate fonts that don't already exist.

To prevent the file from being sent straight to the printer use the option -o to specify file, which then can be sent to the printer of your choice with the lpr (BSD) or lp (SysV) command.

```
dvips -osample.ps sample.dvi
lpr -Pmy_printer sample.ps    or   lp -dmy_printer sample.ps
```

The many other options of dvips are described in the file /usr/local/lib/tex/ps/dvips.ps or one can read the manual page by typing man dvips. Some possibilities (e.g. merging text and graphics) of dvips will also be discussed in chapter 5.

2.5.3 xdvi – DVI previewer for X-windows

The DVI previewer xdvi is a program which runs under the X window system. It has the capability of showing the file shrunken by various (integer) factors, and also has a "magnifying glass" which allows one to see a small part of the unshrunk image momentarily.

Before displaying any page or part thereof, it checks to see if the DVI file has changed since the last time it was displayed. If this is the case, then xdvi will reinitialize itself for the new DVI file. For this reason, exposing parts of the xdvi window while TeX is running should be avoided. This feature allows you to preview many versions of the same file while running xdvi only once.

In addition to using keystrokes to move within the file, xdvi provides buttons on the right side of the window, which are synonymous with various sequences of keystrokes.

```
   xdvi [+[<page>]] [-s <shrink>] [-density <%>] [-p <pixels>] [-l] [-rv]
[-paper <papertype>] [-mgs[n] <size>] [-altfont <font>]
[-margins <dimen>] [-sidemargin <dimen>] [-topmargin <dimen>]
[-offsets <dimen>] [-xoffset <dimen>] [-yoffset <dimen>] [-keep]
```

```
[-hushspecials] [-hushchars] [-hush]
[-fg <color>] [-bg <color>] [-hl <color>] [-bd <color>] [-cr <color>]
[-bw <width>] [-geometry <geometry>] [-icongeometry <geometry>]
[-iconic] [-display <host:display>] [-copy] [-thorough] dvi_file
```

The many options of `xdvi` are described in the manual page obtained by typing `man xdvi`.

2.5.4 `gs` – a PostScript previewer

The public domain `Ghostscript` previewer `gs` is available on Unix workstations. It is part of the `GNU` project. Ghostscript is a programming language similar to Adobe Systems' PostScript (tm) language. Gs reads a file and displays it as a Ghostscript file. It then interprets commands from standard input until an end of file character (`control-D`) is typed. The `'quit'` character (`control-C`) also terminates Ghostscript execution.

To invoke the interpreter, give the command

```
gs <filename1> ... <filenameN>
```

The interpreter will read in the files in sequence and execute them. After doing this, it reads further input from the primary input stream (normally the keyboard). Each line (i.e. characters up to a `<return>`) is interpreted separately. To exit from the interpreter, type `quit<return>`. The interpreter also exits gracefully if it encounters end-of-file.

The program `ghostview` provides the menu/mouse interface for `ghostscript` previewer. To invoke the interpreter, give the command

```
ghostview  <filename>
```

2.6 TeX on personal computers

2.6.1 TeX on the PC

On the PC under MS-DOS the commercial product `PCTEX` is used in the DTP area. There exist public domain versions (most notably `EMTEX` and `SBTEX`) but, due to lack of manpower, these packages are neither generally available nor supported at CERN. The commercial version `PCTEX` can be bought from the PCSHOP (F. Ovett, AS/MI Bld. 513) and costs approximately 1000 CHF. It includes a previewer, which lets you look at your files so that you do not always have to print them to see what they look like. A version of the DVI driver `dvips` is also available for MS-DOS.

2.6.2 TeX on Macintosh

This section gives a short overview of a commercial MacIntosh TeX implementation TeXtures v1.3. It should be noted that there exists at least one complete public domain implementation, `OzTeX`, but for lack of manpower the latter can neither be made generally available nor maintained at CERN.

2.6.2.1 Graphics

In TeXtures v1.3 almost any Mac graphics (Paint- and Draw- format) can be included, scaled and previewed. PostScript graphics will also be rendered if in EPS (Encapsulated PostScript format). TeXtures v1.3 uses two flavours of the `\special` command for inserting pictures:
`\special{picture xxx}` and `\special{picture xxx scaled nnn}`.
Either of these commands inserts the picture named `xxx` at the current position on the typeset page. The `scaled nnn` variation allows the insertion of pictures at other than their actual size. When you typeset a document, make sure that all the pictures you want to appear in it are stored in that document's Picture window. PostScript code can also be included, e.g. for rotating the TeX output.

2.6.2.2 Printing and previewing

One can use the `print` command in the `FILE` menu. However additional steps are required to move a standard DVI file transferred from another computer into the TeXtures v1.3 special format. TeXtures v1.3 has the `preview` facility, which allows zooming, skipping from one page to another, etc.

2.6.2.3 Fonts

TeXtures v1.3 has been designed to use the fonts available in the System. No tools are provided for converting PK files into Macintosh format, but the "standard" set of Computer Modern fonts is provided as well as TFM files for the PostScript fonts resident in the LaserWriter Plus, which can be used at any size.

2.6.3 How to obtain TeXtures v1.3 at CERN

CERN has negotiated with Blue Sky Research, the vendor of TeXtures v1.3, a site licence for 300CHF per copy (instead of the full price of close to 1000 CHF). Those interested can buy the product from the AS/MI PC Shop (K. Pluntke, tel. 8191). by sending him a TID for 300CHF. One then gets a copy of the TeXtures v1.3 user's guide, the TeX program (6 double density `3.5"` diskettes), the LaTeX formatter (3 dd diskettes) and a complete set of Computer Modern fonts (10 dd diskettes).

Users of previous versions of TeXtures will be given the new version 1.3 free of charge in return for the *original* Blue Sky diskettes. Those with a "non-official" version of the software are strongly advised to buy the new version: the coexistence of different versions can result in severe compatibility problems with certain transferred files.

Chapter 3: Recommendations for scientific texts

In scientific texts the printed form of a symbol often implies a meaning which is not easily captured by generic markup. Therefore authors using some form of generic coding (like LaTeX or SGML) need to know about typographical conventions.

3.1 Summary of typographic conventions for scientific texts

The following is a brief summary of the most important rules for composing scientific texts[5, 6, 7].

1. The most important rule is **consistency**: a symbol should always be the same, whether is appears in a formula or in the text, on the main line or as a superscript or subscript. This means that in TeX, once a symbol has been defined in mathematics mode ('$'), it should always be used in math mode. Note that inside math mode, TeX by default prints characters in *italics*.

   For scientific work, however, quite a few symbols must be set in **roman** (upright) characters[1]. This is the case for the following families of symbols, which represent the names of:

   - units, such as g, cm, s, keV. Note that physical constants are usually in italics, so units involving constants are mixed roman-italics, e.g. GeV/*c* (where the *c* is italic because it symbolizes the speed of light, a constant);
   - particles, for example p, K, q, H. For elementary particles the PEN (Particle Entity Notation) scheme is proposed (see the next section);
   - standard mathematical functions (sin, det, cos, tan, Re, Im, etc.). Use the built-in LaTeX functions for these (`\sin` etc.);
   - chemical elements, for example Ne, O, Cu;
   - numbers;
   - names of waves or states (p-wave) and covariant couplings (A for axial, V for vector), names of monopoles (E for electric, M for magnetic);
   - abbreviations that are initials of bits of words (exp, for experimental; min, for minimum);
   - the 'd' in integrands (e.g. d*p*).

   In all cases, following these rules will help the reader understand at first glance what the author means. Some instances in which it is important to use the correct symbol, in the correct type, are shown in the table below:

roman type		italic type	
A	ampere (electric unit)	A	atomic number (variable)
e	electron (particle name)	e	electron charge (constant)
g	gluon (particle name)	g	gravitational constant
l	litre (volume unit)	l	length (variable)
m	metre (length unit)	m	mass (variable)
p	proton (particle name)	p	momentum (variable)
q	quark (particle name)	q	electric charge (variable)
s	second (time unit)	s	c.m. energy squared (variable)
t	tonne (weight unit)	t	time (variable)
V	volt (electric unit)	V	volume (variable)
Z	Z boson (particle name)	Z	atomic charge (variable)

[1] With LaTeX, roman type in math mode can be produced by the `\mbox` or `\mathrm` commands.

2. Let the text processor do as much work as it can. Do not try to change the defaults too much; this will decrease the portability and maintainability of your documents. TEX implements a lot of the rules mentioned above by default in math mode.

3. Do not add blanks at random to make formulae look "nicer'‘.

4. Refrain from using specific page layout commands (like `\break` with TEX). You will forget that you put them in your text and later wonder why some text is badly adjusted or starts a new line.

3.1.1 Entity definitions for elementary particles

In texts on high energy physics, frequently re-occurring strings are the names of elementary particles. For example, the Z^0 particle can be coded in various different ways with LATEX: `$\mbox{Z}^0$`, `$\mathrm{Z^0}$` and `Z$^0$` all achieve the same typographical effect, a roman Z with a superscript 0. In the interest of standardization and typing convenience, a "Particle Entity Naming" scheme has been proposed[8]. It not only relieves the user from having to worry about the correctness of what he types, but also will allow an automatic extraction of the particle names from the input file, so that it will be easy to enter data about an article using this convention into a database of abstracts.

The naming scheme uses a notation which takes the following constraints into consideration:

1 The notation should be able to describe all particles in the particle data summary tables from the "Review of Particle Properties"[9] and any future extension to these.

2 The names should not exceed eight characters. This is the maximum length for entities in the SGML reference concrete syntax[10]. Staying within this limit means that the notation can be used with most SGML applications.

3 Common particles such as protons and electrons should have short and simple names.

4 Items that are indicated by superscripts are indicated before items that are indicated by subscripts.

Due to the eight character limitation the mass could not be added to the name. This means that in general an entity on its own is not adequate to unambiguously identify a particle, c.f. η(549) and η(1300) are both referred to as `Pgh`. Including mass dependences into the names is not a good idea anyway, since the mass can change with time when more precise measurements become available. The ambiguity was solved by adding a letter to the end of the name where a mass appears in the name in the particle data summary tables. Thus η(549) is referred to as `Pgh` while η(1300) is referred to as `Pgha`. Higher letters correspond to higher masses, in the order given in the tables.

The PEN scheme is independent of any text processing system. We have implemented it in TEX (in such a way that it may be used in all macro packages, e.g. LATEX) and SGML. The TEX implementation will print particle masses, which will be regularly updated according to the Review of Particle Properties publication. It is constructed so that the PEN name can be used both in mathematics and text mode. For a detailed discussion users should read the original article[8].

Below follow a few examples.

```
\newcommand{\PWm}{\mbox{$\mathrm{W}^-$}}  \newcommand{\PWp}{\mbox{$\mathrm{W}^+$}}
\newcommand{\PZz}{\mbox{$\mathrm{Z}^0$}}
\newcommand{\PMW}{\mbox{$m_{\mathrm{W}}$}}\newcommand{\PMZ}{\mbox{$m_{\mathrm{Z}^0}$}}

The masses of the \PWm, \PWp\ and \PZz\ particles are
\PMW\ and \PMZ\ respectively. In general one has $\PMW > \PMZ$.
```

This yields the following output (apart from the box, which is only used for clarity!):

The masses of the W^-, W^+ and Z^0 particles are m_{W} and m_{Z^0} respectively. In general one has $m_{\mathrm{W}} > m_{\mathrm{Z}^0}$.

It is seen that the commands operate as expected both in math and in text mode.

Chapter 4: NFSS – The New Font Selection Scheme

Frank Mittelbach and Rainer Schöpf have reimplemented the font selection scheme of LaTeX and made it much more flexible. The standard version of LaTeX on Unix and the `NEWLATEX` commands and VXCRNA and IBM VM/CMS use this new font selection scheme (NFSS). Around Easter 1992 the NFSS will also become the default on the latter two central systems. The NFSS in combination with the virtual font mechanism of TeX and the `dvips` dvi to PostScript driver allows the use of native PostScript fonts (as in this manual). For instance the `times` style file, used in the examples of the CERN specific features, defines the text font as Times Roman, the sans-serif font as Helvetica and the teletype font as Courier. This chapter is based on the original article describing the NFSS by Frank and Rainer [11]. It is available as the PostScript file `fontsel.ps` in the standard `psdoc` directories.

The main characteristics of the NFSS are:

- The possibility to change family, series, shape and sizes independently of one another.
- The existence of a style file to process older documents without changes to either layout or input files.
- A macro setup which is consistent with existing standard document styles.

4.1 General remarks

To get a better understanding of this LaTeX interface, some words on the organisation of font families are in order. In his book about "Methods of Book Design" Hugh Williamson writes [12]

> [. . .] To the printer, an alphabet is a set of twenty-six letters of a certain design and body, together with a few additional combinations of letters. A *fount* is usually made up of a set of alphabets of one size and based on one design. It may consist of one alphabet only, if no more alphabets exist in that design and size. Usually however a text fount will comprise five alphabets — roman and italic upper and lower-case, and small capitals. [. . .] A *series* is a set of founts closely related to each other in design, and usually very similar to each other, but graded in size. If only one alphabet has been made in a certain design, that alphabet alone may be a series. A *family* is a group of series compatible for composition, but loosely related in design. A family may include excerpts from more than one series.

Since TeX's physical fonts (which is the American word for fount) all contain exactly two alphabets, namely the upper and lower-case alphabets of a certain design, the word font will be used for physical TeX fonts, and fount for bundles of TeX fonts consisting for example of roman (upright or normal), italic and small capitals shapes.

Weight Class	
Ultralight	ul
Extralight	el
Light	l
Semilight	sl
Medium (normal)	m
Semibold	sb
Bold	b
Extrabold	eb
Ultrabold	ub

Width Class		
Ultracondensed	50%	uc
Extracondensed	62.5%	ec
Condensed	75%	c
Semicondensed	87.5%	sc
Medium	100%	m
Semiexpanded	112.5%	sx
Expanded	125%	x
Extraexpanded	150%	ex
Ultraexpanded	200%	ux

Table 4.1: Weight and width classification for fonts. To combine the abbreviations in the `\fontseries` command, weight is used first and any instance of medium (`m`) is dropped except when weight and width are both medium. In this case one single `m` is used. So bold expanded would be `bx` whereas medium expanded would be `x`.

The above quotation gives a good clue on how to organize fonts in this font selection scheme. The `\fontshape` command will be used to distinguish between normal (n), italic (it), small caps (sc), sloped or slanted (sl) and upright italic (u) typefaces within one fount. Founts of different sizes form a series, and `\fontsize` is used to access these. Weight and the width of a series are good candidates to distinguish between individual series, therefore they are combined in the `\fontseries` command. One and two letter abbreviations identify the series as shown in Table 4.1. One or more of these series form a family which is accessed via the `\fontfamily` command. As an example, Table 4.2 shows the most important families of the Computer Modern fonts, arranged according to this classification.

family	**series**	**shape(s)**	**Example of external names**
Computer modern roman			
cmr	m	n, it, sl, sc, u	`cmr10, cmti10, cmsl10, cmcsc10, cmu10`
cmr	bx	n, it, sl	`cmbx10, cmbxti, cmbxsl`
cmr	b	n	`cmb10`
Computer modern sans serif			
cmss	m	n, sl	`cmss10, cmssi10`
cmss	bx	n	`cmssbx10`
cmss	sbc	n	`cmssdc10`
Computer modern typewriter			
cmtt	m	n, it, sl, sc	`cmtt10, cmitt10, cmsltt, cmtcsc10`

Table 4.2: Classification of the most important fonts of the Computer Modern family.

Given this overview about the classification of fonts, it should be clear how one selects a specific font with the primitive commands `\fontfamily`, `\fontseries`, `\fontshape`, `\fontsize`, and `\selectfont`. As described in [13], the `\fontsize` macro takes two arguments: the size in printer's points as a numeral (i.e. without the dimension) and the corresponding `\baselineskip` value (with a dimension). `\selectfont` finally selects the font using values of the surrounding environment if some of the commands are missing. For example statements like "Concrete roman condensed slanted font at 9pt with 11pt leading"[1] will be translated into command sequences of the form:

```
\fontfamily{ccr}\fontseries{c}\fontshape{sl}\fontsize{9}{11pt}\selectfont
```

This will explicitly load the font mentioned above, provided the necessary font shapes are known to the system.

However, in the normal case, the LaTeX user can safely rely on the standard LaTeX font selection commands defined in terms of these primitive commands. These standard commands are discussed in the next sections.

4.2 Choosing a new text font

In standard LaTeX, different fonts (of the same size) are selected by commands like `\rm`, `\bf`, `\it`, etc. These commands, however, select a specific font regardless of surrounding conditions. E.g., if you write `\sf\bf` you don't get the "bold extended" *series* of the "sans serif" *family* (i.e. `cmssbx`), instead you get the "bold extended" *series* of the "roman" *family* (i.e. `cmbx`). In the present NFSS implementation this is different.

Commands like `\bf` (or `\sf`) are now implemented to switch to the wanted *series* (or *family*, respectively), but to leave the other font characteristics untouched. However, this concept has one drawback in the current LaTeX version: commands like `\footnote` might switch to a smaller size but will inherit other characteristics for the font

[1] This is pronounced "ledding" and measures the distance between the baselines of succeeding lines. To TeX users it is known as `\baselineskip`.

to use from the environment where they are used. E.g., a footnote appearing in the scope of a theorem environment will erroneously be typeset in italic shape. This problem will vanish in LaTeX version 2.10. Until then all font characteristics in such special circumstances must be reset by hand using the commands given below. However, this is not necessary if one uses the "`oldlfont`" style option described in sections 4.4 and 4.5. This option defines the font selection commands to behave in the same way as they did in previous versions of LaTeX 2.09.

4.2.1 Choosing a new *family*

To switch to another *family* one may use `\rm`, `\sf` or `\tt` denoting the "cmroman", "cmsansserif" or "cmtypewriter" *family*, respectively. The new font is selected without changing the current *series*, *shape*, and *size*. E.g., if the current font is `cmbx10` (that is *family* "computer modern roman", *series* "bold extended", *shape* "normal", and *size* "10pt") then `\sf` will change to `cmssbx10` (that is *family* "computer modern sansserif", *series* "bold extended", *shape* "normal", and *size* "10pt"). Using, e.g., `\tt` afterward will produce a warning and switch to `cmtt10` because the "computer modern typewriter" *family* does not contain a "bold extended" *series*; therefore the default ("medium") *series* is tried.

4.2.2 Choosing a new *series*

To switch between "medium" and "bold extended" *series* the commands `\mediumseries` and `\bf` are provided.

4.2.3 Choosing a new *shape*

Analogously the commands `\sl`, `\it`, and `\sc` are used to switch to the *shapes* "sloped", "italic" and "smallcaps", this time leaving *family*, *series*, and *size* alone.
In addition, we introduce the `\normalshape` command, in case one wants to switch back to the "normal" *shape*. If font changes are done only inside of groups this command is necessary only to reset a shape in a footnote or a similar context to avoid the problem mentioned above.

4.2.4 Choosing a new *size*

To change to another *size* the standard LaTeX commands

```
\tiny    \scriptsize  \footnotesize  \small   \normalsize
\large   \Large       \LARGE         \huge    \Huge
```

may be used. These commands also set the parameter `\baselineskip` and the `\strutbox` as well as the script and scriptscript *sizes* for the new text *size*. They will however not change other font characteristics. So, e.g., it doesn't matter whether one writes `\large\tt` or `\tt\large`, the same (teletype) font will be selected. Remember that in previous versions of LaTeX the latter command sequence would have left selected a large roman typeface, as opposed to the former, which selects a large teletype face, which is what is normally wanted.

4.2.5 Doing it by hand

As mentioned before, primitive font selection commands like `\fontfamily`, `\fontseries`, `\fontshape`, `\fontsize`, and `\selectfont` are also available to carry out the change. E.g. to switch to "normal shape cmsansserif" one can type: `\fontshape{n}\fontfamily{cmss}\selectfont`. For full details of the usage of these primitive commands, see the article about the basic macros [13]. Table 4.3 shows the fonts available with LaTeX at CERN.

4.2.6 Changing the meaning of `\rm`, `\sf` etc.

To make it easy to typeset documents with other font families (e.g. Times-Roman) seven additional macros are maintained:

```
\rmdefault  \sfdefault  \ttdefault  \bfdefault  \itdefault  \scdefault  \sldefault
```

They denote the family chosen by `\rm`, `\sf`, `\tt` or the series chosen by `\bf` or the shape for `\it`, `\sc` and `\sl`.

Family	Series	Shape	Name
cmr	m	n	Computer Modern Roman
cmr	m	sl	Computer Modern slanted
cmr	m	it	*Computer Modern italic*
cmr	m	sc	COMPUTER MODERN SMALL CAPS
cmr	m	u	Computer Modern upright italic (substituted cmr,m,n)
cmr	b	n	**Computer Modern bold**
cmr	bx	n	**Computer Modern bold extended**
cmr	bx	sl	**Computer Modern bold extended slanted**
cmr	bx	it	***Computer Modern bold extended italic***
cmss	m	n	Computer Modern sans serif
cmss	m	sl	Computer Modern sans serif slanted
cmss	bx	n	**Computer Modern sans serif bold extended**
cmtt	m	n	`Computer Modern typewriter`
cmtt	m	it	*Computer Modern typewriter italic*
cmtt	m	sl	Computer Modern typewriter slanted
cmtt	m	sc	`Computer Modern typewriter small caps`
cmm	m	it	*ComputerModernmathitalic*
cmm	b	it	***ComputerModernboldmathitalic***
cmsy	m	n	Computer Modern math symbols
cmsy	b	n	Computer Modern bold math symbols
lasy	m	n	LaTeX extra symbols
lasy	b	n	LaTeX bold extra symbols
ccr	m	n	Concrete Roman
ccr	m	it	Concrete italic
ccr	m	sc	Concrete small caps
ccr	c	sl	Concrete condensed slanted
ccm	m	it	Concrete math italic

Table 4.3: Font name assignments made in LaTeX at CERN

If, for example, a document should be typeset in sans serif one could add in the preamble (between `\documentstyle` and `\begin{document}`) the following redefinitions:

```
\renewcommand{\rmdefault}{cmss}
\renewcommand{\itdefault}{sl}
```

The first line means that, whenever `\rm` is called, the family `cmss` (i.e. computer modern sans serif) is chosen and the second line redefines `\it` to switch to the slanted shape, since this family hasn't got an *italic* shape. Another possible use is to say

```
\renewcommand{\bfdefault}{b}
```

This will redefine `\bf` to select the bold instead of the bold extended series which is the current default. However these commands are probably ignored by document styles for journals which decide to use their own font families in the final print.

4.2.7 Using PostScript fonts

At CERN a set of PostScript font definition commands have been loaded at the time the LaTeX format was generated. This allows the user to use PostScript fonts if his dvi-driver is able to handle them. The dvi to PostScript translator `dvips`, which we use at CERN, disposes of the necessary machinery and permits the use of resident (in the printer) or downloadable (from disk) PostScript fonts with LaTeX.

In the preamble of the document the user can specify the three commands described in table 4.4.

`\romanfont`	font to be used for text
`\sansfont`	font to be used for sans-serif
`\typewriterfont`	font to be used for typewriter

Table 4.4: Commands for using PostScript fonts

In particular, the `times` style file, used e.g. in the examples for the CERN LaTeX extensions(see chapter 6, contains the following three definitions:

```
\romanfont{times}        % use Times-Roman for text
\sansfont{helvetica}     % use Helvetica for sans-serif
\typewriterfont{courier} % use Courier as the monospaced teletype font
```

Recently a font naming scheme that can be used by TeX, was proposed by Karl Berry[14]. He tries to classify all font file names using eight alphanumeric characters, where the case is not significant. This guarantees that the same file names can be used across all computer platforms (from VM/CMS and MVS, via Unix and VMS, to MS-DOS and Macintosh). The principle of the scheme is described in Table 4.5, while table 4.6 shows the classification of the 35 “basic” PostScript fonts according to the NFSS scheme. For each font the full Adobe name and, between parentheses, the corresponding short file name is given.

Most of these fonts are present in the ROM of the Apple Laserwriter. Yet it should be realized that not all printers dispose of these fonts. Therefore, if portability of the printed document is important, it is at present wise to stick to the three “basic” PostScript fonts of the `times` style described above. It is also possible, as done in the present manual, to use Times-Roman as text font and the Computer Modern fonts for all other output. In this case only the command `\romanfont{times}` has to be specified in the preamble.

The mapping between the character layout in a PostScript font and the character matrix needed by TeX is performed using the virtual font mechanism [15], which `dvips` understands.

4.2.8 Playing with PostScript

Simple example on how to generate large letters

```
\font\VB=ptmr at 22mm   % declare very big font (Times at 22 mm, K.Berry name 'ptmr')
{\VB Large 22 mm text}
```

Large 22 mm text

LaTeX offers only a certain number of font sizes (see tables 8.1 and 8.2 in section 8.1). When for a particular purpose a non-available type size or a non-preloaded font is needed, then the basic font commands of TeX can be invoked and the `dvips` driver will then include the font at the desired size. In this case K.Berry's short file name as found in table 4.6 should be specified. For more details the reader should consult the `dvips` manual, available in the `docps` directories, which describes not only the (short) names under which the various PostScript fonts are known to the TeX programs but it also shows other tricks, which can be used to get special effects with PostScript.

F	TT	W	V	E	DD
Foundry	Typeface name	Weight	Variant	Expansion	Design Size
e.g. `p`=PostScript	`tm`=Times	`b`=Bold	`i`=Italic	`c`=Condensed	`10`=10 point

Table 4.5: K.Berry's font file name classification scheme

Family	Series	Shape	External names
Serif families			
Times	m	n, it	`Times-Roman(ptmr), Times-Italic(ptmri)`
	b	n, it	`Times-Bold(ptmb), Times-BoldItalic(ptmbi)`
Palatino	m	n, it	`Palatino-Roman(pplr),` `Palatino-Italic(pplri)`
	b	n, it	`Palatino-Bold(pplb),` `Palatino-BoldItalic(pplbi)`
NewCenturySchoolbook	m	n, it	`NewCenturySchlbk-Roman(pncr),` `NewCenturySchlbk-Italic(pncri)`
	b	n, it	`NewCenturySchlbk-Bold(pncb),` `NewCenturySchlbk-BoldItalic(pncbi)`
Bookman	m	n, it	`Bookman-Light(pbkl),` `Bookman-LightItalic(pbkli)`
	b	n, it	`Bookman-Demi(pbkd),` `Bookman-DemiItalic(pbkdi)`
Sans Serif families			
Helvetica	m	n, it	`Helvetica(phvr), Helvetica-Oblique(phvro)`
	b	n, it	`Helvetica-Bold(phvb),` `Helvetica-BoldOblique(phvbo)`
	c	n, it	`Helvetica-Narrow(phvrrn),` `Helvetica-Narrow-Oblique(phvron)`
	bc	n, it	`Helvetica-Narrow-Bold(phvbrn),` `Helvetica-Narrow-BoldOblique(phvbon)`
AvantGarde	m	n, it	`AvantGarde-Book(pagk),` `AvantGarde-BookOblique(pagko)`
	b	n, it	`AvantGarde-Demi(pagd),` `AvantGarde-DemiOblique(pagdo)`
Non-proportional font			
Courier	m	n, it	`Courier(pcrr), CourierOblique(pcrro)`
	b	n, it	`Courier-Bold(pcrb),` `Courier-BoldOblique(pcrbo)`
Special display fonts			
Symbol	m	n	`Symbol(psyr)`
ZapfChancery	m	n	`ZapfChancery-MediumItalic(pzcmi)`
ZapfDingbats	m	n	`ZapfDingbats(pzdr)`

Table 4.6: NFSS classification of the 35 basic PostScript fonts (in brackets K.Berry's file name)

4.2.9 Using the PostScript display fonts

The special PostScript display fonts Zapfdingbats and Symbol are available with the `dingbat` option on the `\documentstyle` command.

4.2.9.1 Accessing the characters in the ZapfDingbats PostScript font

		32	33 ✁	34 ✂	35 ✃	36 ✄	37 ☎	38 ✆	39 ✇
40 ✈	41 ✉	42 ☛	43 ☞	44 ✌	45 ✍	46 ✎	47 ✏	48 ✐	49 ✑
50 ✒	51 ✓	52 ✔	53 ✕	54 ✖	55 ✗	56 ✘	57 ✙	58 ✚	59 ✛
60 ✜	61 ✝	62 ✞	63 ✟	64 ✠	65 ✡	66 ✢	67 ✣	68 ✤	69 ✥
70 ✦	71 ✧	72 ★	73 ✩	74 ✪	75 ✫	76 ✬	77 ✭	78 ✮	79 ✯
80 ✰	81 ✱	82 ✲	83 ✳	84 ✴	85 ✵	86 ✶	87 ✷	88 ✸	89 ✹
90 ✺	91 ✻	92 ✼	93 ✽	94 ✾	95 ✿	96 ❀	97 ❁	98 ❂	99 ❃
100 ❄	101 ❅	102 ❆	103 ❇	104 ❈	105 ❉	106 ❊	107 ❋	108 ●	109 ❍
110 ■	111 ❏	112 ❐	113 ❑	114 ❒	115 ▲	116 ▼	117 ◆	118 ❖	119 ◗
120 ❘	121 ❙	122 ❚	123 ❛	124 ❜	125 ❝	126 ❞			
	161 ❡	162 ❢	163 ❣	164 ❤	165 ❥	166 ❦	167 ❧	168 ♣	169 ♦
170 ♥	171 ♠	172 ①	173 ②	174 ③	175 ④	176 ⑤	177 ⑥	178 ⑦	179 ⑧
180 ⑨	181 ⑩	182 ❶	183 ❷	184 ❸	185 ❹	186 ❺	187 ❻	188 ❼	189 ❽
190 ❾	191 ❿	192 ➀	193 ➁	194 ➂	195 ➃	196 ➄	197 ➅	198 ➆	199 ➇
200 ➈	201 ➉	202 ➊	203 ➋	204 ➌	205 ➍	206 ➎	207 ➏	208 ➐	209 ➑
210 ➒	211 ➓	212 ➔	213 →	214 ↔	215 ↕	216 ➘	217 ➙	218 ➚	219 ➛
220 ➜	221 ➝	222 ➞	223 ➟	224 ➠	225 ➡	226 ➢	227 ➣	228 ➤	229 ➥
230 ➦	231 ➧	232 ➨	233 ➩	234 ➪	235 ➫	236 ➬	237 ➭	238 ➮	239 ➯
240	241 ➱	242 ➲	243 ➳	244 ➴	245 ➵	246 ➶	247 ➷	248 ➸	249 ➹
250 ➺	251 ➻	252 ➼	253 ➽	254 ➾					

Table 4.7: The characters in the ZapfDingbats PostScript font

The directly accessible characters of the PostScript Zapfdingbats font are shown in table 4.7. A giben character can be chosen via the `\ding` command, with as parameter the character number as given in the table. e.g. `\ding{38}` gives ✆. Similarly a line filled with a given character can be obtained with the `\dingline` command, e.g. `\dingline{35}` gives:

✃ ✃

One can define glue filled with a given character with the `\dingfill` command as follows:

```
text text text text text text text text text \dingfill{253}
```

text text text text text text text text text ➽

Finally, to define an `itemize` list using a given symbol, one has the `dinglist` environment:

```
The full list of dingbat font commands are:
\begin{dinglist}{228}
\item  \Lcs{ding} to print the given character
\item  \Lcs{dingline} to have a complete line with the given character
\item  \Lcs{dingfill} to fill the white space with the given character
\end{dinglist}
```

The full list of dingbat font commands are:

➤ `\ding` to print the given character

➤ `\dingline` to have a complete line with the given character

➤ `\dingfill` to fill the white space with the given character

4.2.9.2 Accessing the characters in the Symbol PostScript font

The directly accessible characters of the Symbol font shown in table 4.8 can be used by specifying their number with the `\Symb` command, e.g. `\Symb{224}` would give ◊.

				32		33	!	34	∀	35	#	36	∃	37	%	38	&	39	∍
40	(	41	)	42	∗	43	+	44	,	45	−	46	.	47	/	48	0	49	1
50	2	51	3	52	4	53	5	54	6	55	7	56	8	57	9	58	:	59	;
60	<	61	=	62	>	63	?	64	≅	65	Α	66	Β	67	Χ	68	Δ	69	Ε
70	Φ	71	Γ	72	Η	73	Ι	74	ϑ	75	Κ	76	Λ	77	Μ	78	Ν	79	Ο
80	Π	81	Θ	82	Ρ	83	Σ	84	Τ	85	Υ	86	ς	87	Ω	88	Ξ	89	Ψ
90	Ζ	91	[	92	∴	93	]	94	⊥	95	_	96	‾	97	α	98	β	99	χ
100	δ	101	ε	102	ϕ	103	γ	104	η	105	ι	106	φ	107	κ	108	λ	109	μ
110	ν	111	ο	112	π	113	θ	114	ρ	115	σ	116	τ	117	υ	118	ϖ	119	ω
120	ξ	121	ψ	122	ζ	123	{	124	|	125	}	126	∼						
		161	ϒ	162	′	163	≤	164	⁄	165	∞	166	ƒ	167	♣	168	♦	169	♥
170	♠	171	↔	172	←	173	↑	174	→	175	↓	176	°	177	±	178	″	179	≥
180	×	181	∝	182	∂	183	•	184	÷	185	≠	186	≡	187	≈	188	…	189	⏐
190	—	191	↵	192	ℵ	193	ℑ	194	ℜ	195	℘	196	⊗	197	⊕	198	∅	199	∩
200	∪	201	⊃	202	⊇	203	⊄	204	⊂	205	⊆	206	∈	207	∉	208	∠	209	∇
210	®	211	©	212	™	213	∏	214	√	215	⋅	216	¬	217	∧	218	∨	219	⇔
220	⇐	221	⇑	222	⇒	223	⇓	224	◊	225	〈	226	®	227	©	228	™	229	∑
230	⎛	231	⎜	232	⎝	233	⎡	234	⎢	235	⎣	236	⎧	237	⎨	238	⎩	239	⎪
		241	〉	242	∫	243	⌠	244	⎮	245	⌡	246	⎞	247	⎟	248	⎠	249	⎤
250	⎥	251	⎦	252	⎫	253	⎬	254	⎭										

Table 4.8: The characters in the Symbol PostScript font

When only the Greek letters are desired, then one can use the correspondence in table 4.9 and the `\symbolfont` command, e.g. `{\symbolfont ALJA\quad wmega\quad alja}` would give ΑΛϑΑ ωμεγα αλφα.

a	α	b	β	c	χ	d	δ	e	ε	f	ϕ	g	γ	h	η	i	ι	j	φ	k	κ	l	λ	m	μ
n	ν	o	ο	p	π	q	θ	r	ρ	s	σ	t	τ	u	υ	v	ϖ	w	ω	x	ξ	y	ψ	z	ζ
A	Α	B	Β	C	Χ	D	Δ	E	Ε	F	Φ	G	Γ	H	Η	I	Ι	J	ϑ	K	Κ	L	Λ	M	Μ
N	Ν	O	Ο	P	Π	Q	Θ	R	Ρ	S	Σ	T	Τ	U	Υ	V	ς	W	Ω	X	Ξ	Y	Ψ	Z	Ζ

Table 4.9: Accessing the Greek characters in the Symbol PostScript font

4.3 Fonts for Math

The selection of a specific typeface in a math formula should not depend on the surrounding environment. Characters in math normally denote special things which should stay fixed even if the surrounding text is set in another *shape* or *series*. Therefore the strategy for selecting math fonts is somewhat different.

4.3.1 Simple formulae

Normal letters and standard symbols are typeset by using the letters directly or using a command that denotes the wanted symbol. So `$\sum A_{i}$` will produce $\sum A_i$. The typeface chosen will depend on the current ⟨*math version*⟩. You can switch between ⟨*math versions*⟩ outside of math mode,[2] thereby changing the overall layout of the following formulae.

LaTeX knows about two versions called "normal" and "bold". As the name indicates, `\mathversion{normal}` is the default. In contrast, the bold version will produce bolder letters and symbols. This might be suitable in certain situations like headings, but you should remember that changing the version means changing the appearance (and perhaps the meaning) of the whole formula. If you want to **bolden** only some symbols or characters within one formula you should not change the `\mathversion`. Instead you should define a special math alphabet for characters (see below) and/or use the command `\boldsymbol` which is provided by the document style option `amsbsy`. Historically LaTeX maintains two abbrevations for its math versions: `\boldmath` and `\unboldmath`.

4.3.2 Special math alphabets

However simple formulae with one alphabet and a huge number of symbols are not sufficient for mathematicians to express their thoughts properly. They tend to use every available typeface to denote special things.

To cope with this need for special alphabets in formulae, we introduce the concept of ⟨*math alphabet identifiers*⟩. These constructs are special commands which switch to a specific typeface. They might correspond to different typefaces in different math versions but within one version they always select the same typeface regardless of surrounding conditions.

A ⟨*math alphabet identifier*⟩ can be defined according to the users' needs but standard LaTeX already has a few of them built in (see table 4.10).

`\cal`	calligraphic letters like $\mathcal{ABCD}$
`\mathrm`	upright roman letters for use in functions like $\max_i$
`\mit`	default math italic alphabet.

Table 4.10: The three predefined ⟨*math alphabet identifiers*⟩ in LaTeX

When using such an ⟨*alphabet identifier*⟩, two syntax variants are available: one can understand a command like `\cal` as a switch to a different font, i.e. using a syntax `{\cal ...}` as the old LaTeX does, but the default ⟨*math alphabet identifier*⟩ is a command with one argument, i.e. one must use a syntax of the form `..\cal{A}..` or `..\mathrm{roman text}...` **To select the first alternative a style option "`nomargid`" is provided. This option is automatically selected if the "`oldlfont`" option is used since this option is supposed to produce identical results for older documents.**

New ⟨*math alphabet identifiers*⟩ are defined in two steps. First the identifier is made known to the system with the `\newmathalphabet` command. Then specific typefaces in some or all ⟨*math versions*⟩ are assigned by means of the `\addtoversion` command. As an example let us suppose that one wants to make a sans serif typeface available as a math alphabet. First we choose a new command name (e.g. `\sfmath`) and tell LaTeX with a line:

```
\newmathalphabet{\sfmath}
```

Then we consult table 4.3 to find suitable fonts to assign to this alphabet identifier. This shows that the computer modern sans serif family consists of three series, a medium, semi bold condensed and a bold extended one. The medium and the bold extended series both contain a normal shape typeface. So we add the lines:

```
\addtoversion{normal}{\sfmath}{cmss}{m}{n}
\addtoversion{bold}{\sfmath}{cmss}{bx}{n}
```

[2] This is done with the command `\mathversion{`⟨*version name*⟩`}`.

Now the alphabet identifier is ready for use in these two versions. We demonstrate this with the formula

$$\sum \mathsf{A}_i = \tan\alpha$$

which was produced by: `\[  \sum \sfmath{A}_{i} = \tan \alpha \]`

If we are interested in a slanted shape we have to face a problem: there is no slanted shape in the bold extended series of the Computer Modern sans serif family. So, if we make the identifier known only in the normal version then it would produce an error message when encountered in the bold (or any other) version. Of course we can get by using always the same typeface in all versions. To make this task a bit easier there is also a `*` variant of the `\newmathalphabet` command which takes three more arguments, the default values for family, series and shape for all math versions in which the alphabet identifier is not explicitly defined via an `\addtoversion` command. So the second example can be set up simply by stating

```
\newmathalphabet*{\sfslmath}{cmss}{m}{sl}
```

This has the additional advantage that the math alphabet identifier is also allowed in math versions which are defined in style files or document styles (like the Euler version mentioned earlier). Any explicit `\addtoversion` command overwrites the defaults given by `\newmathalphabet*`; so it might be a good idea always to specify default values. Now we show the same formula as above, but with `\sfslmath` instead of `\sfmath`:

$$\sum \mathsf{\mathit{A}}_i = \tan\alpha$$

4.4 Processing older documents

To typeset documents which are written with the old LaTeX (i.e. with a format using the old font selection scheme), only the source line containing the `\documentstyle` command has to be changed. More exactly the "`oldlfont`" option must be added to the list of document style options if the new font selection scheme is in force.

4.5 List of style files

Styles which can be used together with the NFSS are the following:

- `newlfont` Selects new version of font selection for LaTeX.
- `oldlfont` Selects old version of font selection for LaTeX(see section 4.4).
- `margid` Style file that defines all ⟨*math alphabet identifiers*⟩ to have one argument. This is the default that is built into the new font selection scheme. Therefore this style file is only necessary if the installation decided to load "`nomargid`" at dump time.
- `nomargid` In contrast to `margid`, defines all ⟨*math alphabet identifiers*⟩ to switch to the alphabet. This style option is necessary if one wants to be compatible with the old LaTeX syntax *in math mode only*.
- `tracefnt` Style file that allows the tracing of font usage. Use `\tracingfonts` with values 1 to 3.
- `syntonly` Defines the `\syntaxonly` declaration, which when used in the preamble of a document suppresses all output.

4.6 Warning message

When using the NFSS, the font names listed in an "overfull hbox" message won't look the same as before. Each font name will have the family, series, shape, and size, separated by slashes. For example, 10-point Computer Modern bold extended will appear as `\cmr/bx/n/10`. Formerly it would have appeared as `\tenbf`.

Chapter 5: Merging Graphics and Text

Some TEX macro packages for allow the creation of graphics e.g. LATEX's `picture` environment and its extensions, `epic` and `eepic` or `PiCTeX`. These will not be discussed here. We will describe, however, ways to merge text and graphics, if the latter are prepared as Encapsulated PostScript form.

TEX has a primitive command called `\special`, which allows arbitrary text to be included in the `dvi` file file at the current position. The text given to the `\special` command is **ignored** by TEX itself. This text can however be interpreted by the dvi-driver when it prepares printable or viewable output from the information in the dvi file, in particular it can be used to insert a graphics file. So, the problem of producing proper graphics output is solved if the dvi-driver and the printer can handle a given format.

At CERN the Encapsulated PostScript (EPS) format has been chosen as a standard for pictures, which can be included in PostScript output with the help of the DVI driver `dvips`[1].

The EPS format is a set of rules for writing programs in PostScript[2]. This comment, which must be present in any (see the article in Computer Newsletter 199 about PostScript and EPS). An EPS file starts with two characters `%!` followed by any text, and has some metacomments, starting with `%%`, for instance:

```
%!PS-Adobe-2.0 EPSF-1.2
%%BoundingBox: 40 -505 507 -87
%%Creator:Adobe Illustrator(TM) 1.1
%%Title:elephant.ps
%%CreationDate:25/4/88 7:57 pm
%%DocumentFonts:Courier
%%EndComments
      ...
```

For EPS conformance only the first line and the one containing the `BoundingBox` comment are mandatory. The programs `dvips` which convert a DVI file into PostScript, use the latter metacomment, which specifies the coordinates of the "bounding box" of the picture (see next section).

5.1 What is a bounding box?

In order to be able to properly translate and scale a figure, TEX must know its "natural" position on the page; this information is present in what is called the *bounding box* of a PostScript program. The bounding box is an outer limit to the marks created by a program, and is specified as four coordinates of a rectangle: the lower-left x coordinate (bbllx), the lower-left y coordinate (bblly), the upper-right x coordinate (bburx), and the upper-right y coordinate (bbury). Adobe uses the convention[2] that the bounding box of a PostScript program must be contained in a "bounding box comment" if the file is to be used as an Encapsulated PostScript figure. It is a line of the form:

`%%BoundingBox:` *bbllx bblly bburx bbury*

Note once more that the only mandatory PostScript convention is that the first line of the file should begin with the characters "`%!`" (a "`%`" begins a comment in PostScript). A good place for the bounding box comment is as the second line of the file.

All coordinate values must be given in so-called Big Points (72 big points equal one inch, or 1cm = 28.35 big points), e.g. the bounding box corresponding to an `A4` (210 mm by 297 mm), page is (see table 5.1):

```
%%BoundingBox: 0 0 595 842
```

If a bounding box comment is present in the figure file, the `epsfig` TEX interface (see section 5.2) will extract its values. The bounding box values may instead be specified directly in the `epsfig` argument, using clauses of the form `bbllx=`*bbllx*, `bblly=`*bblly*, ... in which case the figure file is not searched for the bounding box.

[1] For users working on VM/CMS and who only have easy access to an IBM3812 printer, there exists a file `GRAPHTEX TEX` on the minidisk `TEX 501` on VM, which gives an example on how to input a `PSEG38PP` file. Users should be aware however that this method of including graphics information **is not supported**, since the graphic images cannot be scaled and the resolution of these IBM printers is at least 25% lower that of most PostScript printers. Use of those printers should thus be limited to test purposes only.

[2] See "Appendix G: Document Structuring Conventions — Version 3.0" and "Appendix H: Encapsulated PostScript File Format — Version 3.0" in *The PostScript Language Reference Manual* [16]

5.1.1 Calculating the Bounding Box oneself

To find the parameters of the BoundingBox for any plain PostScript picture, print it separately on a PostScript printer, draw a rectangle around it and measure the (x,y) coordinates of the lower left-hand and upper right-hand corners of that rectangle (with respect to the lower left-hand corner of the physical sheet of paper). These four numbers should then be converted to big points and entered on a `BoundingBox` comment line **in the order given above**. Table 5.1 shows the correspondence between minimeters and big points.

	big points (rounded)									
mm	**+1**	**+2**	**+3**	**+4**	**+5**	**+6**	**+7**	**+8**	**+9**	**+10**
0	3	6	9	11	14	17	20	23	26	28
10	31	34	37	40	43	45	48	51	54	57
20	60	62	65	68	71	74	77	79	82	85
30	88	91	94	96	99	102	105	108	111	113
40	116	119	122	125	128	130	133	136	139	142
50	145	147	150	153	156	159	162	164	167	170
60	173	176	179	181	184	187	190	193	196	198
70	201	204	207	210	213	215	218	221	224	227
80	230	232	235	238	241	244	247	249	252	255
90	258	261	264	266	269	272	275	278	281	283
100	286	289	292	295	298	300	303	306	309	312
110	315	317	320	323	326	329	332	334	337	340
120	343	346	349	351	354	357	360	363	366	369
130	371	374	377	380	383	386	388	391	394	397
140	400	403	405	408	411	414	417	420	422	425
150	428	431	434	437	439	442	445	448	451	454
160	456	459	462	465	468	471	473	476	479	482
170	485	488	490	493	496	499	502	505	507	510
180	513	516	519	522	524	527	530	533	536	539
190	541	544	547	550	553	556	558	561	564	567
200	570	573	575	578	581	584	587	590	592	595
210	598	601	604	607	609	612	615	618	621	624
220	626	629	632	635	638	641	643	646	649	652
230	655	658	660	663	666	669	672	675	677	680
240	683	686	689	692	694	697	700	703	706	709
250	711	714	717	720	723	726	729	731	734	737
260	740	743	746	748	751	754	757	760	763	765
270	768	771	774	777	780	782	785	788	791	794
280	797	799	802	805	808	811	814	816	819	822
290	825	828	831	833	836	839	842	845	848	850

Table 5.1: Correspondence between minimeters and big points. Each row shows, going from left to right, the length in big points corresponding to the length in mm of the left column (in bold) incremented by the number of mm shown in the corresponding column of the top row.

5.1.2 Producing Encapsulated PostScript pictures

Pictures stored in GKS metafile format can be transformed into EPS with the `grconv` program (see also 5.3.2). When running `grconv` the output file type `EPS` and run option `SPLIT` should be specified. This procedure will generate as many EPS files as there are plots in the metafile. Each plot can thus be included as an individual picture into the LaTeX document.

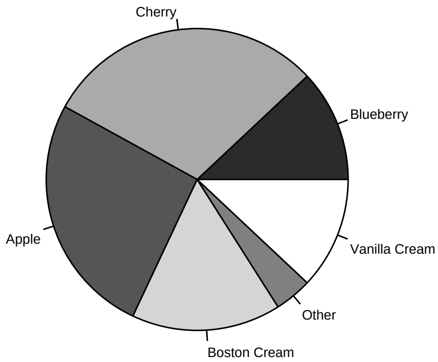
With PAW, workstation type 113 will produce PostScript output with the Boundingbox command parameters included. Below the beginning of a PostScript file generated by this procedure with PAW is shown.

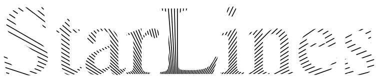
```
%!PS-Adobe-2.0 EPSF-2.0
%%BoundingBox: 0 0 567 567
%%Title: /PAW      PS       A1
%%Creator: HIGZ Version 1.13/00
%%CreationDate: 23/01/92   16.19
%%EndComments
/s stroke def /l lineto def /m moveto def /t  translate def
               ......
```

Other picture formats should first be transformed to PostScript before they can be included easily into LaTeX. Several public domain programs exist to transform popular picture formats into PostScript, e.g. `gif2ps` and `tgifps` for `gif`, `f2ps` for `fig`, `pgmtops` for a portable graymap and `ppmtops` for a portable pixmap (colour is supported). Moreover the utility `XtoPS` dumps an image of an X window as encapsulated Postscript. The image can be colour or grayscale.

5.2 Usage of the epsfig command

The style option `epsfig`, which is based on the `psfig` macros of T.J. Darrell as extended by S. Rahtz, facilitates the inclusion of PostScript figures into TeX documents. With the help of a compatible DVI postprocessor, PostScript figures are automatically scaled and positioned on the page, and the proper amount of space is reserved. Custom characters such as “” and “” may be created and used freely throughout a document, or figures can be presented as traditional broken-out displays:





To include Encapsulated PostScript pictures with `dvips` the style option `epsfig` must be specified as follows:

```
\documentstyle[epsfig,...]{...}
```

The command `\epsfig` is then defined with the following parameters:

```
\epsfig{file=fn,height=ht,width=wd,bbllx=blx,bblly=bly,bburx=brx,bbury=bry}
```

`file` The file name of the Encapsulated PostScript file.

`figure` Alias for `file=`, i.e. the file name of the Encapsulated PostScript figure.

`height` The desired height of the picture (in any of the accepted TEX units). If this parameter is not specified, then the picture will be printed with its "natural" height, i.e. the one specified on the BoundingBox line inside the PostScript file. When a width is specified (see below) and no height, the latter is scaled in the same proportion as the width.

`width` The desired width of the picture (in any of the accepted TEX units). If this parameter is not specified, the picture will be printed with its "natural" width, i.e. the one specified on the BoundingBox line inside the PostScript file. When a height is specified (see above) and no width, the latter is scaled in the same proportion as the height.

`bbllx` The **x**-coordinate of the **lower left** hand corner of the BoundingBox of the PostScript picture.

`bblly` The **y**-coordinate of the **lower left** hand corner of the BoundingBox of the PostScript picture.

`bburx` The **x**-coordinate of the **upper right** hand corner of the BoundingBox of the PostScript picture.

`bbury` The **y**-coordinate of the **upper right** hand corner of the BoundingBox of the PostScript picture.

When the BoundingBox parameters are specified on the `epsfig` command, then the ones inside the PostScript file are ignored. This facility is particularly useful if the BoundingBox parameters are absent from the PostScript file or are wrong. The `\epsfig` macro is (unfortunately) sensitive to whitespace, and will be confused by any extra spaces or newlines in its argument.

5.3 Simple figures

The code below shows the simplest way of how one can include an Encapsulated PostScript file with `epsfig`.

```
\documentstyle[epsfig]{article}
\begin{document}
     .... some  text ....
\epsfig{file=input-file}
     .... some more text ....
\end{document}
```

Here `input-file` is the name of a PostScript file. Epsfig will automatically position the figure at the current point on the page, and reserve the proper amount of space in TEX so as to avoid blocking any other objects on the page.

As a more realistic example let us include a EPS picture (e.g. generated with PAW) and specify the desired height on the output page (if we do not specify any dimensions, the "natural" dimensions of the picture are taken, as read on the `BoundingBox` line in the file, corresponding to the size shown when the picture is printed separately on a PostScript printer). The upper edge of the picture will be located at the point where the command `epsfig` is issued. The graphic will be scaled to the desired width (or height), but it will be scaled by the same factor horizontally and vertically (if only one of the parameters `height` or `width` are specified). The actual commands typed are given below.

```
\begin{figure}
\begin{center}\mbox{\epsfig{file=tac2dim.eps,height=7cm}}\end{center}
\caption{A single centered figure}
\label{fig:simple}
\end{figure}
```

Figure 5.1 shows the resulting picture, with height of the picture equal to 7cm. It is centered by putting it in an `mbox`, which is itself in a `center` environment.

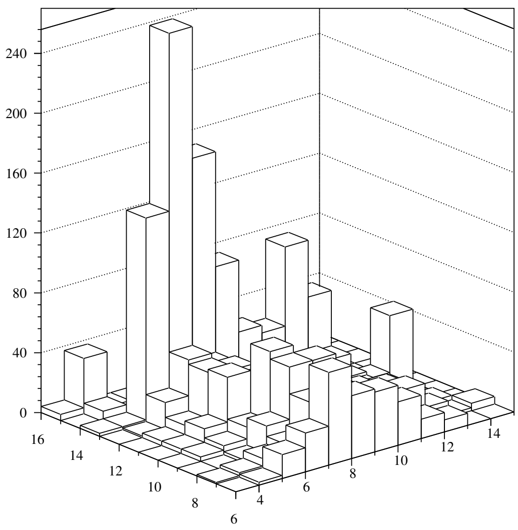


Figure 5.1: A single centered figure

5.3.1 Draft figures and Silent mode

Normally, `epsfig` will print advisory messages to remind you that it is including figures as TeX processes a document. This behaviour can be disabled with `\pssilent` and re-enabled with `\psnoisy`.

Some PostScript figures can take quite a long time to transmit to the printer and print; for these figures a "draft" mode is available to speed printing of draft versions of the document. A figure printed in draft mode will appear as a box with the name of the figure file (Figure 5.2). The macro `\psdraft` will switch into draft mode, and all subsequent `epsfig` macros will produce draft figures until reaching the macro `\psfull`, which switches out of draft mode. No `\special` commands are used in draft mode, so a draft document can be previewed using any DVI driver.

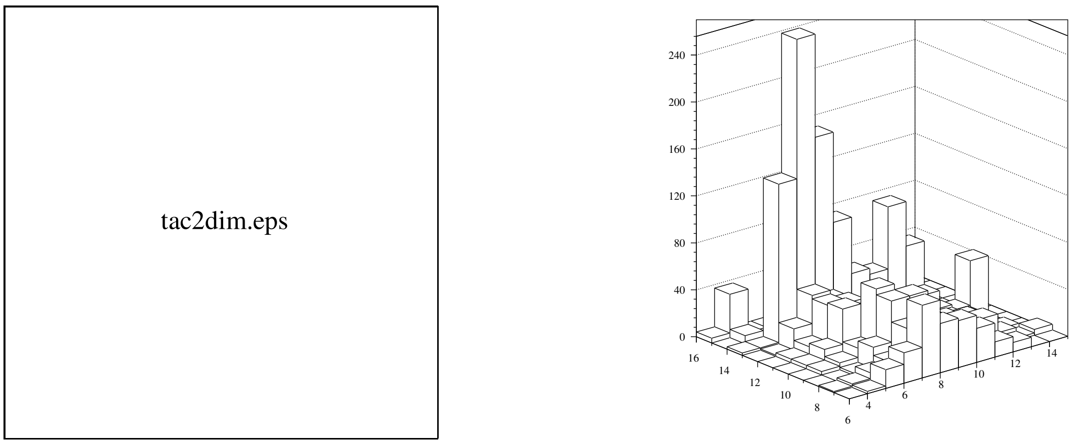


Figure 5.2: A figure in draft (left) and in full (right) mode

5.3.2 Placing PAW and GKS pictures

Pictures in a GKS metafile must first be converted to EPS format using the `grconv` command on VM/CMS, VAX VMS or Unix. The `SPLIT` option, meaning that the pictures will be written into separate files, must be specified. For example on VMS one could type:

```
[DCL $] GRCONV/SPLIT/OTYPE=EPS  filename.metafile
```

With PAW separate Encapsulated PostScript files can be generated directly as explained above.

Figure 5.3 shows how graphics can be introduced in the text (in this case four pictures two by two inside a rectangle `6.5 cm` wide)).

```
\begin{tabular}{||c|c||}                  \hline
   \epsfig{file=f1.eps,width=6.5cm}     &
   \epsfig{file=f2.eps,width=6.5cm}     \\ \hline
   \epsfig{file=f3.eps,width=6.5cm}     &
   \epsfig{file=f4.eps,width=6.5cm}     \\ \hline
\end{tabular}
```

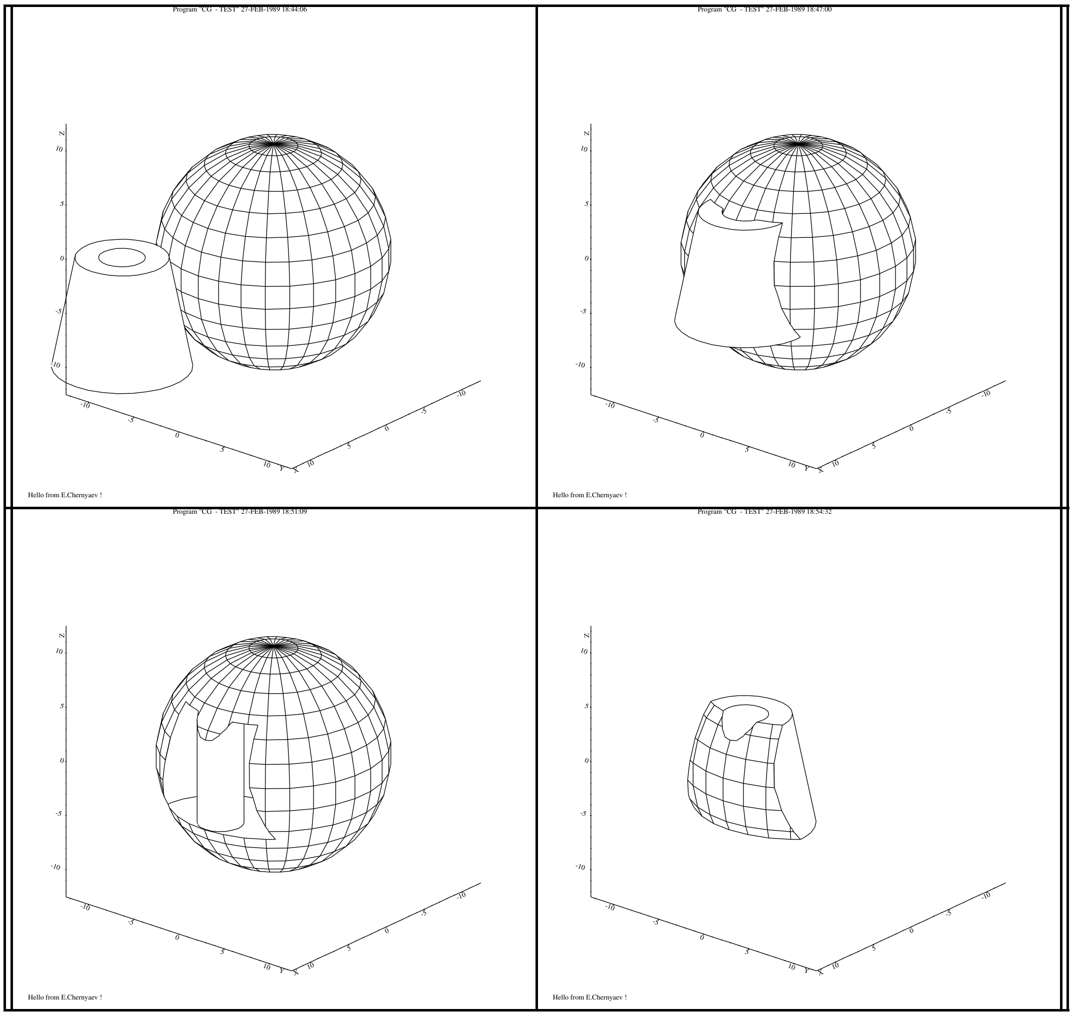


Figure 5.3: Four figures organized in a tabular grid

5.3.3 Distorting a figure

The `\epsfig` command will never distort a picture. If only one of the two dimensions `width` or `height` is specified, the other one is scaled equally. Even by specifying **both** dimensions, `epsfig` will use the more constraining one to define the global scaling factor. Users who want to obtain special effects can use the (undocumented and low level) `\psfig` command, where both dimensions `height` and `width` are taken literally, thus making disproportionate scaling possible. (see figure 5.4).

```
\begin{center}
\mbox{%
\psfig{file=rosette.eps,height=22mm,width=6mm}
\psfig{file=rosette.eps,height=22mm}
\psfig{file=rosette.eps,height=22mm,width=35mm}\qquad
\epsfig{file=rosette.eps,height=22mm,width=6mm}
\epsfig{file=rosette.eps,height=22mm}
\epsfig{file=rosette.eps,height=22mm,width=35mm}
}% end of \mbox
\end{center}
```

Figure 5.4: Distorting (`psfig`) and scaling (`epsfig`) a picture

Chapter 6: CERN extensions

There are some major and minor style files designed for CERN specific documents. They are available on the supported platforms, and have associated example files, which are present in the standard TEX input directories (as shown in table 2.1)

The `times` option used on the `documentstyle` command in the examples tells LATEX to use PostScript fonts instead of the Computer Modern font family. It works only with New Font Selection Scheme (NFSS, see 4.2.7).

6.1 Official CERN letter

This minor style uses the CERN logo which has been programmed in METAFONT by Robin G. Stuart of TH Division. There are only two characters in the font `cernlogo` - upper and lower c.

After defining the font as `\font\Cfont=cernlogo` one can obtain the logo as a $22mm \times 22mm$ square by `{\Cfont C}` or as a $16mm \times 16mm$ square by specifying: `{\Cfont c}`.

`{\Cfont c}` `{\Cfont C}`

The `cernlett` minor style produces the CERN official letter head and has four optional non-standard commands flagged as such in the example below, which is available as a file `cernlett.tex` in the nornal TEX input directories. The generated output is shown on the next page.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                              %
% Example of making an CERNletter with LaTeX                   %
%                                                              %
% Comments to Michel Goossens / GOOSSENS@CERNVM                %
%                                                              %
% Last Mod.  19 Feb. 1992   m.g.                               %
%                                                              %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\documentstyle[12pt,cernlett,times]{letter}
\telephone{7673363}
\ourref{xxx}                          % Non-Standard
\yourref{yyy}                         % Non-Standard
\faxdirect{7838405}                   % Non-Standard
\electronicmail{GOOSSENS@CERNVM.CERN.CH} % Non-Standard
\signature{M. Goossens\\CN Division}
\begin{document}
\begin{letter}{Prof. Donald E. Knuth,\\
               Computer Science Department\\
               Stanford University\\
               Stanford, CA 94305\\
               U.S.A.}
\opening{Dear Professor,}
Is it correct, that \TeX{} is the first English word in computer science?
\closing{Yours sincerely,}
\cc{All \TeX{} users}
\end{letter}
\end{document}
```

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

GENÈVE, SUISSE
GENEVA, SWITZERLAND

Adresse postale / Postal address * :

CERN
CH - 1211 GENÈVE 23

Téléphone / Telephone :
Direct +41 22 7673928
General +41 22 767 6111
Télex / Telex : 419000 CER CH
Télécopieur / Telefax :
Direct +41 22 7830221
General +41 22 767 6555
Electronic mail : GOOSSENS@CERNVM.CERN.CH

Prof. Donald E. Knuth,
Computer Science Department
Stanford University
Stanford, CA 94305
U.S.A.

Votre référence / Your reference yyy
Notre référence / Our reference xxx

2 July 1991

Dear Professor,

Is it correct, that TEX is the first English word in computer science?

Yours sincerely,

M. Goossens
AS Division

cc: All TEX users

* Adresse pour le courrier posté en France: CERN: Site de Prévessin F-01631 CERN CEDEX

6.2 Example of a CERN memorandum

An example of a CERN memorandum is shown below. A longer example is available in the standard TEX input directories in a file `cernmemo.tex`. The resulting output is shown on the next page.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                             %
% Example of making an CERN memorandum with LaTeX             %
%                                                             %
% Comments to Michel Goossens / GOOSSENS@CERNVM               %
%                                                             %
% Last Mod.  July  4  1991  m.g.                              %
%                                                             %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\documentstyle[12pt,times]{cernmemo}
\begin{document}
\copies{Name1 Copy1/AS, Name2-Name3 Family/CN}
\to{
Fname1~Student1/AG, Fname2~Student2/AS, Fname3~Student3/AT,\\
Fname4~Student4/CN, Fname5~Student5/ECP, Fname6~Student6/PE,\\
Fname7~Student7/PPE, Fname8~Student8/SL  }
\from {Michel Goossens /AS-MI}
\subject{LaTeX\ course}
\begin{memo}
Dear Colleague,

You are kindly invited to attend the course ``\LaTeX\ for Beginners''
which starts next Monday, November 5th 1990.

The aim of the course
is to teach the participants (i.e. YOU) to help
yourself if you have problems and to know where to look.

Users can bring specific applications to class
to discuss their problem(s).

The course itself will be structured (approximately)
as follows:

\begin{itemize}
\item {\bf Day 1}  General introduction, principles of use, simple texts.
\item {\bf Day 2}  \LaTeX\ environments.
\item {\bf Day 3}  Constructing tables.
\item {\bf Day 4}  Mathematics.
\item {\bf Day 5}  CERN specific developments and advanced features.
\end{itemize}
The tutorial will be mainly practical and a printer will be available in
the classroom. Students can bring their own documents to work on
if they so desire.

I hope you will be able to attend and look forward to meeting you
next Monday.

\end{memo}
\end{document}
```

Ref: Date: 2 July 1991

MEMORANDUM

From/De	**:**	Michel Goossens /AS-MI
To/à	**:**	Fname1 Student1/AG, Fname2 Student2/AS, Fname3 Student3/AT, Fname4 Student4/CN, Fname5 Student5/ECP, Fname6 Student6/PE, Fname7 Student7/PPE, Fname8 Student8/SL
Subject/Sujet	**:**	LaTeX course
Copies	**:**	Name1 Copy1/AS, Name2-Name3 Family/CN

Dear Colleague,

You are kindly invited to attend the course "LaTeX for Beginners" which starts next Monday, November 5th 1990.

The aim of the course is to teach the participants (i.e. YOU) to help yourself if you have problems and to know where to look.

Users can bring specific applications to class to discuss their problem(s).

The course itself will be structured (approximately) as follows:

- **Day 1** General introduction, principles of use, simple texts.
- **Day 2** LaTeX environments.
- **Day 3** Constructing tables.
- **Day 4** Mathematics.
- **Day 5** CERN specific developments and advanced features.

The tutorial will be mainly practical and a printer will be available in the classroom. Students can bring their own documents to work on if they so desire.

I hope you will be able to attend and look forward to meeting you next Monday.

6.3 Example of making minutes of a meeting

An example of CERN minutes is shown below. A longer example is available in the standard TeX input directories in a file `cernmins.tex`. The resulting output is shown on the next page.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                %
% Example of making  MINUTES  for a meeting with LaTeX           %
%                                                                %
% Comments to Michel Goossens / GOOSSENS@CERNVM                  %
%                                                                %
% Last Mod.  June 13  1991  m.g.                                 %
%                                                                %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\documentstyle[12pt,times]{cernmins}
\begin{document}
\Title{Minutes of the HEP/CCC of Monday October 27th 1986}
\Stitle{CERN/CCC/91-6}
\Those{\bf Present}{P.~Borgeaud (for M.~Banner), M.~Froissart,
H.~Hoffmann, W.~Hoogland (chairman), C.M.~Jones (secretary),
G.~Kalmus, E.~Remiddi (for N.~Cabibbo), F.~Roehner (for H.E.~Stier),
F.~Sacton, J.J.~Thresher, R.~Tirler (for M.~Banner), P.~Zanella}
\Those{\bf Excused}{S.~Loken}
\Those{\bf Invited for specific points\ }{%
R.K.~B\"ock, R.~Brun, B.~Carpenter, J.S.~Hutton, L.M.~Robertson}
\begin{enumerate}
\item Minutes of the last meeting (CCC/CERN/86/04)
\begin{itemize}
\item The Chairman welcomed the new member G. Kalmus from RAL, and
the new secretary C.M.S.
Jones from CERN. He thanked H. Grote for his sterling
work as former secretary.
\end{itemize}
\item Matters arising from the minutes
\begin{itemize}
\item Several members queried the state of the GKS-3D contract
negotiations; who is writing which drivers for which machines, at what cost
and on what timescale.
The relevant specialists not being present at the meeting, it was agreed
to attach this information to the minutes. {\bf Action: CMJ}

                . . . . . . . . . . . . . .

\end{itemize}
\item \ldots
\item Date of the next meeting
\par The next meeting will be held on {\bf Monday 16 March 1987}
at 09:00 in the Director General's conference room in the CERN main
building.
\begin{center}
Recorder: C.M.S. Jones
\end{center}
\end{enumerate}
\end{document}
```

Minutes of the HEP/CCC of Monday October 27th 1986

Present: P. Borgeaud (for M. Banner), M. Froissart, H. Hoffmann, W. Hoogland (chairman), C.M. Jones (secretary), G. Kalmus, E. Remiddi (for N. Cabibbo), F. Roehner (for H.E. Stier), F. Sacton, J.J. Thresher, R. Tirler (for M. Banner), P. Zanella

Excused: S. Loken

Invited for specific points : R.K. Böck, R. Brun, B. Carpenter, J.S. Hutton, L.M. Robertson

1. Minutes of the last meeting (CCC/CERN/86/04)
   - The Chairman welcomed the new member G. Kalmus from RAL, and the new secretary C.M.S. Jones from CERN. He thanked H. Grote for his sterling work as former secretary.
2. Matters arising from the minutes
   - Several members queried the state of the GKS-3D contract negotiations; who is writing which drivers for which machines, at what cost and on what timescale. The relevant specialists not being present at the meeting, it was agreed to attach this information to the minutes. **Action: CMJ**

     . . . .
3. . . .
4. Date of the next meeting
   The next meeting will be held on **Monday 16 March 1987** at 09:00 in the Director General's conference room in the CERN main building.

Recorder: C.M.S. Jones

6.4 Example of making the agenda for a meeting

An example for making the agenda for a CERN meeting is shown below. It is available in the standard TEX input directories in a file `cernagen.tex`. The resulting output is shown on the next page.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                             %
% Example of making an AGENDA for a meeting with LaTeX        %
%                                                             %
% Comments to Michel Goossens / GOOSSENS@CERNVM               %
%                                                             %
% Last Mod.  June 13  1991  m.g.                              %
%                                                             %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\documentstyle[12pt,times]{cernmins}
\begin{document}
\Title{Agenda for the HEP/CCC Meeting}
\begin{flushleft}
{\bf Time:} Monday October 27th 1996 at 9:00\\
{\bf Place:}
Director General's conference room, sixth floor, Main building.
\end{flushleft}
\Those{\bf Invited}{Members of the CCC, L.M.~Robertson,
B.~Carpenter,\\ J.S.~Hutton, R.~B\"ock, R.~Brun, A.~Berglund.}
\begin{itemize}
\item Minutes of the last meeting (CCC/CERN/86/04)
\item Matters arising from the minutes
\item Report on MEDDLE meetings
\item \ldots
\item Date of the next meeting
\end{itemize}
\begin{center}
\bf Secretary: C.M.S. Jones
\end{center}
\end{document}
```

Agenda for the HEP/CCC Meeting

Time: Monday October 27th 1996 at 9:00
Place: Director General's conference room, sixth floor, Main building.

Invited: Members of the CCC, L.M. Robertson, B. Carpenter,
J.S. Hutton, R. Böck, R. Brun, A. Berglund.

- Minutes of the last meeting (CCC/CERN/86/04)
- Matters arising from the minutes
- Report on MEDDLE meetings
- ...
- Date of the next meeting

Secretary: C.M.S. Jones

6.5 Example of a CERN preprint style

A preprint style `cernart.sty` with minor style `12pt` corresponding to the format of preprints, which historically were composed in the "typing pool" of CERN, has been developed. Users can study the example `crnartex.tex` in the standard TeX input directories. This style is quite flexible, to be able to cope with the many types of title pages (from 1 to > 500 authors, coming from few to many institutes . . .). This style should be used for **all** preprints at CERN. For compatibility reasons there exists also minor style options `crna10` and `crna11` which correspond respectively to 10 and 11 point versions of the same CERN style.

It is extremely important to construct your preprint like the example shown, particularly the titlepage, as the central library automatically extracts bibliographic information from the source of your preprint. This can only be done if the authors and institutes, for example, are correctly tagged with the commands `\authlist`, `\Iref` and `\Instfoot`. On request of the library and the publishers, a few commands were added to mark up supplementary information on a title page – `\submitted`, `\collaboration`, `\conference`, `\note` and `\dedicated`. They produce one or more lines of italized centered text at the current vertical location on the output page. The user can specify them in any order and control the amount of white space by adding commands like `\vspace{-5mm}`.

Two forms of a CERN title page layout are shown on the next two pages. The first (Fig. 6.1) is used for a small number of authors, while the second (Fig. 6.2) can be used to cope with a large number of authors and institutes (e.g. the LEP experiments). An agreement has been reached with North Holland Publishing Company, that articles, which are written in "standard" LaTeX and use the proposed markup will be handled within 24 hours.

If you wish to convert your article to Microsoft Word, this can be done, provided you stick to the format of the example.

```
\documentstyle[12pt]{cernart}
\begin{document}
\begin{titlepage}
\docnum{CERN--PPE/91--49}
\date{7 March 1991}
\title{TEST-BEAM PERFORMANCE OF A TRACKING TRD PROTOTYPE}
\begin{Authlist}
J.T.~Shank, J.S.~Whitaker
\Instfoot{a1}{Boston University, Boston, Mass., USA.}
V.A.~Polychronakos,  V.~Radeka,  D.~Stephani
\Instfoot{a2}{Brookhaven National Laboratory, Upton, NY, USA.}
H.~Beker,  R.K.~Bock,  M.~Botlo,  L.~DiCiaccio\Aref{c},
M.~Koratzinos,  A.~Lopez\Aref{*}
\Instfoot{a3}{CERN, Geneva, Switzerland.}
W.J.~Willis
\Instfoot{a4}{Columbia University, New York, NY, USA.}
T.~Akesson
\Instfoot{a5}{Lund University, Lund, Sweden.}
V.~Chernyatin,  B.~Dolgoshein,  P.~Nevski
\Instfoot{a6}{Moscow Physical Engineering Institute, Moscow, USSR.}
\end{Authlist}
\collaboration{Our collaboration}
\begin{abstract}
This sample article shows how to type a CERN PPE preprint using the
standard generic notation for the tagging of authors, institutes
and the likes on the title page. It also teaches how to
include a picture and a table and how to get the typographic type
correct right inside mathematics mode. Furthermore there is a
citation and a bibliography. This ends the funny abstract.
\end{abstract}
\vspace{2cm}
\submitted{(Submitted to some important Journal)}
\conference{To be presented by the author\\
on the conference in somewhere at sometimes.}
\note{NOTE: not yet final}
\dedication{Dedicated to AAA}
\Anotfoot{c}{Univ. di Roma II, `Tor Vergata', Rome, Italy.}
\Anotfoot{*}{On leave from Fac. de Ciencias F\'\i sicas,
Univ. Complutense, Madrid, Spain.}
\end{titlepage}
     main text of article ...
\end{document}
```

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN–PPE/91–49
7 March 1991

TEST-BEAM PERFORMANCE OF A TRACKING TRD PROTOTYPE

J.T. Shank, J.S. Whitaker
Boston University, Boston, Mass., USA.

V.A. Polychronakos, V. Radeka, D. Stephani
Brookhaven National Laboratory, Upton, NY, USA.

H. Beker, R.K. Bock, M. Botlo, L. DiCiaccio[c]), M. Koratzinos, A. Lopez[*])
CERN, Geneva, Switzerland.

W.J. Willis
Columbia University, New York, NY, USA.

T. Akesson
Lund University, Lund, Sweden.

V. Chernyatin, B. Dolgoshein, P. Nevski
Moscow Physical Engineering Institute, Moscow, USSR.

Our collaboration

Abstract

This sample article shows how to type a CERN PPE preprint using the standard generic notation for the tagging of authors, institutes and the likes on the title page. It also teaches how to include a picture and a table and how to get the typographic type correct right inside mathematics mode. Furthermore there is a citation and a bibliography. This ends the funny abstract.

(Submitted to some important Journal)

To be presented by the author
on the conference in somewhere at sometimes.

NOTE: not yet final

Dedicated to AAA

---

c) Univ. di Roma II, 'Tor Vergata', Rome, Italy.
$*$) On leave from Fac. de Ciencias Físicas, Univ. Complutense, Madrid, Spain.

Figure 6.1: CERN preprint title page for many authors

```
\documentstyle[12pt]{cernart}
\begin{document}
\begin{titlepage}
\docnum{CERN--PPE/91--49}
\date{7 March 1991}
\title{TEST-BEAM PERFORMANCE OF A TRACKING TRD PROTOTYPE}
\begin{Authlist}
J.T.~Shank\Iref{a1}, J.S.~Whitaker\Iref{a1},V.A.~Polychronakos\Iref{a2},
V.~Radeka\Iref{a2}, D.~Stephani\Iref{a2}, H.~Beker\Iref{a3},
R.K.~Bock\Iref{a3}, M.~Botlo\Iref{a3}, W.J.~Willis\Iref{a4},
T.~Akesson\Iref{a5}, V.~Chernyatin\Iref{a6}, B.~Dolgoshein\Iref{a6},
P.~Nevski\Iref{a6}, L.~DiCiaccio\IAref{a3}{c},
M.~Koratzinos\IIIref{a3}{b1}{b2} and A.~Lopez\IIAref{a3}{b2}{*}
\end{Authlist}
\begin{abstract}
This sample article shows how to type a CERN PPE preprint using the
standard generic notation for the tagging of authors, institutes and
the likes on the title page. It also teaches how to
include a picture and a table and how to get the typographic type
correct right inside mathematics mode. Furthermore there is a
citation and a bibliography. This ends the funny abstract.
\end{abstract}
\vspace{2cm}% Lower the following text somewhat
%
\submitted{(Submitted to some important Journal)}
%
\Instfoot{a1}{Boston University, Boston, Mass., USA.}
\Instfoot{a2}{Brookhaven National Laboratory, Upton, NY, USA.}
\Instfoot{a3}{CERN, Geneva, Switzerland.}
\Instfoot{a4}{Columbia University, New York, NY, USA.}
\Instfoot{a5}{Lund University, Lund, Sweden.}
\Instfoot{a6}{Moscow Physical Engineering Institute, Moscow, USSR.}
\Instfoot{b1}{Blackett Lab., Imperial College, London, UK.}
\Instfoot{b2}{LAL, IN2P3--CNRS and Univ. Paris-Sud, Orsay, France.}
\Anotfoot{c}{Univ. di Roma II, `Tor Vergata', Rome, Italy.}
\Anotfoot{*}{On leave from Fac. de Ciencias F\'\i sicas,
Univ. Complutense, Madrid, Spain.}
\end{titlepage}
     main text of article ...
\end{document}
```

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN–PPE/91–49
7 March 1991

TEST-BEAM PERFORMANCE OF A TRACKING TRD PROTOTYPE

J.T. Shank[1)], J.S. Whitaker[1)],V.A. Polychronakos[2)], V. Radeka[2)], D. Stephani[2)], H. Beker[3)], R.K. Bock[3)], M. Botlo[3)], W.J. Willis[4)], T. Akesson[5)], V. Chernyatin[6)], B. Dolgoshein[6)], P. Nevski[6)], L. DiCiaccio[3,c)], M. Koratzinos[3,7,8)] and A. Lopez[3,8,*)]

Abstract

This sample article shows how to type a CERN PPE preprint using the standard generic notation for the tagging of authors, institutes and the likes on the title page. It also teaches how to include a picture and a table and how to get the typographic type correct right inside mathematics mode. Furthermore there is a citation and a bibliography. This ends the funny abstract.

(Submitted to some important Journal)

1) Boston University, Boston, Mass., USA.
2) Brookhaven National Laboratory, Upton, NY, USA.
3) CERN, Geneva, Switzerland.
4) Columbia University, New York, NY, USA.
5) Lund University, Lund, Sweden.
6) Moscow Physical Engineering Institute, Moscow, USSR.
7) Blackett Lab., Imperial College, London, UK.
8) LAL, IN2P3–CNRS and Univ. Paris-Sud, Orsay, France.
c) Univ. di Roma II, 'Tor Vergata', Rome, Italy.
$*$) On leave from Fac. de Ciencias Físicas, Univ. Complutense, Madrid, Spain.

Figure 6.2: CERN preprint title page for few authors

6.6 Example of making CERN foils

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                                                      %
% Example of making transparencies with cernfoil.sty                   %
%                                                                      %
% Last Modification: 19 February 1992   m.g.  13:10                    %
%                                                                      %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\documentstyle[cernfoil,epsfig,rotating,example,times]{article}
\author{Michel Goossens}
\begin{document}
\Trtitle{Making foils}%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\begin{titlepage}
\begin{center}
{\huge Making foils with \LaTeX}\\[2cm]
{\LARGE Michel Goossens}\\[1cm]
{\LARGE CN Division}\\[1cm]
\mbox{\epsfig{file=rosette.eps,height=10cm}}\\[1cm]
\end{center}
\Tableofcontents%  Special version of Table of Contents
\end{titlepage}
\sloppy\Large
\Tran{The cernfoil user commands}%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

To make life easier for the users, some simple commands are  defined with the
{\tt cernfoil} style. They all start with an uppercase letter, and are described below.

\begin{verbatim}
  \Trtitle{My title}
\end{verbatim}
Defines the title of the foils. This title will be reproduced
at the center of the bottom line on each foil.

\begin{verbatim}
  \Tr
\end{verbatim}
Start a new page (provides page control).

\begin{verbatim}
  \Tran{Top title}
\end{verbatim}
Goes to a new page, defines the title to be repeated at the top
line on each page and enters the title in the table on contents.

\begin{verbatim}
  \Stitle{Section title}
\end{verbatim}
Writes a section title in boldface centered type, enters   it
in the table of contents but does not begin a new page nor change the
text repeated at the top of each foil.

On top of these commands, the basic \LaTeX{} commands remain
available, but it is recommended to only use the sectioning commands
{\tt\bs Tran} and {\tt\bs Stitle} for making titles and entering
info in the table of contents.
```

```
\Tran{Including pictures in slides}%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\Stitle{A normal, turned and sideways picture}%%%%%%%%%%%%%%%%%%%%%%
In order to obtain the examples below, you must specify the following
style options and use the {\tt dvips} dvi to PostScript driver.

\begin{verbatim}
 \documentstyle[cernfoil,epsfig,rotating]{article}
\end{verbatim}
\begin{example}
---\epsfig{figure=cat.eps,width=4cm}---
\end{example}
\begin{example}
---\begin{turn}{-156}
        \epsfig{figure=cat.eps,width=4cm}
   \end{turn}---
\end{example}
\begin{example}
---\begin{sideways}
        \epsfig{figure=cat.eps,width=4cm}
   \end{sideways}---
\end{example}

\Tran{\LaTeX{} does French and Math}%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\Stitle{Les math\'ematiques: Les structures simples} %%%%%%%%%%%%%%%
Indices et exposants: \verb|_| et \verb|^| :
\begin{center}
\begin{tabular}{r@{\qquad}l@{\hskip2cm}r@{\qquad}l}
$x^y$ & \verb|x^y| &$x_1$ & \verb|x_1| \\[5mm]
$x^{2y+1}$ & \verb|x^{2y+1}| &$x^{y_{i,j_k}}$ & \verb|x^{y_{i,j_k}}| \\[5mm]
$x^y_1$ & \verb|x^y_1|&$x_1^y$& \verb|x_1^y|
\end{tabular}
\end{center}

Le caract\`ere {\tt solidus}  \verb|/| (l'oblique ou le slash)
est utilis\'e pour s\'eparer les deux parties d'une
fraction~: \verb|x/y| qui donne $x/y$.

Gr\^ace \`a la commande \verb|\frac|, de grandes fractions
peuvent \^etre compos\'ees~:

\begin{verbatim}
$$x= \frac{2x + y^2 ( 3x+y )}{2y}$$
\end{verbatim}
$$x= \frac{2x + y^2 ( 3x+y )}{2y}$$

Ou \'egalement $\frac{1}{2}$ : \verb|$\frac{1}{2}$|

Le signe ``racine'' est repr\'esent\'e par \verb|\sqrt|~:

\begin{verbatim}
Une racine carr\'ee $\sqrt{x+y}$ et
la racine d'ordre n $\sqrt[n]{3}$
\end{verbatim}
Une racine carr\'ee $\sqrt{x+y}$ et la racine d'ordre n $\sqrt[n]{3}$
\end{document}
```

Making foils with LaTeX

Michel Goossens

CN Division

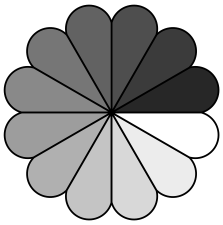


Table of Contents

The cernfoil user commands

The cernfoil user commands

To make life easier for the users, some simple commands are defined with the `cernfoil` style. They all start with an uppercase letter, and are described below.

```
\Trtitle{My title}
```

Defines the title of the foils. This title will be reproduced at the center of the bottom line on each foil.

```
\Tr
```

Start a new page (provides page control).

```
\Tran{Top title}
```

Goes to a new page, defines the title to be repeated at the top line on each page and enters the title in the table on contents.

```
\Stitle{Section title}
```

Writes a section title in boldface centered type, enters it in the table of contents but does not begin a new page nor change the text repeated at the top of each foil.

On top of these commands, the basic LaTeX commands remain available, but it is recommended to only use the sectioning commands `\Tran` and `\Stitle` for making titles and entering info in the table of contents.

February 19, 1992 Making foils-1 Michel Goossens

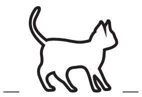
Including pictures in slides

Including pictures in slides

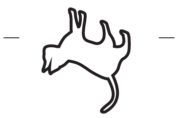
A normal, turned and sideways picture

In order to obtain the examples below, you must specify the following style options and use the `dvips` dvi to PostScript driver.

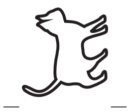
```
\documentstyle[cernfoil,epsfig,rotating]{article}
```



```
---\epsfig{figure=cat.eps,width=4cm}---
```



```
---\begin{turn}{-156}
      \epsfig{figure=cat.eps,width=4cm}
   \end{turn}---
```



```
---\begin{sideways}
      \epsfig{figure=cat.eps,width=4cm}
   \end{sideways}---
```

February 19, 1992 Making foils-2 Michel Goossens

LaTeX does French and Math

LaTeX does French and Math

Les mathématiques: Les structures simples

Indices et exposants: _ et ^ :

x^y	`x^y`	x_1	`x_1`
x^{2y+1}	`x^{2y+1}`	$x^{y_{i,j_k}}$	`x^{y_{i,j_k}}`
x^y_1	`x^y_1`	x^y_1	`x_1^y`

Le caractère `solidus` / (l'oblique ou le slash) est utilisé pour séparer les deux parties d'une fraction : `x/y` qui donne x/y.

Grâce à la commande `\frac`, de grandes fractions peuvent être composées :

```
$$x= \frac{2x + y^2 ( 3x+y )}{2y}$$
```

$$x = \frac{2x + y^2(3x + y)}{2y}$$

Ou également $\frac{1}{2}$: `$\frac{1}{2}$`

Le signe "racine" est représenté par `\sqrt` :

```
Une racine carr\'ee $\sqrt{x+y}$ et
la racine d'ordre n $\sqrt[n]{3}$
```

Une racine carrée $\sqrt{x+y}$ et la racine d'ordre n $\sqrt[n]{3}$

February 19, 1992 Making foils-3 Michel Goossens

Chapter 7: Document Styles and utilities

This chapter describes style files and utility programs, which are not or little described in the LaTeX book. First there are a few extensions made by Lamport himself, then a brief description is given of other style-files, which have been copied to the TeX file base at CERN.

7.1 The Lamport Extensions

7.1.1 The `proc` Style Option

The `proc` option is used with the `article` document style. It produces two-column output for ACM and IEEE conference proceedings. The command `\copyrightspace` makes the blank space at the bottom of the first column of the first page, where the proceedings editor will insert a copyright notice. This command works by producing a blank footnote, so it is placed in the text of the first column. It must go after any `\footnote` command that generates a footnote in that column.

LaTeX automatically numbers the output pages. It's a good idea to identify the paper on each page of output. Placing the command `\markright{Jones---Foo}` in the preamble (before the `\begin{document}` command) prints "Jones—Foo" at the bottom of each page.

7.1.2 The `bezier` Style Option

This option defines a single command, `\bezier`, that draws a curved line in a `picture` environment. Let P_i be the point with coordinates (x_i, y_i), for $i = 1$, 2, and 3. The command

`\bezier{`n`}(`x_1`,`y_1`)(`x_2`,`y_2`)(`x_3`,`y_3`)`

draws n points on the quadratic Bezier spline determined by the three points P_1, P_2, and P_3. The locus of points on this spline is a parabolic arc from P_1 to P_3 having the line P_1P_2 tangent to it at P_1 and the line P_2P_3 tangent to it at P_3. Note that P_2 is *not* on this arc unless P_1, P_2, and P_3 are colinear, in which case the arc is a straight line. Bezier splines are useful because it's easy to join two of them together smoothly by giving them the same tangent line where they meet.

It takes roughly 75 points per inch to form a solid line, depending upon the line thickness. See Section C.13.3 of the manual for commands to specify line thickness in a `picture` environment. This command is *very* slow, and TeX has enough memory to hold only about 1000 points plus a page of text. (Remember that TeX keeps the current page plus all as yet unprinted figures in memory.) So, the `bezier` command should be used for only a small number of small curves.

7.1.3 The `ifthen` Style Option

This option provides two programming language features that are useful only for people who already know how to program. It defines the two commands

`\ifthenelse{`*test*`}{`*then clause*`}{`*else clause*`}`
`\whiledo{`*test*`}{`*do clause*`}`

that implement the following two Pascal language structures

if *test* **then** *then clause*
    else *else clause*
while *test* **do** *do clause*

The *then*, *else*, and *do* clauses are ordinary LaTeX input; *test* is one of the following:

- A relation between two numbers formed with <, >, or =; for example, `\value{page}>3`.
- `\equal{`*string1*`}{`*string2*`}`, which evaluates to *true* if *string1* and *string2* are the same strings of characters after all commands have been replaced by their definitions. (Upper- and lowercase letters are unequal.)
- A logical combination of the above two kinds of tests using the operators `\or`, `\and`, and `\not` and the parentheses `\(` and `\)`—for example:

```
\not \( \value{section} = 1  \and  \equal{Jones}{\myname} \)
```

The *test* argument is a violently moving argument, which means that not only fragile commands but even some commands that are not normally fragile will break, causing TEX to enter an infinite loop. The `\protect` command works in these situations.

These commands, together with `\renewcommand` and the commands of Section C.7.4 for manipulating counters, open up a whole new world of hacking.

7.1.4 The `showidx` Style Option

This style option, for use with the `report` or `book` document styles, causes index entries to be printed in the outer margin. It does not change the effect of `\makeindex`, which controls whether or not an `idx` file file is written. No attempt is made to avoid overprinting marginal notes. This option issues a `\flushbottom` declaration.

7.2 AMS – American Mathematical Society

The complete functionality of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX is now available with the `amstex` option of LATEX, whose facilities are described in chapter 9 and in the document `amslatex.ps`, available in the PostScript documentation repositories on the various systems (table 2.2 on page 5). For those who want to submit articles to AMSjournals, there exist the LATEX styles listed below.

`amsart.sty`	major style for AMS journals.
`amsart10.sty`	minor style for 10pt option of the above.
`amsart11.sty`	minor style for 11pt option of the above.
`amsart12.sty`	minor style for 12pt option of the above.
`amsbook.sty`	major style for AMS book series.
`amsbk10.sty`	minor style for 10pt option of the above.
`amsbsy.sty`	minor style which defines bold math symbols.
`amscd.sty`	minor style which defines commutative diagram macros.
`amssym.sty`	minor style which defines supplementary math macros.
`amssymb.sty`	minor style which defines supplementary math symbol names.
`amstex.sty`	minor style which defines the AMS extensions for use with LATEX.
`amstext.sty`	minor style which defines macros to insert text inside math.

7.3 Elsevier publishing

These are LATEX styles for Nuclear Physics A and Physics Letters.

`fm.sty`	minor style file
`footnote.sty`	minor style file
`np.sty`	major style file for Nuclear Physics A
`np10.sty`	minor style file - setting "10pt" for NP.STY
`pl.sty`	major style file for Physics Letters
`pl10.sty`	minor style file - setting "10pt" for PL.STY
`npsample.tex`	example
`plsample.tex`	example
`supcite.sty`	minor style file

7.4 APS - American Physics Society Journals

The series of journals edited by the American Physics Society, i.e. Physical Review A, B, C and D now accepts compuscripts marked up in LaTeX. At the end of 1991 Physical Review Letters and Reviews of Modern Physics will join the scheme. Please refer to the file `APGUIDE.TEX` in the TeX input directories for more information.

`apguide.tex`	The Tex Author Prepared Input Guide
`aps.sty`	Major style file for APS journals
`aps10.sty`	Minor style file for the above ("10pt" galley output)
`preprint.sty`	Style file for preprints
`revtex.sty`	Minor style file
`smplea.tex`	Brief example of `REVTEX` use
`smpleb.tex`	A complete Physical Review paper, galley format
`smplec.tex`	As `smplec.tex` but in preprint format

7.5 Drawing Feynman diagrams

A package for drawing Feynman diagrams, developed by Michael Levine in 1988, when he was working in the Cavendish Laboratory (Cambridge U.K.) has been installed. Documentation is available as a PostScript file `feynman.ps` in the `docps` directories. This file corresponds to Michael's PhD. thesis and report `Cavendish-HEP 88/11`. The source of this report is also available in TeX's `doc` directory. On Unix please be careful to <u>`uppercase`</u> the name of the files.

`FEYNMAN.tex`	master file to be input when using the system
`feynman.ps`	PostScript file with the description
`doc/feynman/*.tex`	Source for the above.

7.6 LaTeX style file collection

A large collection of LaTeX style files available on various public ftp repositories have been transfered to CERN and are available in the TeX input directories. Whenever you want to know whether a certain minor style has already been developped somewhere, consult table 8.11 on page 57, which contains a list of the files with a short description.

On the VM/CMS system, where filenames are limited to eight characters, the installed version of TeX will take the **first five** and the **last three** letters of a filename with more than eight characters originally. For instance the filename `fancyheadings.sty` on Unix or VMS would be called `FANCYNGS STY` on VM/CMS. This algorithm does in general not concern the user, since one must still use the full name in the TeX input file, e.g.

```
\documentstyle[fancyheadings]{report}
```

7.7 Supplementary utilities

7.7.1 Using `makeindex`

The LaTeX `\index` command only enters information into the `idx` file file. A separate program is needed for sorting this information and putting it in printable form, to be included later in the LaTeX document. One such program is `makeindex`. It generates an `ind` file file and it is described in the separate documents, `makeindex.ps` (`MAKEINDX PS` on VM/CMS) and `index.ps` or in help files.

Markup	Description
`\index{entry}`	Simple one-level entry
`\index{text lev1!text lev2`	Two level entry
`\index{text lev1!text lev2!text lev3}`	Three level entry (maximum three levels allowed)
`\index{entry|(}`	Start of range for `entry`
`\index{entry|)}`	End of range for `entry`
`\index{lexical@actual}`	Sorts as `lexical`, prints as `actual`
`\index{entry|see{other entry}}`	Gives "entry, *see* other entry"
`\index{user"@computer}`	`"` escapes special `\index` characters `|`, `@` and `!`

Table 7.1: Syntax of index entries recognized by `makeindex`

7.7.2 Using BIBTeX

BIBTeX is a program for compiling a reference list for a document from a bibliographic database. It is run by typing

```
bibtex myfile
```

where `myfile.tex` is the name of your LaTeX input file. This reads the file `myfile.aux`, which was generated when you ran LaTeX on `myfile.tex`, and produces the file `myfile.bbl`. BIBTeX should be run from the directory containing `myfile.tex` (which should be the same directory from which LaTeX was run on that file). Do not forget that you will have to run LaTeX at least once (and most probably twice) again, to get the citations correct in your document.

If the `bib` file file is not in the same directory as the LaTeX input file—for example, if you're using someone else's `bib` file file—then you must include the full path as part of the file name specified by the `\bibliography` command. On Unix a `~` cannot appear in the argument of a `\bibliography` command, so you should use a complete path name. For example, the LaTeX command

```
\bibliography{/udir/jones/bibfiles/gnus}
```

specifies the file `gnus.bib` kept by Jones in his `/bibfiles` directory.

There is now no formal provision for sharing bibliographic database information, nor are there programs to assist in making your own `bib` files. For more details the user can print the PostScript files `bibnotes.ps` and `btxdoc.ps`, which are available in the `docps` directories see table 2.2) on the various platforms.

In addition to the bibliography styles described in the manual, there exist a few styles file with filetype `bst` file. Please look in the TeX input directory and for possible accompanying documentation.

Chapter 8: Advanced Features

8.1 Fonts in LaTeX

8.1.1 Minimum available fontset

Tables 8.1 and 8.2 allow you to determine if the font for a type style at a particular size is preloaded, loaded on demand, or unavailable in standard LaTeX. On some platforms more fonts can be available than listed below.

size	default (10pt)	11pt option	12pt option
`\tiny`	5pt	6pt	6pt
`\scriptsize`	7pt	8pt	8pt
`\footnotesize`	8pt	9pt	10pt
`\small`	9pt	10pt	11pt
`\normalsize`	10pt	11pt	12pt
`\large`	12pt	12pt	14pt
`\Large`	14pt	14pt	17pt
`\LARGE`	17pt	17pt	20pt
`\huge`	20pt	20pt	25pt
`\Huge`	25pt	25pt	25pt

Table 8.1: Type sizes for LaTeX size-changing commands.

	\it	\bf	\sl	\sf	\sc	\tt
5pt	D	D	X	X	X	X
6pt	X	D	X	X	X	X
7pt	P	D	X	X	X	X
8pt	P	D	D	D	D	D
9pt	P	P	D	D	D	P
10pt	P	P	P	P	D	P
11pt	P	P	P	P	D	P
12pt	P	P	P	P	D	P
14pt	D	P	D	D	D	D
17pt	D	P	D	D	D	D
20pt	D	D	D	D	D	D
25pt	X	D	X	X	X	X

Table 8.2: LaTeX Font classes: P = preloaded, D = loaded on demand, X = unavailable.

Table 8.1 tells you what size of type is used for each LaTeX type-size command in the various document-style options. For example, with the `12pt` option, the `\large` declaration causes LaTeX to use 14pt type. Table 8.2 tells, for every type size, to which class of fonts each type style belongs. For example, in 14pt type, `\bf` uses a preloaded font and the other five type-style commands use load-on-demand fonts. Roman (`\rm`) and math italic (`\mit`) fonts are all preloaded; the `\em` declaration uses either italic (`\it`) or roman.

8.1.2 Font naming conventions

The raster font files for printing and previewing TeX output have the following parameters:

font_name e.g. CMR - Computer Modern Roman, CMTT - Computer Modern Typewriter Type, etc.

design_size Size of the native font, measured in pt (points), e.g. "10pt". Usually these two parameters are concatenated into the name, e.g. "CMR10".

magnification The font's shapes may be magnified during creation.

coding scheme Three coding schemes exist for raster fonts: `PXL (pixel)`, `PK (packed)` and `GF (generic font)`. The last is the output from METAFONT.

The first three parameters are found in the file name and/or (sub)directory name. Generally for `PK` encoding dots per inch (**dpi** is used e.g. "`CMR10.300`").

8.1.3 Magnification

TeX and LaTeX use magnifications with steps of 1.2^k, where the k is an integer value. This corresponds to TeX's primitive `\magstep k`. Sometimes the magnification $\sqrt(k)$ (`\magstephalf`) is used too. So one should have different fonts files with similar sets of magnification. The common formula for calculating the "digits" for `PK` files for any given magnification m is:

$$N = \lfloor (1.2^m \times R) + 0.5 \rfloor$$

where R is the output device's resolution in dots per inch and $\lfloor x \rfloor$ represents the floor operation, yielding the largest integer $< x$. The unmagnified Computer Modern Roman 10pt font would be found in `CMR10.300PK`, and its `\magstep 5` version would be in `CMR10.746PK`.

Table 8.3 described the magnifications used by a dvi file driver for a laser printer with resolution 300 dpi.

magstep	magnification	scaling factor	for PXL	for PK
	0.50	500	750	150
	0.60	600	900	180
demagnified fonts	0.70	700	1050	210
	0.80	800	1200	240
	0.90	900	1350	270
`\magstep0`	1.2^0	1000	1500	300
`\magstephalf`	$1.2^{0.5}$	1095	1646	329
`\magstep1`	1.2^1	1200	1800	360
`\magstep2`	1.2^2	1440	2160	432
`\magstep3`	1.2^3	1728	2592	518
`\magstep4`	1.2^4	2074	3110	622
`\magstep5`	1.2^5	2488	3732	746
`\magstep6`	1.2^6	2986	4478	895

Table 8.3: Relation between the magstep, magnification, scaling factor and filename extentions for packed and pixel font images

8.1.4 Choosing fonts

In the standard version of LaTeX a new font can be defined with:

```
\newfont{\newname}{fontname scaled scaling factor}
```

A scaled font is not identical to a font specifically constructed for a given size, as shown in the following example.

cmr17 unscaled

cmr10 scaled 1700

```
\newfont{\mifont}{cmr17}
\newfont{\myfont}{cmr10 scaled\magstep3}
\mifont cmr17 unscaled   \\[5mm]
\myfont cmr10 scaled 1700
```

8.2 TeX units for measuring lengths

Lengths can be specified to TeX in various units, as shown in Table 8.4. The conversion factors between these units are shown in Table 8.5.

`in`	Inch = 25.4 mm
`cm`	Centimeter = 10 mm
`mm`	Millimeter
`pt`	Point = $\frac{1}{72.27}$ in $\approx \frac{1}{3}$ mm
`pc`	Pica = 12pt
`bp`	Big point (72 bp = 1 in) PostScript point
`dd`	Didôt point = $\frac{1}{72}$ of a French inch, ≈ 0.376 mm
`cc`	Cicero = 12dd
`em`	Width of the capital “M” in the current font
`ex`	Height of a small “x” for the current font

Table 8.4: Possible TeX units of length

	pt	dd	pc	cc	mm	in
pt	1.0	0.935	0.083	0.078	0.351	0.014
dd	1.070	1.0	0.089	0.083	0.376	0.015
pc	12.0	11.215	1.0	0.935	4.218	0.166
cc	12.840	12.0	1.070	1.0	4.531	0.178
mm	2.845	2.659	0.237	0.222	1.0	0.039
cm	28.453	26.591	2.371	2.216	10.0	0.394
in	72.27	67.542	6.022	5.628	25.4	1.0

Table 8.5: Conversion factors between TeX units of length

8.2.1 Horizontal space

A horizontal space is produced by the `\hspace` command. Beware of spaces in front and after the `\hspace` command. The command `\hspace*` is the same as `\hspace`, but the space it generates is not removed, even at the start of a line. Table 8.6 shows horizontal space commands known to LaTeX. The table is followed by an example using “stretchable glue”.

```
Here\hspace{0.5in}is a .5 inch space.
Here \hspace{0.5in}is a .5 inch space.
Here \hspace{0.5in} is a .5 inch space.
```

Here   is a .5 inch space.
Here   is a .5 inch space.
Here   is a .5 inch space.

`\enspace`	yields a space equal to half a quad
`\quad`	yields a space equal to the value of the point-size
`\hfill`	horizontal “glue”, corresponding to a distance between 0 and ∞.

Table 8.6: Predefined horizontal spaces

```
\begin{center}
left\hfill right
\end{center}
```

left right

8.2.2 Vertical space

A vertical space is produced with the `\vspace` command, which works similarly to `\hspace`. In particular a `\vspace*` command, will generate vertical space, even at the top of a page. Table 8.7 shows vertical space commands known to LaTeX. The action of the various commands is shown in a text sample which follows the table.

name	description	actual value	size
`\smallskip`	$\approx \frac{1}{4}$ of lineskip	`3.0pt plus 1.0pt minus 1.0pt`	
`\medskip`	$\approx \frac{1}{2}$ of “standard” interlinespace	`6.0pt plus 2.0pt minus 2.0pt`	
`\bigskip`	$\approx$ “standard” interlinespace	`12.0pt plus 4.0pt minus 4.0pt`	

Table 8.7: Predefined vertical spaces

This is the text in a sentence. This is the text in a sentence. This is the text in a sentence. This is the text in a sentence.

This is the text in a sentence. This is the text in a sentence. This is the text in a sentence. This is the text in a sentence.

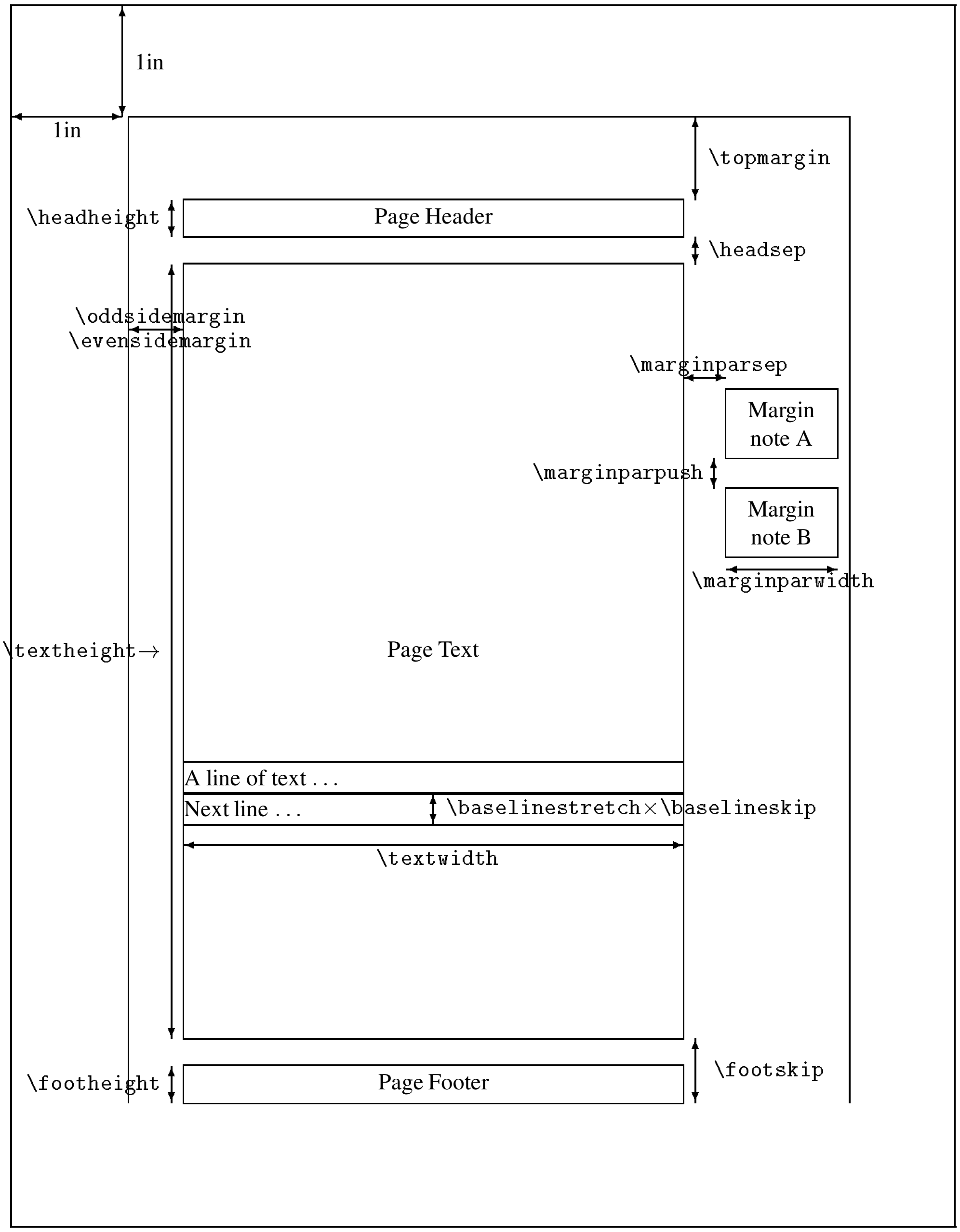
This is the text in a sentence. This is the text in a sentence. This is the text in a sentence. This is the text in a sentence.

This is the text in a sentence. This is the text in a sentence. This is the text in a sentence. This is the text in a sentence.

This is the text in a sentence. This is the text in a sentence. This is the text in a sentence. This is the text in a sentence.

```
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
\par\vspace{6mm}\noindent
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
\par\smallskip\noindent
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
\par\medskip\noindent
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
\par\bigskip\noindent
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
 This is the text in a sentence.
```

8.2.3 Changing the dimensions on a page



Example of how to use these page layout parameters:

```
\setlength{\textwidth}{160mm}           % Width of text
\setlength{\textheight}{210mm}          % Height of text
\setlength{\footheight}{2\baselineskip} % Height of footer information
\setlength{\footskip}{3\baselineskip}   % Depth of footer
\setlength{\headheight}{2\baselineskip} % Height of header information
\setlength{\headsep}{2\baselineskip}    % Separation text/header
\setlength{\topmargin}{0pt}             % Separation page top/header
```

8.3 The new LaTeX developments

8.3.1 NFSS – The New Font Selection Scheme

Frank Mittelbach and Rainer Schöpf have reimplemented the font selection scheme of LaTeX and made it much more flexible. The January 1992 version of LaTeX installed at CERN uses the NFSS scheme by default. It allows together with the virtual font mechanism of TeX and the `dvips` dvi to PostScript driver the use of native PostScript fonts for the text (as done in this manual). For instance the `times.sty` style file, used in the examples of the CERN specific features, defines the text font as `Times-Roman`, the sans-serif font as `Helvetica` and the teletype font as `Courier`.

Table 8.8 shows the most important commands of the NFSS scheme. For more details see chapter 4 and the file `fontsel.ps`, which can be found in the standard `psdoc` directories.

`\fontfamily{ccr}`	Change font family to `ccr`
`\fontseries{c}`	Change font series condenced
`\fontshape{sl}`	Change font shape to slanted
`\fontsize{9}{11pt}`	Change font size and leading
`\selectfont`	Load the font selected
`\rm, \sf, \tt`	Change font family (implicitly)
`\rmdefault`	Specify default family for `\rm`

Table 8.8: Main commands of the new font selection scheme - NFSS

8.3.2 The `array` style

Frank Mittelbach and Rainer Schöpf have extended the LaTeX `tabular` and `array` environments by providing a new style `array`. They introduce a parameter called `\extrarowheight`, which takes a positive length, whose value is added to the normal height of every row of the table, while the depth will remain the same. This is important for tables with horizontal lines because those lines normally touch the capital letters. For example, `\setlength{\extrarowheight}{1pt}` is used in the table below:

`m{width}`	Defines a column of width `width`. Every entry will be centered in proportion to the rest of the line. It is somewhat like `\parbox{width}`.
`p{width}`	Equivalent to `\parbox[t]{width}`.
`b{width}`	Coincides with `\parbox[b]{width}`.
`>{decl.}`	Can be used before an `l`, `r`, `c`, `p`, `m` or a `b` option. It inserts `decl.` directly in front of the entry of the column.
`<{decl.}`	Can be used after an `l`, `r`, `c`, `p{..}`, `t{..}` or a `b{..}` option. It inserts `decl.` right after the entry of the column.
`|`	Inserts a vertical line. The distance between two columns will be enlarged by the width of the line in contrast to the original definition of LaTeX.
`!{decl.}`	Can be used anywhere and corresponds with the `|` option. The difference is that `decl.` is inserted instead of a vertical line, so this option doesn't suppress the normally inserted space between columns in contrast to `@{...}`.

Table 8.9: Supplementary preamble commands in the `array` style

A few examples on how to use the new preamble commands are given below:

- If you want to use a special font, (for example `\bf`) in a flushed left column, you can do it with `>{\bf}l`. You do not have to begin every entry of the column with `\bf` any more.
- In columns which have been generated with `p`, `m` or `b`, the default value of `\parindent` is `0pt`. This can be changed with `>{\setlength{\parindent}{1cm}}p`.
- The <–option was originally developed for the following application: `>{$}c<{$}` generates a column in math mode in a `tabular`–environment. The use of this type of preamble in an `array`–environment results in a column in LR mode because the additional \$'s cancel the existing \$'s.
- Using `c!{\hspace{1cm}}c` gives space between two columns which is enlarged by one centimeter, while `c@{\hspace{1cm}}c` yields exactly one centimeter space between two columns.

Note that with the `array` option the width of the rule (by default .4pt) is taken into account in the calculation of the table's width (this is not the case in "standard" LaTeX).

8.3.3 Other new styles

Frank and Rainer created some more new styles (table 8.10) in the framework of the development of LaTeX3.

Environment for multi-column output (see document `multicol.ps`)	
multicol	Option to be specified on `\documentstyle`
\begin{multicols}% {<number>} <multicolumn text> \end{multicols}	Use of a multicolumn `multicols` environment, where `<number>` indicates the number of columns and `<multicolumn text>` can contain arbitrary LaTeX commands, except floats and marginpars.
Footnotes in multi-column layout (see document `fntright.ps`)	
ftnright	Option to be specified on `\documentstyle`
Extended Theorem environment (see document `theorem.ps`)	
theorem	Option to be specified on `\documentstyle`
`\newtheorem ...`	defines new `theorem` like structure
`\theoremstyle{style}`	defines theorem layout
`\theorembodyfont{font}`	chooses font for theorem body
`\theoremheaderfont{font}`	ditto for theorem head
`\theorempreskipamount`	LaTeX length for space in front of theorem
`\theorempostskipamount`	ditto following theorem
Extended verbatim environment (see document `verbatim.ps`)	
verbatim	Option to be specified on `\documentstyle`
\begin{verbatim} <lines of text> \end{verbatim}	Works like original `verbatim`
\begin{comment} <lines of text> \end{comment}	Ignores all text lines
`\verbatiminput{xx.yy}`	Reads file `xx.yy` in verbatim.

Table 8.10: Further new styles with LaTeX

8.4 A tabular overview of available style files

A list of minor style files available at CERN can be found in Table 8.11 on the following pages.

Table 8.11: List of available minor style files

File name	Description
a4.sty	Set page size to A4
a4wide.sty	Set page size to A4 with narrow margins
a5.sty	Sets A5 page size (use only with 10pt)
a5comb.sty	Sets A5 page style but for spirally-bound documents (bigger inner margins)
aip.sty	For American Institute of Physics journals
album	Style for printing cassette labels
alleqno.sty	Makes all displayed equations numbered by default
alltt.sty	Like verbatim, but permits other commands inside
amssymbols.sty	Load AMS font
apalike.sty	For American Psychological Association. (BibTeX style in bibtex-style)
apl.sty	For typesetting APL
apsabstract.sty	For American Physical Society meetings
array.sty	Frank Mittelbach's reimplementation of tabular
asaetr	Transactions of the ASAE (American Society for Agricultural Engineers)
biihead.sty	Underlined heading
boxedminipage.sty	Puts a box round a minipage
breakcites.sty	Allows citations to break across lines
bsf.sty	Provide access to bold san serif fonts in LaTeX
captcont.sty	Captions in continuations of floats
catmac.sty catmac-doc.tex	Commutative diagram macros
cd.sty cd-doc.tex	More commutative diagram macros
changebar.sty	Changebars for LaTeX
chapterbib.sty	Allow LaTeX & BibTeX to produce separate bibliographies for each chapter.
cite.sty	Compress lists of numbers in citations to ranges, and allow linebreaks with difficulty
cup.sty	Document style for books in the Cambridge University Press, British Computer Society Workshop series.
cyrillic.sty	Load Cyrillic font
doublespace.sty	Double spacing in text
draft.sty	Draft option for documents for "debugging"
drafthead.sty	Prints DRAFT in heading
drop.sty	Style for making large dropped initials for starting paragraphs
dspc.sty	Style to produce double-spaced document
ecl	Draw graphs and trees
env.sty	Style files to print on envelopes
equations.sty	Macros to aid in constructing displayed equations in LaTeX
espo.sty	Style file for Esperanto
fancyheadings.sty	Modify the headers and footers
farticle.sty	French version of article.sty
fixup.sty	Fixup Plain's `\bigl`, etc. to track LaTeX size changes
flowchart.sty	Macros to write flow charts

Table 8.11: List of styles (continued)

File name	**Description**
fnpara.sty	Sets footnotes as parapraphs
format.sty	Print FP numbers in fixed format
frenchponct.sty	French punctuation
frontiers.sty	For Frontiers '88 symposium and other IEEE conferences
fullpage.sty	Get more out of a page
geophysics.sty	Geophysics journal style
german.sty	Style file for German
hackalloc.sty	Make allocation local for LaTeX
headerfooter.sty	Adds the capability of underlining the heading, like the LaTeX manual
iso.sty iso9.sty iso-doc.tex	For use by those writing ISO standards
jbs.sty	For the Journal of Business Strategies
jeep.sty jeep.tex	Useful modifications of the article style
jmb.sty	Journal of Molecular Biology
layout.tex layout.readme	Prints nice diagram showing page parameters
lablst.sty	For printing label definitions at the end of the document
lcustom.tex	Useful macros and definitions for LaTeX
local-suppl.tex	Supplement to local guide that describes lcustom.tex sfwmac.sty tgrind.sty trademarks.sty xxxcustom.tex xxxslides.sty
longtable.sty longtable.tex	For tables which can be broken across pages; works with F.M.'s array.sty
ltugbot.sty	For articles to tugboat
manual	Like "book" but for manuals Need to look at "book" for documentation
memo.sty	Memo and memo for the record style option
mfr.sty	
merge.sty	Form letter option to LaTeX letter style
mf.sty	Make METAFONT logos at all sizes
mitpress.sty	Simple MIT Press format
mitthesis-sample.tex mitthesis.sty	Massachusetts Institute of Technology thesis format
multibox.sty	Provides multiple boxes in pictures
nl.sty	Style file customized for Dutch
nofm.sty	For "n of M" style pagination
nopagenumbers.sty	Remove page numbers
overcite.sty	Give superscript numbers for citations, compressing lists to ranges, and move past punctuation
oxford.sty	Oxford University Press
pagefoots.sty	Puts footnotes at the bottom of each page
parskip.sty	Sets parindent to 0 and puts some glue into parskip to aid page breaks
portland.sty	Environments to switch between portrait mode and landscape mode
refman.sty	Document style for reference manuals similar to the PostScript manual
remark.sty	Like newtheorem but no \it

Table 8.11: List of styles (continued)

File name	Description
res-sample.tex res.sty	Format for doing resumes by Michael DeCorte
resume-sample.tex resume.sty	Format for doing resumes by Stephen Gildea
romanneg.sty	Roman-numbered pages get negative page numbers (useful when selecting only part of a document to be printed)
schedule.sty	Style for generating schedule sheets
screen.sty	Helps create a document suitable for screen previewing
semitic.sty	Used to set Semitic languages
sfwmac.sty	Useful macros for Unix documentation
shadow.sty	Put a box with a shadow around text
showlabels.sty	Shows labels and references to them
slem.sty	Change `\sl` to `\em`
spacecites.sty	Modified to give spacing between citations
subeqn.sty	Allows related equations to be numbered with the same number but is further qualified by a,b,c etc.
subeqnarray.sty	Allows related eqnarrays to be numbered with the same number but is further qualified by a,b,c etc.
subfigure.sty	Allows related figures to be numbered with the same number but is further qualified by a,b,c etc.
supertab.sty	Allows multipage tabulars
suthesis.sty	Stanford U thesis style
svma-doc.tex svma.sty	Style for Springer-Verlag reports, multi-author
svsa.sty	Ditto for single author
tables-doc.tex tables.sty	Ruled and unruled tables made easy
tabls.sty	Simulate minimum-lineskip glue in tabular environments
texnames.sty	Define a couple more TeX names
tgrind.sty	Tgrind macros for LaTeX instead of TeX
threepart.sty	Three part page headers
trademarks.sty	Definitions of common trademarks
twoup.sty	Change the page sizes so that 2 pages can fit onto one with the help of dvidvi
ucthesis	U of California thesis style
ukdate.sty	Changes the `\today` command to UK style
ulem.sty	Use underlining for `\em`-phasis
usenix.sty	For Usenix conference proceedings
vdm-doc.tex vdm.sty	Vienna Development Method LaTeX style and documentation
verbatimfiles.sty	include a file in a verbatim mode

8.5 The babel system for multi-language LaTeX

The standard distribution of LaTeX contains a number of document styles `article` and friends, which were developed by Leslie Lamport for American tastes and they contain a number of hard-wired texts. The babel system provides a set of document-style options that can be used in combination with the standard styles, which makes these texts adaptable to other languages.

The user interface of this system of style options is quite simple. It consists of only two commands. These commands can be used to select another language or to find out what the current language is.

`\selectlanguage`

This command allows the user to switch from one language to another. This macro uses the language, defined previously by a language-specific option, as its argument. It calls several macros that should be defined in the language-specific files to activate the special definitions for the language chosen.

`\iflanguage`

If more than one language is used it might be necessary to know which language is active at a specific time. This can be checked by a call to `\iflanguage`. This macro takes three arguments. The first argument is the name of a language, the second and third arguments are the actions to take if the result of the test is `true` or `false` respectively.

The following languages are at present supported:

- Esperanto,
- Dutch, English, German (`germanb`),
- French (`francais`), Italian, Portuguese (`portuges`), Romanian, Spanish (with its "dialect" Catalan),
- Danish, Norwegian (`norsk`), Swedish,
- Finnish, Hungarian (`magyar`),
- Croatian, Czech, Slovene,
- Russian (transliteration not yet completely fixed)

Between parentheses the style option to be specified if different from the language's name.

8.5.1 Example

You would call the style file option(s) as:

```
\documentstyle[ ... ,francais,germanb]{report}
```

In this case the "current" language will be `German` (the last language option specified). To switch to French, one must use the command `\switchlanguage{francais}`.

There are two files `babelexa.tex` and `babellet.tex` which show in a simple way how the system can be used.

8.5.2 Caveats

If someone uses a document-style option like `openbib.sty` which produces another layout of the bibliography, `babel` will not function correctly. The reason for this is that the macro `\thebibliography` receives a modified definition. When `babel.sty` is read *before* `openbib.sty` the title of the bibliography will always be the same. When `openbib.sty` is read first, its definition will be superseded by the definition as it is included in `babel.sty`.

The only solution to this problem would be to modify *all* standard LaTeX document styles and document-style options as was done by Joachim Schrod's `ilatex`. *But* this should be done in the officially distributed versions of the files. In principle internationalization will be part of LaTeX version 3.xx.

8.6 Rotating material with dvips

The rotating style file (by S. Rahtz) defines three environments, which make it possible to rotate information in LaTeX documents in a simple way. The style option must be specified on the \documentstyle command as a minor style

```
\documentstyle[..,rotating,..]{article}
```

8.6.1 The rotate environment

"Rotate" provides a generalised rotation environment, where the text will be rotated (clockwise, as is normal in PostScript) by the number of degrees specified as a parameter to the environment, but no special arrangement is made to find space for the result. Note the % at the end of \begin{rotate}{56} — this is vital to prevent a space getting into the rotated text.

Start here End here
Save whales

```
Start here
  \begin{rotate}{56}%
   Save whales
  \end{rotate}
End here
```

8.6.2 The turn environment

If the user desires LaTeX to leave space for the rotated box, then "turn" is used:

Start here Save the whale end here

```
 Start here \begin{turn}{-56}%
   Save the whale
  \end{turn} end here
```

8.6.3 The sideways environment

The environment "sideways" is a special case, setting the rotation to -90, and leaving the correct space for the rotated box.

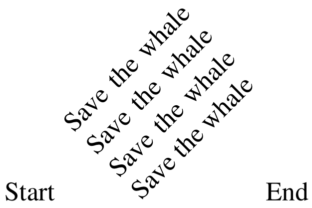
Start here Save the whale End here

```
Start here
\begin{sideways}%
Save the whale
\end{sideways}
End here
```

If you deal with whole paragraphs of text, you realize that TeX boxes are not as simple as they sometimes look: they have a height *and* a depth. So when you rotate, you rotate about the point on the left-hand edge of the box that meets the baseline. The results can be unexpected, as shown in the full set of paragraph rotations in Figures 8.1 and 8.2. If you really want to turn a paragraph so that it appears to rotate about the *real* bottom of the TeX box, you have to adjust the box in the normal LaTeX way:

Start
Save the whales
Save the whale
Save the whale
Save the whale
End

```
\newsavebox{\foo}
\savebox{\foo}{\parbox{1in}{Save
the whales Save the whale
Save the whale
Save the whale}}%
Start
\begin{turn}{-45}\usebox{\foo}\end{turn}
End
```




```
\savebox{\foo}{\parbox[b]{22mm}{Save
the whale Save the whale
Save the whale
Save the whale}}%
Start
\begin{turn}{-45}\usebox{\foo}\end{turn}
End
```

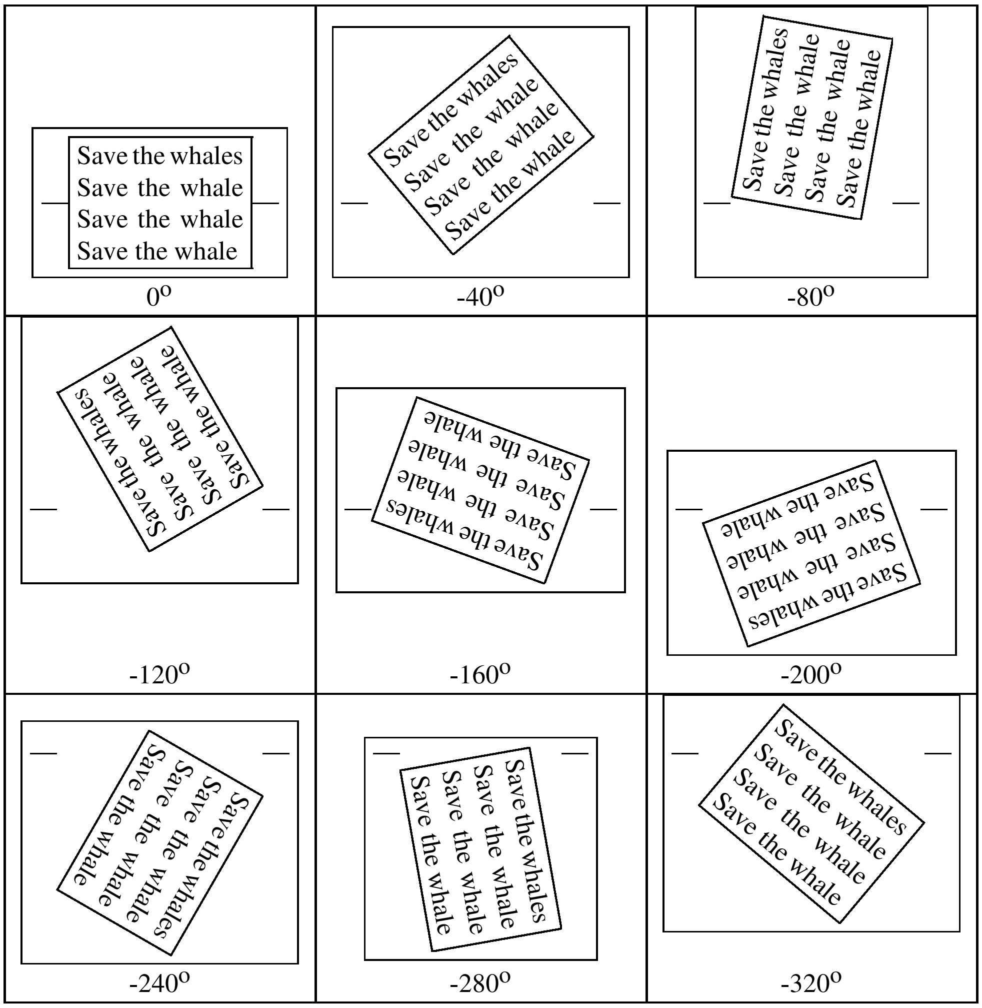


Figure 8.1: Rotation of paragraphs between 0 and -320°

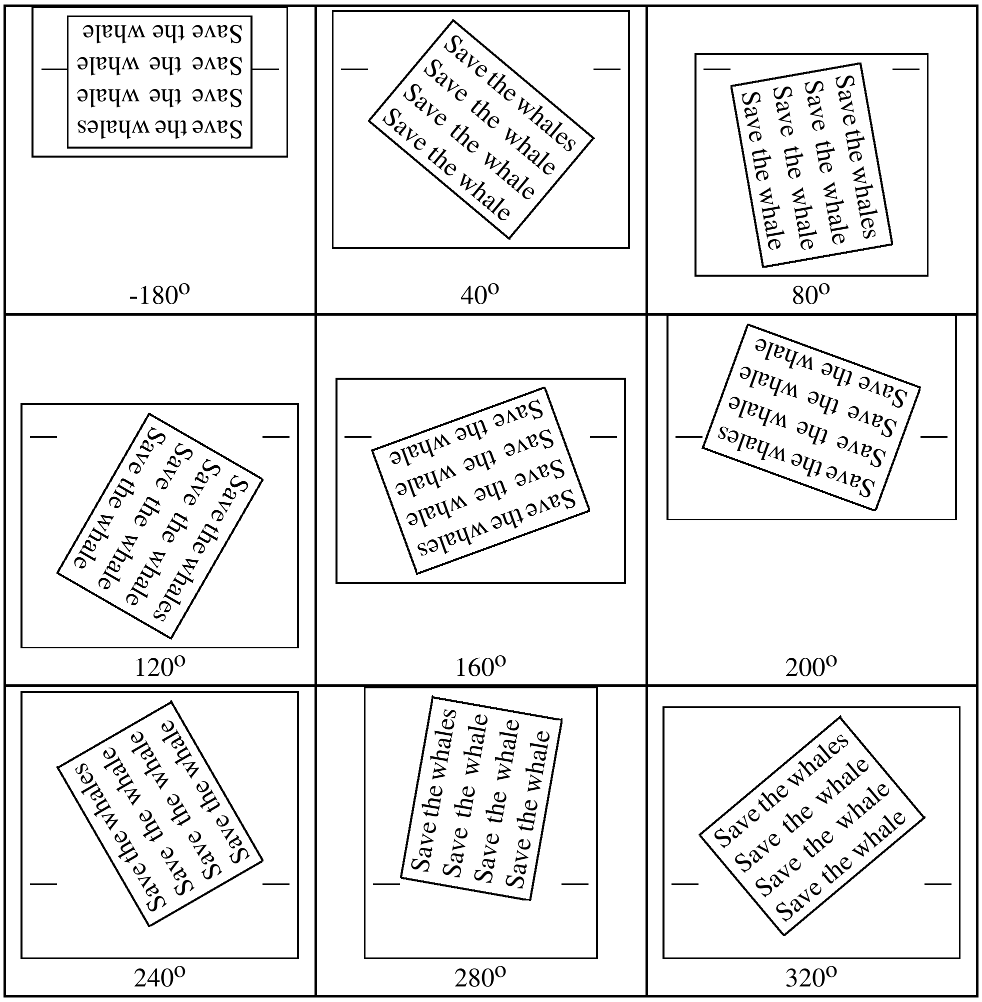
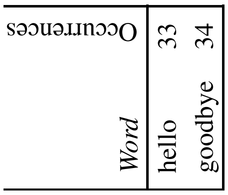


Figure 8.2: Rotation of paragraphs between 0 and 320°

8.6.4 Rotating tabular material

We can set tabular material in this way; at the same time, we demonstrate that the rotation can be nested:




```
\begin{sideways}
\newlength{\Strut}
\settowidth{\Strut}{Occurrences}
\begin{tabular}{|lr|}
\em Word & \rule{0pt}{\Strut}
\begin{rotate}{-90}%
Occurrences\end{rotate}  \\ \hline
hello & 33\\ goodbye & 34\\ \hline
\end{tabular}
\end{sideways}
```

The examples below show how the distance between the columns can be controlled by the use of zero width or zero height rules.

Column 1	Column 2	Column 3
1	2	3
4	5	6
7	8	9

```
\begin{quote}
\rule{0pt}{2cm}\begin{tabular}{rrr}
\begin{rotate}{-45}Column 1\end{rotate}&
\begin{rotate}{-45}Column 2\end{rotate}&
\begin{rotate}{-45}Column 3\end{rotate}\\
\hline
1& 2& 3\\
4& 5& 6\\
7& 8& 9\\
\hline
\end{tabular}
\end{quote}
```

Column 1	Column 2	Column 3
1	2	3
4	5	6
7	8	9

```
\begin{quote}
\begin{tabular}{rrr}
\begin{turn}{-45}Column 1\end{turn}&
\begin{turn}{-45}Column 2\end{turn}&
\begin{turn}{-45}Column 3\end{turn}\\
\hline
1& 2& 3\\
4& 5& 6\\
7& 8& 9\\
\hline
\end{tabular}
\end{quote}
```

Column 1	Column 2	Column 3
1	2	3
4	5	6
7	8	9

```
\begin{quote}
\rule{0pt}{1.5in}\begin{tabular}{rrr}
\begin{rotate}{-45}Column 1\end{rotate}
\rule{.5cm}{0pt}&
\begin{rotate}{-45}Column 2\end{rotate}
\rule{.5cm}{0pt}&
\begin{rotate}{-45}Column 3\end{rotate}
\rule{.5cm}{0pt}\\
\hline
1& 2& 3\\
4& 5& 6\\
7& 8& 9\\
\hline
\end{tabular}
\end{quote}
```

A more complex table with nested rotations and the use of zero width or zero height rules to control the spacing in the table is given below.

		NUMBER OF SITES				ACCEPT or
	STUDY AREA		IN BOUNDARY ZONE			REJECT
				EXPECTED		NULL
		TOT	OBS	FROM	TO	HYPOTH
	FULL SAMPLE	41	31	10.3	27.0	REJECT
	SAMPLE AREA 1	23	16	4.3	16.7	ACCEPT
	SAMPLE AREA 2	18	15	2.8	13.7	REJECT
	RUSHEN	13	9	1.2	10.4	ACCEPT
	ARBORY	10	7	0.6	8.8	ACCEPT
	MAROWN	10	8	0.4	8.6	ACCEPT
PRIMARY UNITS	SANTON	8	7	0.0	7.3	ACCEPT

```
\begin{sideways}
\begin{tabular}{|l|c|c|c|c|c|p{1in}|}
\hline
 &&\multicolumn{4}{c}{NUMBER OF SITES}%
                      \vline &ACCEPT or\\
 \cline{3-6} &STUDY AREA&&
 \multicolumn{3}{c}{IN BOUNDARY ZONE}
                      \vline&REJECT   \\
 \cline{4-6}&&&&
 \multicolumn{2}{c}{EXPECTED}
                      \vline&NULL     \\
\cline{5-6}&&TOT&OBS&FROM&TO&HYPOTH   \\
\cline{2-7}
&FULL SAMPLE&41&31&10.3&27.0&REJECT   \\
&SAMPLE AREA 1&23&16&4.3&16.7&ACCEPT  \\
&SAMPLE AREA 2&18&15&2.8&13.7&REJECT  \\
&RUSHEN&13&9&1.2&10.4&ACCEPT          \\
&ARBORY&10&7&0.6&8.8&ACCEPT           \\
&MAROWN&10&8&0.4&8.6&ACCEPT           \\
\rule{0.5cm}{0pt}
\begin{rotate}{-90}PRIMARY UNITS%
\end{rotate}\rule{0.5cm}{0pt}
&SANTON&8&7&0.0&7.3&ACCEPT            \\
\hline
\end{tabular}
\end{sideways}
```

As a final example let us use the table shown in the discussion of the CERN article style on Page 40 and rotate it over a few different angles.

```
\begin{tabular}{|c|c|c|c|}
\hline
\Rule\bf Event & $P_{\Tr}^{\PW}$ & $M_{jj}$     & $M_{\PW_{jj}}$ \\
\Rule          & $(\GeVc)$       & $(\GeVcc)$   & $(\GeVcc)$     \\
\hline
\Rule\bf A     & $82 \pm 12$     & $82 \pm 10$  & $299 \pm 28$   \\
\hline
\Rule\bf B     & $105 \pm 14$    & $97 \pm 12$  & $279 \pm 28$   \\
\hline
\end{tabular}
```

Now let us try out all possible rotations over 90 degrees and look at the result shown in Figure 8.3.

```
\begin{table}[p]
  \begin{center}
    \begin{tabular}{|c|c|c|c|}
      .....  (rest of table)
    \end{tabular}
  \end{center}
\caption{Example table (not rotated)}
\begin{minipage}{.45\textwidth}
  \begin{center}
    \mbox{\begin{turn}{-90}
    \begin{tabular}{|c|c|c|c|}
      .....  (rest of table)
    \end{tabular}
          \end{turn}}% End of turn and mbox
  \end{center}
\caption{Example of rotated table
         (turned left $90^{\circ}$)}
\end{minipage}\hfill
\begin{minipage}{.45\textwidth}
  \begin{center}
    \mbox{\begin{turn}{90}
    \begin{tabular}{|c|c|c|c|}
      .....  (rest of table)
    \end{tabular}
          \end{turn}}% End of turn and mbox
  \end{center}
\caption{Example of rotated table
        (turned right $90^{\circ}$)}
\end{minipage}
  \begin{center}
    \mbox{\begin{turn}{180}
    \begin{tabular}{|c|c|c|c|}
      .....  (rest of table)
    \end{tabular}
          \end{turn}}% End of turn and mbox
  \end{center}
\caption[]{Example of rotated table
           (upside-down)}
  \begin{center}
    \mbox{\begin{turn}{-20}
    \begin{tabular}{|c|c|c|c|}
      .....  (rest of table)
    \end{tabular}
          \end{turn}}% End of turn and mbox
  \end{center}
\caption[]{Example of rotated table
        (turned $20^{\circ}$ anticlockwise)}
\end{table}
```

Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

(a) Original form (not rotated)

Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

(b) Table turned left $90°$

Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

(c) Table turned right $90°$

Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

(d) Table upside-down

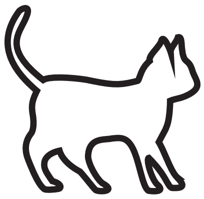
Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

(e) Table rotated $20°$ counterclockwise

Figure 8.3: Example of rotated tables

8.6.5 Rotating a figure

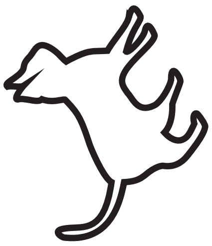
Figures can also be rotated with the same procedures. Figure 8.4 shows how an EPS file incorporated using the `\epsfig` command can be rotated at will. Please note the position of the current line, shown by the emdash. This should be compared to the rotated paragraphs of figures 8.1 and 8.2.

—  —

```
---\epsfig{figure=cat.eps,width=3cm}---
```

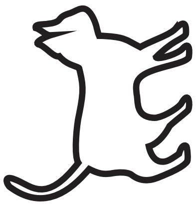
— —

```
---\begin{turn}{-240}
\epsfig{figure=cat.eps,width=3cm}
\end{turn}---
```



— —

```
---\begin{turn}{240}
\epsfig{figure=cat.eps,width=3cm}
\end{turn}---
```



— —

```
---\begin{sideways}
\epsfig{figure=cat.eps,width=3cm}
\end{sideways}---
```

Figure 8.4: A normal, turned and sideways picture within a figure

Now let us consider some real world examples. Figure 8.5 shows the picture of an elephant, which was originally in portrait mode. It is rotated 90° counterclockwise together with its caption.

```
\begin{figure}[p]
    \begin{sideways}
      \begin{minipage}[b]{\textheight}% Width of page in landscape mode
        \begin{center}
           \mbox{\epsfig{figure=elephant.eps,height=15cm}}
        \end{center}
        \caption{A large, rotated picture of an elephant}  \label{fig:rot1}
      \end{minipage}
    \end{sideways}
\end{figure}
```

Figures 8.6 to 8.8 show how to place various figures on a page using the `\minipage` environment. Figure 8.8 had moreover to be turned 90° counterclockwise, since originally it was in landscape mode.

```
\begin{figure}[p]
  \vfill \begin{minipage}{.495\linewidth}
            \begin{center}
              \mbox{\epsfig{figure=euromap.eps,width=.9\linewidth}}
            \end{center}
            \caption{Map of Europe in Spring 1991}   \label{fig:rot3}
         \end{minipage}\hfill
         \begin{minipage}{.495\linewidth}
           \begin{center}
             \mbox{\epsfig{figure=ukmap.eps,width=.9\linewidth}}
          \end{center}
          \caption{England and Wales in the U.K.}  \label{fig:rot4}
        \end{minipage}
  \vfill \begin{center}
           \mbox{\begin{turn}{-90}%
              \epsfig{figure=usamap.eps,width=.70\textwidth}
                 \end{turn}} % end of turn and mbox
         \end{center}
         \caption{The United States of America}     \label{fig:rot5}
  \vfill
\end{figure}
```

Figure 8.9 shows how two pictures can be put side by side and rotated together with the figure caption.

```
\begin{figure}[p]
  \begin{sideways}
    \begin{minipage}[b]{\textheight}% Width of page in landscape mode
      \mbox{\epsfig{figure=tacart1.eps,width=.48\textwidth}}       \hfill
      \mbox{\epsfig{figure=tacart2.eps,width=.48\textwidth}}
      \caption{Two pictures side by side and rotated} \label{fig:rot6}
    \end{minipage}
  \end{sideways}
\end{figure}
```

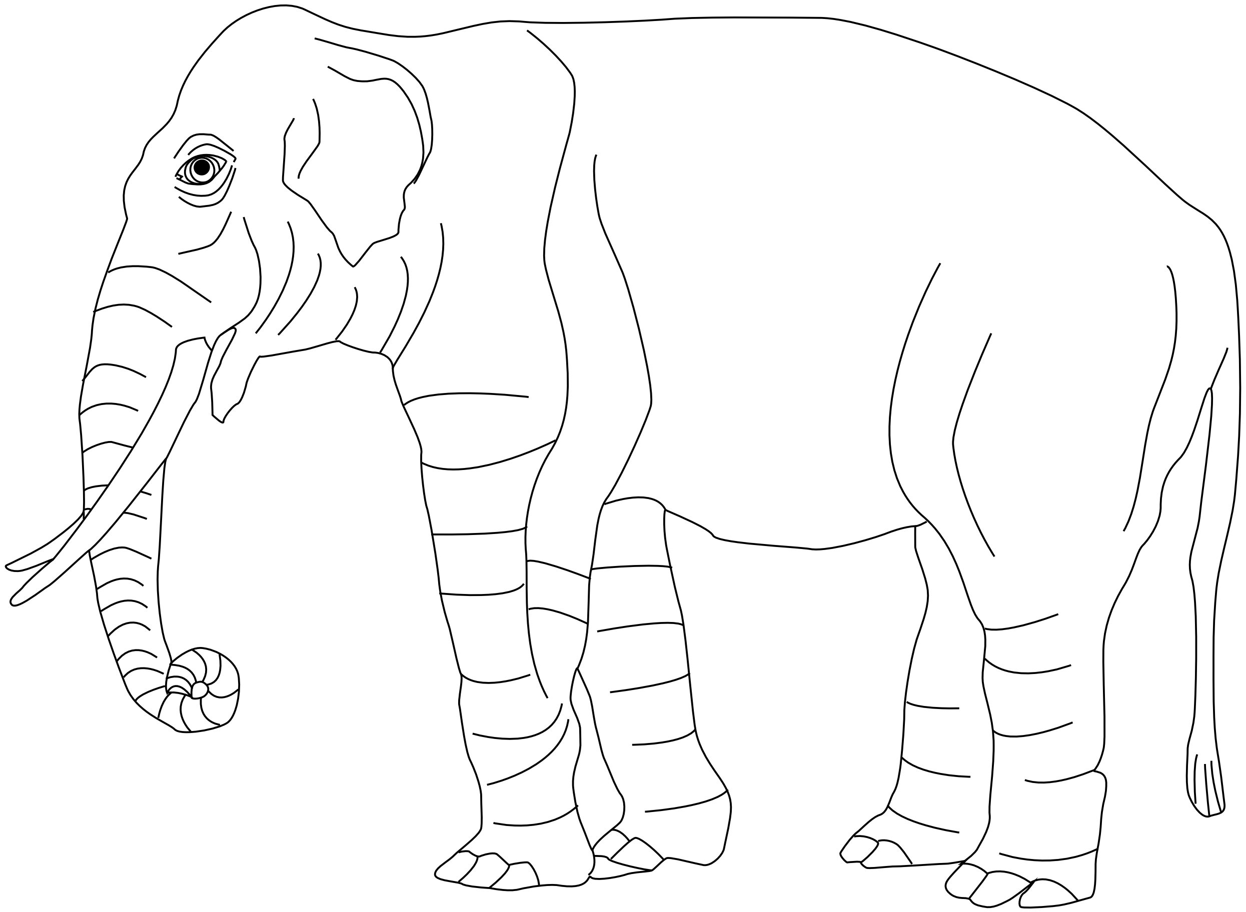


Figure 8.5: A large, rotated picture of an elephant

Figure 8.6: Map of Europe in Spring 1991

Figure 8.7: England and Wales in the U.K.

Figure 8.8: The United States of America

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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TEST-BEAM PERFORMANCE OF A TRACKING TRD PROTOTYPE

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Abstract

This sample article shows how to type a CERN PPE preprint using the standard generic notation for the tagging of authors, institutes and the likes on the title page. It also teaches how to include a picture and a table and how to get the typographic type correct right inside mathematics mode. Furthermore there is a citation and a bibliography. This ends the funny abstract.

(Submitted to some important Journal)

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1 INTRODUCTION

The two-dimensional distribution of the events looks like Figure 1, which also shows how to include an EPS picture, center it and surround it by a box.

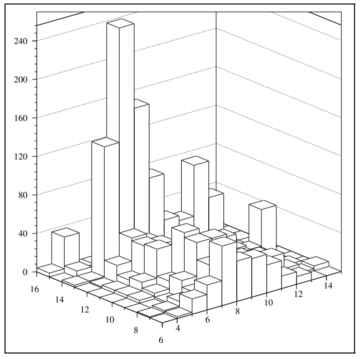


Figure 1: Borrowed from example 21 in the PAW manual.

Next comes table 1 on page 1.

Table 1: Example of a simple table.

Event	$P_{\mathrm{T}}^{\mathrm{W}}$ (GeV/c)	M_{jj} (GeV/c^2)	$M_{\mathrm{W}_{jj}}$ (GeV/c^2)
A	82 ± 12	82 ± 10	299 ± 28
B	105 ± 14	97 ± 12	279 ± 28

Finally an example of citing a bibliography item: Our previous investigations [1] showed that this mixture combines the advantages of efficient TR absorption and short drift time.

Aknowledgements

We wish to thank L. Gatignon for his help with the X5 beam, and K. Bussmann and G. DiTorre for engineering support.

REFERENCES

[1] V. Chernyatin et al., preprint CERN–EP/89–161 (1989).

1

Figure 8.9: Two pictures side by side and rotated

8.7 Subdividing LATEX constructs

Sometimes it is useful to subdivide a LATEX structural element into smaller units. This can be done for figures, equation arrays and equations. The minor styles, which can be used in each case, are described below:

8.7.1 Using subfigures

The `subfigure` minor style option allows the creation of subfigure boxes with an optional caption under the figure as a whole.

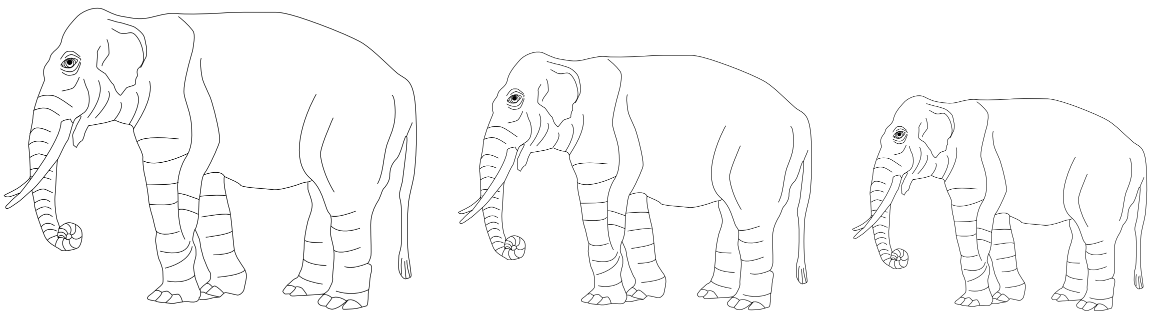
```
\documentstyle[subfigure]{article}
```

The figure is centered with `\subfigtopskip` of vertical space added above and `\subfigcapskip` vertical space added below it followed by the caption. The subfigure is followed by another `\subfigtopskip` of vertical space added at the bottom.

If a caption is specified between square brackets (including a null caption `[]`) then the subfigure is labeled with a counter supplied by the macro "`\thesubfigure`" which returns `'(a)'`, `'(b)'`, etc. If desired, this macro may be redefined. The counter used for labeling the subfigures is "`subfigure`" and is incremented for each subfigure regardless of whether a caption was printed.

As an example let us put three pictures next to one another using a tabular environment:

```
  \begin{figure}[h]
    \begin{center}
      \fbox{\begin{tabular}[t]{ccc}
        \subfigure[Big]{\epsfig{figure=elephant.eps,width=.35\textwidth}}    &
        \subfigure[Medium]{\epsfig{figure=elephant.eps,width=.3\textwidth}}  &
        \subfigure[Small]{\epsfig{figure=elephant.eps,width=.25\textwidth}}
      \end{tabular}}
    \end{center}
  \caption{Three Subfigures}
\end{figure}
```



(a) Big (b) Medium (c) Small

Figure 8.10: Three Subfigures

8.7.2 Using subequations and subarrays

Sometimes it is useful to number equations or arrays of equations as part of a higher level structure.

8.7.2.1 The subequations environment

As compared to the `equations` environment, the `subequations` environment, available with the `subeqn` minor style option, labels equations with the same number appending lower case letters.

```
\documentstyle[subeqn]{article}
```

Both text and equations can be put inside the `subequations` environment and references are possible either to individual equations or to all of them. A `\label` command immediately following `\begin{subequations}` generates a reference to that to the equation number without the alphabetic extension. As shown in the example below, if two equations, numbered 1, and 2, are followed by a `subequations` environmment containing two more equations, then the latter are numbered 3a, and 3b. The next equation will be numbered 4.

```
\begin{equation}
a+b=c+d=xy=w/z \label{eq:sum}
\end{equation}
For equation \ref{eq:sum} and equations
\ref{eq:sub}, more particularly equation
\ref{eq:gamma}, as well as in \ref{eq:frac},
the numbering works as indicated \ldots
\begin{equation}
(fg)'=f'g+fg'  \label{eq:quote}
\end{equation}
Text before subeqations \ldots
\begin{subequations}
\label{eq:sub}
Text inside subequations \ldots
\begin{equation}
\alpha\beta=\gamma+\delta  \label{eq:alpha}
\end{equation}
Text inside subequations \ldots
\begin{equation}
\Gamma(n)=(n-1) \label{eq:gamma}
\end{equation}
Text inside subequations \ldots
\end{subequations}
Text following subeqations \ldots
\begin{equation}
\frac{\partial}{\partial y}f(x y)=0
\label{eq:frac}
\end{equation}
Some more text following everything \ldots
```

$$(8.1)\qquad a+b=c+d=xy=w/z$$

For equation 8.1 and equations 8.3, more particularly equation 8.3b, as well as in 8.4, the numbering works as indicated . . .

$$(8.2)\qquad (fg)'=f'g+fg'$$

Text before subeqations . . . Text inside subequations . . .

$$(8.3a)\qquad \alpha\beta=\gamma+\delta$$

Text inside subequations . . .

$$(8.3b)\qquad \Gamma(n)=(n-1)$$

Text inside subequations . . . Text following subeqations . . .

$$(8.4)\qquad \frac{\partial}{\partial y}f(xy)=0$$

Some more text following everything . . .

8.7.2.2 The subeqnarray environment

The `subeqnarray` minor style option defines the `subeqnarray` and `subeqnarray*` environments. They behave like the `eqnarray` environment, except that the lines are numbered like `1a`, `1b`, `1c`, etc. To refer to these numbers an extra label command `\slabel` has been defined.

```
\documentstyle[subeqnarray]{article}
```

An example of how to use this functionality is shown below:

```
The array of equations \ref{eq:ex} and
\ref{eq:ey}, as well as \ref{eq:subeq},
\ref{eq:sex} and \ref{eq:sey} \ldots
\begin{eqnarray}
x & = & 17y    \label{eq:ex}      \\
y & > & a + 3x + b + c + \nonumber\\
  &   & d + e + f + g + H \label{eq:ey}
\end{eqnarray}
Text in the middle
\begin{subeqnarray}
\label{eq:subeq}
x & = & 17y     \slabel{eq:sex}   \\
y & > & a + 3x + b + c + \nonumber\\
  &   & d + e + f + g + H \slabel{eq:sey}
\end{subeqnarray}
Text following \ldots
```

The array of equations 8.5 and 8.6, as well as 8.7, 8.7a and 8.7b . . .

$$x = 17y \tag{8.5}$$

$$\begin{aligned} y &> a + 3x + b + c + \\ &\quad d + e + f + g + H \end{aligned} \tag{8.6}$$

Text in the middle

$$x = 17y \tag{8.7a}$$

$$\begin{aligned} y &> a + 3x + b + c + \\ &\quad d + e + f + g + H \end{aligned} \tag{8.7b}$$

Text following . . .

Chapter 9: The AMS extensions and LaTeX

9.1 Introduction

The full documentation for using the AMS-LaTeX package has two parts: the *User's Guide*, in `amslatex.tex` file and some sample files illustrating the features available as `testart.tex` file and `testbook.tex` file.

To really understanding the present chapter, which is largely based on the documents mentioned above, the reader should already be reasonably familiar with the LaTeX manual: *LaTeX: A document preparation system*, by Leslie Lamport [3]. Reading the *Joy of TeX* [17] (the manual for AMS-TeX) will help one get the most out of the AMS-LaTeX software.

Notes

The notation ⟨*dimension*⟩, ⟨*number*⟩, and the like will be used to indicate that an arbitrary dimension or number or whatever is to be substituted by the user. By *dimension* we mean a number followed by one of TeX's standard units `pt`, `pc`, `in`, `mm`, `cm`, etc.

It is important that we distinguish between the original, non-LaTeX implementation of AMS-TeX and the modified form of it that constitutes the LaTeX option `amstex`. Typewriter type will be used for the LaTeX option `amstex`, and the standard logo AMS-TeX will be used for the original non-LaTeX version.

9.2 The AMS-LaTeX project

AMS-TeX was originally released for general use in 1982. Its main strength is that it makes it easy for the user to typeset mathematics, while taking care of the many details necessary to make the output satisfy the high standards of mathematical publishing. It provides a predefined set of natural commands such as `\matrix` and `\text` that make complicated mathematics reasonably convenient to type. These commands incorporate the typesetting experience and standards of the American Mathematical Society, to handle problematic possibilities without burdening the user, matrices within matrices, or a word of text within a subscript, and so on.

AMS-TeX, unlike LaTeX, does not have certain features that are very convenient for authors—automatic numbering that adjusts to addition or deletion of material being the primary one. There are also labor-saving ways provided in LaTeX for preparing such items as indexes, bibliographies, tables, and simple diagrams. These features are such a convenience for authors that the use of LaTeX spread rapidly in the mid-80s (a reasonably mature version of LaTeX was available by the end of 1983), and the American Mathematical Society began to be asked by its authors to accept electronic submissions in LaTeX.

The obvious question to ask was whether the strengths of AMS-TeX could be combined with the strengths of LaTeX, and in 1987 the American Mathematical Society began to investigate the possibility of doing just that. Work on the AMS-LaTeX project was carried out over the next three years by Romesh Kumar, a TeX consultant in the Chicago area, and by West German LaTeX experts Frank Mittelbach and Rainer Schöpf, with assistance from Michael Downes of the American Mathematical Society technical support staff.

The overall philosophy was to provide AMS-TeX commands to the LaTeX user whilst adhering to standard LaTeX syntax as much as possible.

9.3 Major components of the AMS-LaTeX package

To use the AMS-LaTeX developments with LaTeX the documentstyle declaration should look like this:

```
\documentstyle[amstex]{article}
```

Within the AMS-LaTeX package are a pair of documentstyles called `amsart` and `amsbook`, corresponding to LaTeX's `article` and `book`, which are designed to be used in preparing manuscripts for submission to the AMS, but there is nothing to prohibit their use for other purposes. When these style files are used the `amstex` option will be automatically included, so that the documentstyle declarations would simply be `\documentstyle{amsart}` or `\documentstyle{amsbook}`.

9.4 Font considerations

9.4.1 Names of math font commands

The single biggest issue in the integration of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX and LATEX font usage was that in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX math font commands work differently from text font commands and have different names. Instead of being a simple switch, whose scope is bounded by curly braces, a math font command in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX is a command with one argument. This means that in $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX, to obtain a single bold letter in math one types `\bold{A}` rather than `{\bf A}`, and two bold letters would be typed `\bold{A}\bold{B}` instead of `{\bf AB}`. (A similar distinction between text accents and math accents already existed in LATEX.) Having the font command apply only to a single letter in this way is more natural in math formulas, because letters are usually single variables rather than components of a word, and different fonts are mixed in all combinations; four consecutive letters might be from four different fonts.

The full list of math font commands in the `amstex` option is `\mathrm`, `\bold`, `\cal`, with the addition of `\frak` (Fraktur) and `\Bbb` (blackboard bold) if AMSFonts are available. Math italic, the default font for letters in math, also has a name, `\mit`, but this is never needed in ordinary use. Tables 9.1 and 9.2 give a comprehensive listing of font change commands for convenient reference.

Table 9.1: Font commands used in text with the `amstex` option

Font command	Equivalent	Font selected
`\normalshape`	`\shape{n}`	normal, upright, “roman”
`\it`	`\shape{it}`	*italic*
`\em`	`\shape{it}`*	*emphasis*
`\sl`	`\shape{sl}`	*slanted*
`\sc`	`\shape{sc}`	SMALL CAPS
`\mediumseries`	`\series{m}`	medium weight
`\bf`	`\series{bx}`	**bold extended weight**
`\tt`	`\family{cmtt}`	`typewriter style`
`\sf`	`\family{cmss}`	sans serif
`\rm`	`\family{cmr}`	roman

*The command `\em` selects shape `it` if the current font is upright, otherwise it selects shape `n` (normal).

Table 9.2: Font commands used in math with the `amstex` option

`\bold`	Used to obtain bold letters from the English alphabet.
`\boldsymbol`	Used to obtain bold numbers and other nonalphabetic symbols, as well as bold Greek letters.
`\pmb`	“Poor man’s bold,” used for math symbols when bold versions don’t exist in the currently available fonts.
`\cal`	Calligraphic letters. Only uppercase is available.
`\mit`	Math italic. This font is automatically selected in math mode, so the command `\mit` is not needed in normal use.
`\mathrm`	Roman, normal shape. Note: most of the time, `\text` or `\operatorname` should be used instead of `\mathrm` to produce this font in math.
`\frak`	Euler Fraktur alphabet.
`\Bbb`	Blackboard bold alphabet. Only uppercase is available.

To gain access to a new math alphabet, one uses the `\newmathalphabet` command in the preamble of the document. If one wants to use a certain font in math, one needs to find out the family name assigned to the font and the shapes and weights available. Table 4.3 shows what family names are included in the standard font definition used by default at CERN. On top of that one can use PostScript fonts as explained in chapter 4.

In the `amstex` option, `\boldsymbol` is to be used for individual bold math symbols and bold Greek letters—everything in math except for letters (where one would use `\bold`). For example, to obtain a bold ∞, $+$, π, or 0, one would use the commands `\boldsymbol{\infty}`, `\boldsymbol{+}`, `\boldsymbol{\pi}`, or `\boldsymbol{0}`.

Since `\boldsymbol` takes rather a lot of typing, one would usually put some definitions in the preamble for any bold symbols one is going to use frequently:

```
\newcommand{\bpi}{\boldsymbol{\pi}}
\newcommand{\binfty}{\boldsymbol{\infty}}
```

For some math symbols `\boldsymbol` will not have any effect because bold versions of those symbols do not exist in the currently available fonts. These include extension symbols and large operator symbols from the font CMEX, as well as the AMS extra math symbols from the fonts MSAM and MSBM. "Poor man's bold" (`\pmb`) can be used for some of the things that aren't handled properly by `\boldsymbol`. It works by typesetting several copies of the symbol with slight offsets. With large operators and extension symbols, however, `\pmb` does not currently work very well because the proper spacing and treatment of limits is not preserved.

To make an entire math formula bold (or as much of it as possible, depending on the available fonts), use `\boldmath` preceding the formula, as described in the LaTeX manual.

The sequence `{\bf\hat{a}}` (in ordinary LaTeX) or `\bold{\hat{a}}` (in the `amstex` option) produces a bold accent character over the **a**, as one would expect. However, combinations like `{\cal\hat{a}}` will not work in ordinary LaTeX because the `\cal` font does not have its own accents. In the `amstex` option the font change commands are defined in such a way that accent characters will be taken from the `\rm` font if they are not available in the current font (in addition to the `\cal` font, the `\Bbb` and `\frak` fonts don't contain accents).

In ordinary LaTeX uppercase Greek can be made bold by, e.g., `{\bf\Gamma}`. In the `amstex` option, uppercase Greek can be made bold only by using `\boldsymbol` (in other words, uppercase Greek is handled the same as lowercase Greek).

9.4.2 The `amssymb` option

If one is running a version of LaTeX with extra memory available for control sequence names, and one wants to use the extra math symbols from the AMSFonts (see table A.16), one should specify the `amssymb` documentstyle option, which will define all the necessary symbol names (about 200).

9.5 An overview of the `amstex` option

9.5.1 Math spacing commands

Both the spelled-out and abbreviated forms of these commands are robust, and in addition they can also be used outside of math. The primary math spacing commands are:

Abbrev.	Spelled out	Abbrev.	Spelled out
`\,`	`\thinspace`	`\!`	`\negthinspace`
`\:`	`\medspace`		`\negmedspace`
`\;`	`\thickspace`		`\negthickspace`
`@,`		`@!`	
	`\quad`		
	`\qquad`		

`@,` and `@!` give one-tenth the space of `\,` and `\!` respectively, for extra fine tuning where necessary.

9.5.2 Multiple integral signs

\iint, \iiint, and \iiiint give multiple integral signs with the spacing between them nicely adjusted, in both text and display style. \idotsint gives two integral signs with dots between them.

$$\iint\limits_A f(x,y)\,dx\,dy\qquad\iiint\limits_A f(x,y,z)\,dx\,dy\,dz \tag{9.1}$$

$$\iiiint\limits_A f(w,x,y,z)\,dw\,dx\,dy\,dz\qquad\idotsint\limits_A f(x_1,\dots,x_k) \tag{9.2}$$

```
\begin{gather}
\iint\limits_A f(x,y)\,dx\,dy\qquad\iiint\limits_A
f(x,y,z)\,dx\,dy\,dz\\
\iiiint\limits_A
f(w,x,y,z)\,dw\,dx\,dy\,dz\qquad\idotsint\limits_A f(x_1,\dots,x_k)
\end{gather}
```

9.5.3 Over and under arrows

Some extra over and under arrow operations are provided in the amstex option. (Basic LaTeX has \overrightarrow and \overleftarrow).

$$\begin{aligned}
\overrightarrow{\psi_\delta(t) E_t h} &=\underrightarrow{\psi_\delta(t) E_t h}\\
\overleftarrow{\psi_\delta(t) E_t h} &=\underleftarrow{\psi_\delta(t) E_t h} \\
\overleftrightarrow{\psi_\delta(t) E_t h}&=\underleftrightarrow{\psi_\delta(t) E_t h}
\end{aligned}$$

```
\begin{align*}
\overrightarrow{\psi_\delta(t) E_t h}    &=\underrightarrow{\psi_\delta(t) E_t h}\\
\overleftarrow{\psi_\delta(t) E_t h}     &=\underleftarrow{\psi_\delta(t) E_t h} \\
\overleftrightarrow{\psi_\delta(t) E_t h}&=\underleftrightarrow{\psi_\delta(t) E_t h}
\end{align*}
```

These all scale properly in subscript sizes:

$$\int_{\overrightarrow{AB}} ax\,dx$$

```
\[\int_{\overrightarrow{AB}} ax\,dx\]
```

9.5.4 Dots

In the amstex option, ellipsis dots should almost always be typed as \dots. Positioning (on the baseline or centered) is selected according to whatever follows the \dots. If the next character is a plus sign, the dots will be centered; if it's a comma, they will be on the baseline. These default dot placements provided by the amstex option can be changed by the documentstyle if different conventions are wanted.

If the dots fall at the end of a math formula, the next character is something like \end or \) or $, which does not give any information about how to place the dots. Then one must help by using \dotsc for "dots with commas," or \dotsb for "dots with binary operators/relations," or \dotsm for "multiplication dots," or \dotsi for "dots with integrals." In the example below, low dots are produced in the first instance and centered dots in the others, with the spacing on either side of the dots nicely adjusted.

Then we have the series $A_1, A_2, \dots$, the regional sum $A_1 + A_2 + \cdots$, the orthogonal product $A_1 A_2 \cdots$, and the infinite integral

$$\int_{A_1}\int_{A_2}\cdots$$

```
Then we have the series $A_1,A_2,\dotsc$, the regional sum $A_1+A_2+\dotsb$,
the orthogonal product $A_1A_2\dotsm$, and the infinite integral
\[\int_{A_1}\int_{A_2}\dotsi\].
```

9.5.5 Accents in math

The following accent commands automatically give good positioning of double accents:

```
\Hat    \Check  \Tilde  \Acute  \Grave  \Dot    \Ddot   \Breve  \Bar    \Vec
```

Double accents:

$$\hat{\hat{H}} \quad \check{\check{C}} \quad \tilde{\tilde{T}} \quad \acute{\acute{A}} \quad \grave{\grave{G}} \quad \dot{\dot{D}} \quad \ddot{\ddot{D}} \quad \breve{\breve{B}} \quad \bar{\bar{B}} \quad \vec{\vec{V}}$$

```
\[  \Hat{\Hat{H}}     \quad\Check{\Check{C}} \quad
    \Tilde{\Tilde{T}} \quad\Acute{\Acute{A}} \quad
    \Grave{\Grave{G}} \quad\Dot{\Dot{D}}     \quad
    \Ddot{\Ddot{D}}   \quad\Breve{\Breve{B}} \quad
    \Bar{\Bar{B}}     \quad\Vec{\Vec{V}}           \]
```

This double accent operation is complicated and tends to slow down the processing of a LaTeX file. If the document contains many double accents, one can use `\accentedsymbol` in the preamble of the document to help speed things up. It stores the result of the double accent command in a box register, for quick retrieval. `\accentedsymbol` is used like `\newcommand`:

```
\accentedsymbol{\Ahathat}{\Hat{\Hat A}}
```

9.5.6 Superscripted accents

Some accents have a wide form: typing `$\widehat {xy},\widetilde{xy}$` produces $\widehat{xy}, \widetilde{xy}$. Because these wide accents have a certain maximum size, extremely long expressions are better handled by a different notation: $(AmBD)\hat{}$ instead of $\widehat{AmBD}$. `amstex` has the following control sequences to achieve this easily:

```
\sphat    \spcheck   \sptilde   \spdot    \spddot    \spdddot    \spbreve
```

The example above would be typed `(AmBD)\sphat`.

$$(AmBD)^{\wedge} \quad (AmBD)^{\vee} \quad (AmBD)^{\sim} \tag{9.3}$$

$$(AmBD)^{\cdot} \quad (AmBD)^{\cdot\cdot} \quad (AmBD)^{\cdot\cdot\cdot} \quad (AmBD)^{\breve{}} \tag{9.4}$$

```
\begin{gather}
(AmBD)\sphat \quad (AmBD)\spcheck \quad (AmBD)\sptilde                 \\
(AmBD)\spdot \quad (AmBD)\spddot  \quad (AmBD)\spdddot \quad (AmBD)\spbreve
\end{gather}
```

9.5.7 Dot accents

`\dddot` and `\ddddot` are available to produce triple and quadruple dot accents in addition to the `\dot` and `\ddot` accents already available in LaTeX:

$$\dddot{Q} \qquad \ddddot{R}$$

```
\[  \dddot{Q}  \qquad  \ddddot{R}  \]
```

9.5.8 Roots

In ordinary LaTeX the placement of root indices is sometimes not good i.e. $\sqrt[\beta]{k}$ (`\sqrt[\beta]{k}`). In the `amstex` option `\leftroot` and `\uproot` allow one to adjust the position of the root: `\sqrt[\leftroot{-2}\uproot{2}\beta]{k}` will move the beta up and to the right. The negative argument used with `\leftroot` moves the β to the right. The units are a small dimension that is a useful size for such adjustments.

In the `amstex` option `\leftroot` and `\uproot` allow one to adjust the position of the root index of a radical with good positioning of the β:

$$\sqrt[\leftroot{-2}\uproot{2}\beta]{k}$$

```
\[\sqrt[\leftroot{-2}\uproot{2}\beta]{k}\]
```

9.5.9 Boxed formulas

The command `\boxed` puts a box around its argument, like `\fbox` except that the contents are in math mode:

$$\boxed{W_t-F\subseteq V(P_i)\subseteq W_t}.$$

```
\[\boxed{W_t-F\subseteq V(P_i)\subseteq W_t}.\]
```

9.5.10 Extensible arrows

`@>>>` and `@<<<` produce arrows that extend automatically to accommodate unusually wide subscripts or superscripts. The text of the subscript or superscript is typed in between the > or < symbols. Example:

$$F\times\triangle[n-1] \xrightarrow[\partial_0\alpha(b)]{} E^{\partial_0b}$$

```
\[F\times\triangle[n-1]  @>>{\partial_0\alpha(b)}>E^{\partial_0b}\]
```

For users whose keyboards don't have < and > keys, `@)))` and `@(((` are available as synonyms.

9.5.11 `overset`, `underset`, and `sideset`

LaTeX provides `\stackrel` for placing a superscript above a binary relation. In `amstex` there are somewhat more general commands, `\overset` and `\underset`, that can be used to place one symbol above or below another symbol, whether it's a relation or something else. The input `\overset{*}{X}` will place a superscript-size $*$ above the X; `\underset` performs the parallel operation that one would expect.

$$\overset{*}{X}\qquad\underset{*}{X}\qquad\overset{a}{\underset{b}{X}}$$

```
\[\overset{*}{X}\qquad\underset{*}{X}\qquad\overset{a}{\underset{b}{X}}\]
```

There's also a command called `\sideset`, for a rather special purpose: putting symbols at the subscript and superscript corners of a large operator symbol such as $\sum$ or $\prod$. The prime example is the case when one wants to put a prime on a sum symbol. If there are no limits above or below the sum, one could just use `\nolimits`: here's `{sum\nolimits} E_n` in display mode:

$$\sum\nolimits' E_n. \tag{9.5}$$

But if one wants not only the prime but also something below or above the sum symbol, it's not so easy. If one has

$$\sum_{n<k,\;n\;odd} nE_n \tag{9.6}$$

and one wants to add a prime on the sum symbol, use `\sideset` like this: `\sideset{}{'}\sum_{...}nE_n`. The extra pair of empty braces is explained by the fact that `\sideset` has the capability of putting an extra symbol or symbols at each corner of a large operator.

Examples:

$$\sideset{_*^*}{_*^*}\prod_k\qquad\sideset{}{'}\sum_{0\le i\le m} E_i\beta x$$

```
\[\sideset{_*^*}{_*^*}\prod_k\qquad\sideset{}{'}\sum_{0\le i\le m} E_i\beta x\]
```

9.5.12 The `text` command

The main use of the command `\text` is for words or phrases in a display. It is very similar to the LaTeX command `\mbox` in its effects, but has a couple of advantages. If one wants a word or phrase of text in a subscript, one can type `..._{\text{word or phrase}}`, which is slightly easier than the `\mbox` equivalent: `..._{\mbox{\scriptsize word or phrase}}`. The other advantage is the more descriptive name.

$$\mathbf{y}=\mathbf{y}'\quad\text{if and only if}\quad y'_k=\delta_k y_{\tau(k)}$$

```
\[\bold{y}=\bold{y}'\quad\text{if and only if}\quad y'_k=\delta_k y_{\tau(k)}\]
```

9.5.13 Operator names

Math functions such as $\log$, $\sin$, and $\lim$ are traditionally typeset in roman type to help avoid confusion with single math variables, set in math italic. The more common ones have predefined names, `\log`, `\sin`, `\lim`, and so forth, but new ones come up all the time in mathematical papers. The `amstex` option provides `\operatorname` and `\operatornamewithlimits` for producing new function names that will have the same typographical treatment. For instance `\operatorname{xxx}` produces xxx in the proper font and automatically adds proper spacing on either side when necessary, so that one gets $A \operatorname{xxx} B$ instead of $AxxxB$. Examples:

$$\|f\|_\infty=\operatorname*{ess\,sup}_{x\in R^n}|f(x)|$$

```
\[\|f\|_\infty=\operatornamewithlimits{ess\,sup}_{x\in R^n}|f(x)|\]
```

$$\operatorname{meas}_1\{u\in R_+^1\:f^*(u)>\alpha\}=\operatorname{meas}_n\{x\in R^n\:|f(x)|\geq\alpha\}\quad\forall\alpha>0.$$

```
\[\operatorname{meas}_1\{u\in R_+^1\:f^*(u)>\alpha\}
  =\operatorname{meas}_n\{x\in R^n\:|f(x)|\geq\alpha\}\quad \forall\alpha>0.\]
```

If one uses a particular operator name often, one can save some typing and make the LaTeX file more readable by defining an abbreviation in the preamble area of the document, using `\newcommand`:

```
\newcommand{\esssup}{\operatornamewithlimits{ess\,sup}}
\newcommand{\meas}{\operatorname{meas}}
```

Some of the operator names, such as `\lim`, have actually been defined using `\operatornamewithlimits` rather than `\operatorname`, because, in displayed formulas, if there is a subscript on `\lim`, it is conventionally placed underneath, like the limits on sums:

$$C_+f(x)=\lim_{t\to 0}C(f)(x+it) \tag{9.7}$$

One can use `\operatornamewithlimits` just like `\operatorname`; the only difference is the placement of subscripts and superscripts.

Some special operator names are predefined in the amstex option: \varlimsup, \varliminf, \varinjlim, and \varprojlim. Here's what they look like in use:

$$\varlimsup_{n\rightarrow\infty} \mathcal{Q}(u_n,u_n-u^{\#})\le 0 \tag{9.8}$$

$$\varliminf_{n\rightarrow\infty} \left|a_{n+1}\right|/\left|a_n\right|=0 \tag{9.9}$$

$$\varinjlim (m_i^\lambda\cdot)^*\le 0 \tag{9.10}$$

$$\varprojlim_{p\in S(A)}A_p\le 0 \tag{9.11}$$

```
\begin{align}
&\varlimsup_{n\rightarrow\infty} \cal{Q}(u_n,u_n-u^{\#})\le0             \\
&\varliminf_{n\rightarrow\infty} \left|a_{n+1}\right|/\left|a_n\right|=0 \\
&\varinjlim (m_i^\lambda\cdot)^*\le0                                     \\
&\varprojlim_{p\in S(A)}A_p\le0
\end{align}
```

9.5.14 `mod` and its relatives

Commands \mod, \bmod, \pmod, \pod are provided to deal with the rather special spacing conventions of "mod" notation. \bmod and \pmod are available in LaTeX, but in the amstex option the spacing of \pmod will adjust to a smaller value if it's used in a non-display-mode formula. \mod and \pod are variants of \pmod preferred by some authors; \mod omits the parentheses, whereas \pod omits the "mod" and retains the parentheses. Examples:

$$x\equiv y+1 \pmod{m^2} \tag{9.12}$$

$$x\equiv y+1 \mod{m^2} \tag{9.13}$$

$$x\equiv y+1 \pod{m^2} \tag{9.14}$$

```
\begin{align}
x&\equiv y+1\pmod{m^2}\\
x&\equiv y+1\mod{m^2}\\
x&\equiv y+1\pod{m^2}
\end{align}
```

9.5.15 Fractions and related constructions

In addition to \frac (which was already available in LaTeX), amstex provides \dfrac and \tfrac as convenient abbreviations for {\displaystyle\frac ... } and {\textstyle\frac ... }. Furthermore, the thickness of the fraction line can be varied, using a new square-bracket option of the \frac command. \frac[⟨*dimension*⟩]{...}{...} makes a fraction where the thickness of the horizontal rule is determined by the given dimension. The sample file testart.tex file shows an example using a thickness of 1.5pt.

\fracwithdelims⟨*left delimiter*⟩⟨*right delimiter*⟩[⟨*dimension*⟩] is an extension of the same idea, with delimiters on either side specified by the user..

Example:

$$\frac{H(z+v)-H(z)-BH(z)v}{\|v\|}$$

```
\[\frac[1.5pt]{H(z+v)-H(z)-BH(z)v}{\|v\|}\]
```

There is also \fracwithdelims, for stacked constructions with delimiters on either side.

$$\left[\frac{H(z+v)-H(z)-BH(z)v}{\|v\|}\right]$$

```
\[\fracwithdelims[]{H(z+v)-H(z)-BH(z)v}{\|v\|}\]
```

For binomial expressions such as $\binom{n}{k}$ `amstex` has `\binom`, `\dbinom` and `\tbinom`. `\binom` is an abbreviation for `\fracwithdelims()[0pt]`. Example:

$$\begin{split}\sum_{\gamma\in\Gamma_C} I_\gamma&=2^k-\binom{k}{1}2^{k-1}+\binom{k}{2}2^{k-2}\\ &\quad+\dots+(-1)^l\binom{k}{l}2^{k-l}+\dots+(-1)^k\\ &=(2-1)^k=1\end{split}\tag{9.15}$$

```
\begin{equation}
\begin{split}
\sum_{\gamma\in\Gamma_C} I_\gamma&=2^k-\binom{k}{1}2^{k-1}+\binom{k}{2}2^{k-2}\\
                                 &\quad+\dots+(-1)^l\binom{k}{l}2^{k-l}+\dots+(-1)^k\\
                                 &=(2-1)^k=1
\end{split}
\end{equation}
```

There are also abbreviations

```
\dfrac        \dbinom
\tfrac        \tbinom
```

for the commonly needed constructions

```
{\displaystyle\frac ... }   {\displaystyle\binom ... }
{\textstyle\frac ... }      {\textstyle\binom ... }
```

9.5.16 Continued fractions

The continued fraction

$$\cfrac{1}{\sqrt{2}+\cfrac{1}{\sqrt{2}+\cfrac{1}{\sqrt{2}+\cfrac{1}{\sqrt{2}+\cfrac{1}{\sqrt{2}+\dotsb}}}}}\tag{9.16}$$

can be obtained by typing

```
\cfrac{1}{\sqrt{2}+
 \cfrac{1}{\sqrt{2}+
  \cfrac{1}{\sqrt{2}+
   \cfrac{1}{\sqrt{2}+
    \cfrac{1}{\sqrt{2}+\dotsb
}}}}}
```

Left or right positioning of any of the numerators is achieved by using `\lcfrac` or `\rcfrac` instead of `\cfrac`.

9.5.17 Smash

In `amstex` there are optional arguments `t` and `b` for the plain TeX command `\smash`, because sometimes it is advantageous to be able to 'smash' only the top or only the bottom of something while retaining the natural depth or height. In the formula $X_j=(1/\sqrt{\smash[b]{\lambda_j}})X_j'$ `\smash[b]` has been used to limit the size of the radical symbol.

```
$X_j=(1/\sqrt{\smash[b]{\lambda_j}})X_j'$
```

Without the use of `\smash[b]` the formula would have appeared thus: $X_j=(1/\sqrt{\lambda_j})X_j'$, with the radical extending to encompass the depth of the subscript j.

9.5.18 The 'cases' environment

'Cases' constructions like the following can be produced using the cases environment.

$$P_{r-j}=\begin{cases}0 & \text{if } r-j \text{ is odd},\\ r!\,(-1)^{(r-j)/2} & \text{if } r-j \text{ is even}.\end{cases} \tag{9.17}$$

```
\begin{equation} P_{r-j}=
  \begin{cases}
    0&  \text{if $r-j$ is odd},\\
    r!\,(-1)^{(r-j)/2}&  \text{if $r-j$ is even}.
  \end{cases}
\end{equation}
```

Notice the use of `\text` and the embedded math.

9.5.19 Matrix

The matrix environments are similar to LaTeX's `array`, except that they don't have an argument specifying the format of the columns. Instead a default format is provided: up to 10 centered columns.

Here are samples of the matrix environments, `\matrix`, `\pmatrix`, `\bmatrix`, `\vmatrix` and `\Vmatrix`:

$$\begin{matrix}\vartheta & \varrho\\ \varphi & \varpi\end{matrix}\quad \begin{pmatrix}\vartheta & \varrho\\ \varphi & \varpi\end{pmatrix}\quad \begin{bmatrix}\vartheta & \varrho\\ \varphi & \varpi\end{bmatrix}\quad \begin{vmatrix}\vartheta & \varrho\\ \varphi & \varpi\end{vmatrix}\quad \begin{Vmatrix}\vartheta & \varrho\\ \varphi & \varpi\end{Vmatrix} \tag{9.18}$$

```
\begin{matrix}
\vartheta& \varrho\\\varphi& \varpi
\end{matrix}\quad
\begin{pmatrix}
\vartheta& \varrho\\\varphi& \varpi
\end{pmatrix}\quad
\begin{bmatrix}
\vartheta& \varrho\\\varphi& \varpi
\end{bmatrix}\quad
\begin{vmatrix}
\vartheta& \varrho\\\varphi& \varpi
\end{vmatrix}\quad
\begin{Vmatrix}
\vartheta& \varrho\\\varphi& \varpi
\end{Vmatrix}
```

The maximum number of columns is determined by the counter `MaxMatrixCols`, which one can change if necessary using LaTeX's `\setcounter` or `\addtocounter` commands. I.e., suppose one has a big matrix with 19 or 20 columns. Then one can do something like this:

```
\begin{equation}
\setcounter{MaxMatrixCols}{20}
A=\begin{pmatrix}
...&...&...&...&...&...&...&...&...&...&...&...&  ... \\
  ...  \\
  ...
\end{pmatrix}
\end{equation}
```

To produce a small matrix suitable for use in text, use the `smallmatrix` environment.

```
\begin{math}
  \bigl( \begin{smallmatrix}
      a&b\\ c&d
    \end{smallmatrix} \bigr)
\end{math}
```

To show the effect of the matrix on the surrounding lines of a paragraph, we put it here: $\bigl(\begin{smallmatrix} a&b\\ c&d \end{smallmatrix}\bigr)$ and follow it with enough text to ensure that there will be at least one full line below the matrix.

`\hdotsfor{`*number*`}` produces a row of dots in a matrix spanning the given number of columns:

$$W(\Phi)= \begin{Vmatrix}
\dfrac\varphi{(\varphi_1,\varepsilon_1)}&0&\dots&0\\
\dfrac{\varphi k_{n2}}{(\varphi_2,\varepsilon_1)}&
\dfrac\varphi{(\varphi_2,\varepsilon_2)}&\dots&0\\
\hdotsfor{5}\\
\dfrac{\varphi k_{n1}}{(\varphi_n,\varepsilon_1)}&
\dfrac{\varphi k_{n2}}{(\varphi_n,\varepsilon_2)}&\dots&
\dfrac{\varphi k_{n\,n-1}}{(\varphi_n,\varepsilon_{n-1})}&
\dfrac{\varphi}{(\varphi_n,\varepsilon_n)}
\end{Vmatrix}$$

```
\[W(\Phi)= \begin{Vmatrix}
\dfrac\varphi{(\varphi_1,\varepsilon_1)}&0&\dots&0\\
\dfrac{\varphi k_{n2}}{(\varphi_2,\varepsilon_1)}&
\dfrac\varphi{(\varphi_2,\varepsilon_2)}&\dots&0\\
\hdotsfor{5}\\
\dfrac{\varphi k_{n1}}{(\varphi_n,\varepsilon_1)}&
\dfrac{\varphi k_{n2}}{(\varphi_n,\varepsilon_2)}&\dots&
\dfrac{\varphi k_{n\,n-1}}{(\varphi_n,\varepsilon_{n-1})}&
\dfrac{\varphi}{(\varphi_n,\varepsilon_n)}
\end{Vmatrix}\]
```

The spacing of the dots can be varied through use of a square-bracket option, for example, `\hdotsfor[1.5]{3}`. The number in square brackets will be used as a multiplier; the normal value is 1.

9.5.20 The `Sb` and `Sp` environments

The `Sb` and `Sp` environments can be used to typeset several lines as a subscript or superscript: for example

```
\begin{equation}
  \sum\begin{Sb}
        0\le i\le m\\ 0<j<n
      \end{Sb}
    P(i,j)
\end{equation}
```

produces a two-line subscript underneath the sum:

$$\sum_{\substack{0\le i\le m\\ 0<j<n}} P(i,j) \tag{9.19}$$

`Sb` and `Sp` can be used anywhere where an ordinary subscript or superscript can be used.

9.5.21 Commutative diagrams

The commutative diagram commands of $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TeX are not included in the `amstex` option, but are available as a separate option, `amscd`. This conserves memory for users who don't need commutative diagrams. The `picture` environment can be used for complex commutative diagrams but for simple diagrams without diagonal arrows the `amscd` commands are more convenient.

Example:

```
\begin{equation}\begin{CD}
S^{{\cal W}_\Lambda}\otimes T   @>j>>   T\\
@VVV                                    @VV{\End P}V\\
(S\otimes T)/I                  @=      (Z\otimes T)/J
\end{CD}\end{equation}
```

This could be produced in ordinary LaTeX by

```
\begin{array}{ccc}
S^{{\cal W}_\Lambda}\otimes T&
    \stackrel{j}{\longrightarrow}&  T\\
\Big\downarrow&
        &\Big\downarrow\vcenter{%
          \rlap{$\scriptstyle{\rm End}\,P$}}\\
(S\otimes T)/I& =&  (Z\otimes T)/J
\end{array}
```

$$\begin{array}{ccc}
S^{{\cal W}_\Lambda}\otimes T & \stackrel{j}{\longrightarrow} & T\\
\Big\downarrow & & \Big\downarrow\vcenter{\rlap{$\scriptstyle{\rm End}\,P$}}\\
(S\otimes T)/I & = & (Z\otimes T)/J
\end{array}$$

(with `\End` defined as `\operatorname{End}`; see §9.5.13). When using the `amstex` option, one will obtain longer horizontal arrows and improved spacing between elements of the diagram. In the `CD` environment the commands `@>>>`, `@<<<`, `@VVV`, and `@AAA` give respectively right, left, down, and up arrows. For the horizontal arrows, material between the first and second > or < symbols will be typeset as a superscript, and material between the second and third will be typeset as a subscript. Similarly, material between the first and second, or second and third, `A`s or `V`s of vertical arrows will be typeset as left or right "sidescripts".

9.5.22 Big-g-g-g delimiters

Here are some big delimiters, first in `\normalsize`:

$$\biggl(\mathbf{E}_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds\biggr)$$

```
\[\biggl(\bold E_{y}
  \int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds
  \biggr)
\]
```

and now in `\Large` size:

$$\biggl(\mathbf{E}_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds\biggr)$$

```
{\Large
\[\biggl(\bold E_{y}
  \int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds
  \biggr)
\]}
```

9.5.23 Alignment structures for equations

In the `amstex` option, several environments exist for creating multi-line displayed equations. They are similar in function to LaTeX's `equation` and `eqnarray` environments. These environments are:

```
align    gather    alignat    xalignat    xxalignat    multline    split
```

Each environment, except for `split`, has both starred and unstarred forms, where the unstarred forms have automatic numbering, using LaTeX's `equation` counter. One can suppress the number on any particular line by putting `\notag` before the `\\`; one can also override it with a tag of one's own using `\tag{`⟨*label*⟩`}`, where ⟨ *label* ⟩ means arbitrary text such as `$*$` or `ii` used to "number" the equation. There is also a `\tag*` command that causes the tag to be typeset absolutely literally, without putting parentheses around it. `\tag` and `\tag*` can also be used in the starred versions of all the `amstex` alignment structures.

9.5.23.1 The `align` environment

The `align` environment is used for two or more equations when vertical alignment is desired (usually binary relations such as equal signs are aligned). The term "equation" is used rather loosely here to mean any math formula that is intended by the author to be a self-contained subdivision of the larger display, usually, but not always, containing a binary relation.

9.5.23.2 The `gather` environment

Like the `align` environment, the `gather` environment is used for two or more equations, but when there is no alignment desired among them; each one is centered separately between the left and right margins.

9.5.23.3 The `alignat` environment

The `align` environment takes up the whole width of a display. If one wants to have several "align"-type structures side by side, there is an `alignat` environment one can use. There is one required argument, to specify the number of "align" structures.[1] The `xalignat` and `xxalignat` environments are forms of the `alignat` environment with expanded spacing between the component align structures. If we consider each align structure to be a column, `xalignat` has equal spacing between columns and at the margins; `xxalignat` has equal spacing between columns and zero spacing at the margins. See `testart.tex` file for examples.

9.5.23.4 The `multline` environment

The `multline` environment is a variation of the `equation` environment used for equations that don't fit on a single line. The first line of a `multline` will be at the left margin and the last line at the right margin, except for an indention on both sides whose amount is equal to `\multlinegap`. The value of `\multlinegap` can be changed using LaTeX's `\setlength` and `\addtolength` commands. If the `multline` contains more than two lines, any lines other than the first and last will be centered individually between the margins.

9.5.23.5 The `split` environment

Like `multline`, the `split` environment is for *single* equations that are too long to fit on one line and hence must be split into multiple lines. Unlike `multline`, however, the `split` environment provides for alignment among the split lines, using `&` to mark alignment points, as usual. In addition, unlike the other `amstex` equation structures, the `split` environment provides no numbering, because it is intended to be used only inside some other displayed equation structure, usually an `equation`, `align`, or `gather` environment, which provides the numbering.

9.5.23.6 Alignment environments that don't constitute an entire display

In addition to the `split` environment, there are some other equation alignment environments that do not constitute an entire display. They are self-contained units that can be used inside other formulas, or set side-by-side. The environment names are `aligned`, `gathered`, and `alignedat`. These environments take an optional argument to specify their vertical positioning with respect to the material on either side. The default is `[c]`. A `gathered` environment with the first line level with the material on either side would be created like this.

[1] For an argument of n, the number of `&`'s per line is $2n-1$ (one ampersand for alignment within each align structure, and ampersands to separate the align structures from one another).

```
\begin{gathered}[t]
...\\
...
\end{gathered}
```

9.5.24 Vertical spacing and page breaks in the amstex equation structures

One can use the `\\[`⟨*dimension*⟩`]` command to get extra vertical space between lines in all the `amstex` displayed equation environments, as is usual in LaTeX. Unlike `eqnarray`, the `amstex` environments don't allow page breaks between lines, unless `\displaybreak` or `\allowdisplaybreaks` is used. The philosophy is that page breaks in such situations should receive individual attention from the author. `\displaybreak` must go before the `\\` where it is supposed to take effect. Like LaTeX's `\pagebreak`, `\displaybreak` takes an optional argument between 0 and 4 denoting the desirability of the pagebreak. `\displaybreak[0]` means "it is permissible to break here" without encouraging a break; `\displaybreak` with no optional argument is the same as `\displaybreak[4]` and forces a break.

There is also an optional argument for `\allowdisplaybreaks`. `\allowdisplaybreaks` obeys the usual LaTeX scoping rules; the normal way of limiting its scope is to put `{\allowdisplaybreaks` at the beginning and `}` at the end of the desired range. Within the scope of an `\allowdisplaybreaks` command, the `\\*` command can be used to prohibit a pagebreak, as usual.

9.5.25 The \intertext command

The command `\intertext` is used for a short interjection of one or two lines of text in the middle of a display alignment. Its salient feature is preservation of the alignment, which would not be possible if one simply ended the display and then started it up again afterwards. `\intertext` may only appear immediately after a `\\` or `\\*` command. An example of its use follows.

$$A_1 = N_0(\lambda;\Omega') - \phi(\lambda;\Omega'), \tag{9.20}$$

$$A_2 = \phi(\lambda;\Omega') - \phi(\lambda;\Omega), \tag{9.21}$$

and

$$A_3 = \mathcal{N}(\lambda;\omega). \tag{9.22}$$

```
\begin{align}
A_1&=N_0(\lambda;\Omega')-\phi(\lambda;\Omega'),\\
A_2&=\phi(\lambda;\Omega')-\phi(\lambda;\Omega),\\
\intertext{and}
A_3&=\cal N(\lambda;\omega).
\end{align}
```

Here the word "and" falls outside the display, at the left margin.

9.5.26 Equation numbering

In LaTeX if one wanted to have equations numbered within sections—that is, have equation numbers (1.1), (1.2), ..., (2.1), (2.2), ..., in sections 1, 2, and so forth—one would probably redefine `\theequation`:

```
\renewcommand{\theequation}{\thesection.\arabic{equation}}
```

This works well except that the equation counter won't be reset to zero at the beginning of a new section or chapter, unless one does it oneself using `\setcounter`. To make this a little more convenient, the `amstex` option provides a command `\numberwithin`. To have equation numbering tied to section numbering, with automatic reset of the equation counter, the command is

```
\numberwithin{equation}{section}
```

As the name implies, `\numberwithin` can be applied to other counters besides the equation counter, but the results are not guaranteed because of potential complications. Normal LaTeX methods should be used where available, e.g., in `\newtheorem`.

To make cross-references to equations easier, an `\eqref` command is provided. This automatically supplies the parentheses around the equation number, and adds an italic correction if necessary. To refer to an equation that was labeled with the label `e:baset`, the usage would be `\eqref{e:baset}`.

9.5.27 Error messages

One kind of error message in particular should be mentioned, since it follows from a mistake that is easy to make.

```
Runaway argument?
 \left |\frac {\hat v(s)-\hat v(t)}{|\widetilde {D} \ETC.
! Paragraph ended before \multline* was complete.
<to be read again>
                   \par
l.17

? h
I suspect you've forgotten a `}', causing me to apply this
control sequence to too much text. How can we recover?
My plan is to forget the whole thing and hope for the best.

? e
```

This usually means one of two things: Either one has an equation alignment environment where the end doesn't match the beginning—perhaps something like

```
\begin{multline*}
...
\end{multline}
```

(as in this case)—or else one has a missing `}` or `\right` delimiter inside of the environment. A `}` is rather easy to leave off accidentally when using certain commands, such as `\frac`.

9.6 Miscellaneous

In the `amstex` option `~`, `\/`, and `\slash` will remove superfluous spaces on either side of them, as a convenience to the user (in the case of `\/`, only a space on the left will be removed). For example, if one has typed `p. 63` and then realizes one should add a `~`, one can insert the `~` without deleting the space.

In ordinary LaTeX `\big`, `\bigg`, `\Big`, and `\Bigg` delimiters don't adjust properly over the full range of LaTeX font sizes. In the `amstex` option they do.

9.7 New documentstyle options available

Several new documentstyle options have been created. About half of them have to do with the positioning of "limits" or `\tags`. The abbreviation of the names reflects the MS-DOS limitation of eight characters for file names,[2] which we need to allow for.

`nosumlim`	No limits on sums
`intlim`	Limits on integrals
`nonamelm`	No limits on operatornames
`ctagsplt`	Vertically centered tags on the `split` environment
`righttag`	Equation tags on the right

[2] Not including the file extension.

Some of the component parts of the `amstex` option are also available individually, that is, they can be used in the options list of the `\documentstyle` command:

`amstext`	defines `\text`
`amsbsy`	defines `\boldsymbol` and `\pmb`
`amsfonts`	defines `\frak` and `\Bbb` and sets up the fonts MSAM (extra math symbols A), MSBM (extra math symbols B, and blackboard bold), EUFM (Euler Fraktur), as well as extra sizes of CMMIB (bold math italic and bold lowerCase Greek), and CMBSY (bold math symbols and bold script), for use in mathematics.

Another option, `amssymb`, defines names for all the symbols in the AMS math symbol fonts. It can be used with or without the `amstex` option.

9.7.1 Syntax checking

Another new style option is called `syntonly`; if one includes this in the document options list, then one can put `\syntaxonly` in the document preamble to run the file with syntax check only. No output will be produced, but any LaTeX errors will be uncovered. The advantage of this is that LaTeX will run significantly faster when `\syntaxonly` is in effect. How much faster depends on the particular computer being used and other variables but 30%–40% is typical.

9.8 Protecting fragile commands

Many of the commands added by the `amstex` option are fragile and will need to be `\protect`ed in commands with “moving arguments”—`\section` and other sectioning commands, `\caption`, `\addcontentsline`, `\addtocontents`, `\markboth`, `\markright`, `@`-expressions in an `array` or `tabular` environment, and others (see the LaTeX manual, Section C.1.3).

9.9 Differences the LaTeX user should note

In `amstex` the `@` character has a special use, in the extensible arrows `@>>>` and `@<<<` and in the math microspacing commands `@,` and `@!`. In order to get an ordinary printed @ character, type `@@` instead of `@`.

With the various alignment environments available in the `amstex` option, the `eqnarray` environment is no longer needed. Furthermore, since it does not prevent overlapping of the equation numbers with wide formulas, as most of the `amstex` alignments do, using the `amstex` alignments seems better.

`\nonumber` is interchangeable with `\notag`; the latter seems slightly preferable, for consistency with the name of `\tag`.

In math `\bf`, `\rm`, and other text font commands should not be used for single math variables; `\bold`, `\mathrm`, etc. should be used instead. (See section 9.4.1 for details.)

Note: Starting on the following page, vertical rules are added at the margins so that the positioning of various display elements with respect to the margins can be seen more clearly.

9.10 Examples of multiple-line equation structures

The lines indicating the margins are to make the marginal spacing stand out more clearly in some of the display examples in this appendix.

9.10.1 Split

The `split` environment is not an independent environment but should be used inside something else such as `equation` or `align`.

If there is not enough room for it, the equation number for a `split` will be shifted to the previous line, when equation numbers are on the left; the number shifts down to the next line when numbers are on the right.

$$
\begin{split}
f_{h,\varepsilon}(x,y)
&=\varepsilon\mathbf{E}_{x,y}\int_0^{t_\varepsilon}
L_{x,y_\varepsilon(\varepsilon u)}\varphi(x)\,du\\
&= h\int L_{x,z}\varphi(x)\rho_x(dz)\\
&\quad+h\biggl[\frac{1}{t_\varepsilon}\biggl(\mathbf{E}_{y}
\int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds
-t_\varepsilon\int L_{x,z}\varphi(x)\rho_x(dz)\biggr)\\
&\phantom{{=}+h\biggl[}+\frac{1}{t_\varepsilon}
\biggl(\mathbf{E}_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}
\varphi(x)\,ds -\mathbf{E}_{x,y}\int_0^{t_\varepsilon}
L_{x,y_\varepsilon(\varepsilon s)}
\varphi(x)\,ds\biggr)\biggr]\\
&=h\widehat{L}_x\varphi(x)+h\theta_\varepsilon(x,y),
\end{split}
\tag{9.23}
$$

Some text after to test the below-display spacing.

```
\begin{equation}
\begin{split}
f_{h,\varepsilon}(x,y)
&=\varepsilon\bold E_{x,y}\int_0^{t_\varepsilon}
L_{x,y_\varepsilon(\varepsilon u)}\varphi(x)\,du\\
&= h\int L_{x,z}\varphi(x)\rho_x(dz)\\
&\quad+h\biggl[\frac{1}{t_\varepsilon}\biggl(\bold E_{y}
  \int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds
  -t_\varepsilon\int L_{x,z}\varphi(x)\rho_x(dz)\biggr)\\
&\phantom{{=}+h\biggl[}+\frac{1}{t_\varepsilon}
  \biggl(\bold E_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}
    \varphi(x)\,ds -\bold E_{x,y}\int_0^{t_\varepsilon}
   L_{x,y_\varepsilon(\varepsilon s)}
   \varphi(x)\,ds\biggr)\biggr]\\
&=h\widehat{L}_x\varphi(x)+h\theta_\varepsilon(x,y),
\end{split}
\end{equation}
```

Unnumbered version:

$$
\begin{split}
f_{h,\varepsilon}(x,y)
&=\varepsilon\mathbf{E}_{x,y}\int_0^{t_\varepsilon} L_{x,y_\varepsilon(\varepsilon u)}\varphi(x)\,du\\
&= h\int L_{x,z}\varphi(x)\rho_x(dz)\\
&\quad+h\biggl[\frac{1}{t_\varepsilon}\biggl(\mathbf{E}_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds-t_\varepsilon\int L_{x,z}\varphi(x)\rho_x(dz)\biggr)\\
&\phantom{{=}+h\biggl[}+\frac{1}{t_\varepsilon}\biggl(\mathbf{E}_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds-\mathbf{E}_{x,y}\int_0^{t_\varepsilon}L_{x,y_\varepsilon(\varepsilon s)}\varphi(x)\,ds\biggr)\biggr]\\
&=h\widehat{L}_x\varphi(x)+h\theta_\varepsilon(x,y),
\end{split}
$$

Some text after to test the below-display spacing.

```
\begin{equation*}
\begin{split}
f_{h,\varepsilon}(x,y)
&=\varepsilon\bold E_{x,y}\int_0^{t_\varepsilon}
L_{x,y_\varepsilon(\varepsilon u)}\varphi(x)\,du\\
&= h\int L_{x,z}\varphi(x)\rho_x(dz)\\
&\quad+h\biggl[\frac{1}{t_\varepsilon}\biggl(\bold E_{y}
  \int_0^{t_\varepsilon}L_{x,y^x(s)}\varphi(x)\,ds
  -t_\varepsilon\int L_{x,z}\varphi(x)\rho_x(dz)\biggr)\\
&\phantom{{=}+h\biggl[}+\frac{1}{t_\varepsilon}
  \biggl(\bold E_{y}\int_0^{t_\varepsilon}L_{x,y^x(s)}
    \varphi(x)\,ds -\bold E_{x,y}\int_0^{t_\varepsilon}
   L_{x,y_\varepsilon(\varepsilon s)}
   \varphi(x)\,ds\biggr)\biggr]\\
&=h\widehat{L}_x\varphi(x)+h\theta_\varepsilon(x,y),
\end{split}
\end{equation*}
```

If the option `ctagsplt` is included in the documentstyle options list, the equation numbers for `split` environments will be centered vertically on the height of the `split`:

$$
\begin{split}
|I_2| &= \left| \int_0^T \psi(t) \left\{ u(a,t) - \int_{\gamma(t)}^a \frac{d\theta}{k(\theta,t)} \int_a^\theta c(\xi) u_t(\xi,t)\,d\xi \right\} dt \right|\\
&\le C_6 \left| \left| f \int_\Omega \left| \widetilde{S}^{-1,0}_{a,-} W_2(\Omega, \Gamma_l) \right| \right| \left| |u| \overset{\circ}{\to} W_2^{\widetilde{A}}(\Omega;\Gamma_r,T) \right| \right|.
\end{split}
\tag{9.24}
$$

Some text after to test the below-display spacing.

Use of `split` within `align`:

$$\begin{split}|I_1|&=\left|\int_\Omega gRu\,d\Omega\right|\\ &\le C_3\left[\int_\Omega\left(\int_{a}^x g(x\i,t)\,d\xi\right)^2d\Omega\right]^{1/2}\\ &\quad\times \left[\int_\Omega\left\{u^2_x+\frac{1}{k}\left(\int_{a}^x cu_t\,d\xi\right)^2\right\}c\Omega\right]^{1/2}\\ &\le C_4\left|\left|f\left|\widetilde{S}^{-1,0}_{a,-}W_2(\Omega,\Gamma_l)\right|\right|\left||u|\overset{\circ}\to W_2^{\widetilde{A}}(\Omega;\Gamma_r,T)\right|\right|.\end{split}\tag{9.25}$$

$$\begin{split}|I_2|&=\left|\int_{0}^T \psi(t)\left\{u(a,t)-\int_{\gamma(t)}^a\frac{d\theta}{k(\theta,t)}\int_{a}^\theta c(\xi)u_t(\xi,t)\,d\xi\right\}dt\right|\\ &\le C_6\left|\left|f\int_\Omega\left|\widetilde{S}^{-1,0}_{a,-}W_2(\Omega,\Gamma_l)\right|\right|\left||u|\overset{\circ}\to W_2^{\widetilde{A}}(\Omega;\Gamma_r,T)\right|\right|.\end{split}\tag{9.26}$$

Some text after to test the below-display spacing.

```
\begin{align}
\begin{split}|I_1|&=\left|\int_\Omega gRu\,d\Omega\right|\\
  &\le C_3\left[\int_\Omega\left(\int_{a}^x
  g(x\i,t)\,d\xi\right)^2d\Omega\right]^{1/2}\\
&\quad\times \left[\int_\Omega\left\{u^2_x+\frac{1}{k}
  \left(\int_{a}^x cu_t\,d\xi\right)^2\right\}
  c\Omega\right]^{1/2}\\
&\le C_4\left|\left|f\left|\widetilde{S}^{-1,0}_{a,-}
  W_2(\Omega,\Gamma_l)\right|\right|
  \left||u|\overset{\circ}\to W_2^{\widetilde{A}}
  (\Omega;\Gamma_r,T)\right|\right|.
\end{split}\label{eq:A}\\
\begin{split}|I_2|&=\left|\int_{0}^T \psi(t)\left\{u(a,t)
  -\int_{\gamma(t)}^a\frac{d\theta}{k(\theta,t)}
  \int_{a}^\theta c(\xi)u_t(\xi,t)\,d\xi\right\}dt\right|\\
&\le C_6\left|\left|f\int_\Omega
  \left|\widetilde{S}^{-1,0}_{a,-}
  W_2(\Omega,\Gamma_l)\right|\right|
  \left||u|\overset{\circ}\to W_2^{\widetilde{A}}
  (\Omega;\Gamma_r,T)\right|\right|.
\end{split}
\end{align}
```

Unnumbered align, with a number on the second split:

$$
\begin{aligned}
|I_1| &= \left|\int_\Omega gRu\,d\Omega\right|\\
&\le C_3\left[\int_\Omega\left(\int_{a}^x g(x_1,t)\,d\xi\right)^2 d\Omega\right]^{1/2}\\
&\times \left[\int_\Omega\left\{u^2_x+\frac{1}{k}\left(\int_{a}^x cu_t\,d\xi\right)^2\right\} c\Omega\right]^{1/2}\\
&\le C_4\left|\left|f\left|\widetilde{S}^{-1,0}_{a,-} W_2(\Omega,\Gamma_l)\right|\right|\right| \left|\left|u\right|\overset{\circ}\to W_2^{\widetilde{A}}(\Omega;\Gamma_r,T)\right|\right|.
\end{aligned}
$$

$$
\begin{aligned}
|I_2| &= \left|\int_{0}^T \psi(t)\left\{u(a,t)-\int_{\gamma(t)}^a\frac{d\theta}{k(\theta,t)}\int_{a}^\theta c(\xi)u_t(\xi,t)\,d\xi\right\}dt\right|\\
&\le C_6\left|\left|f\int_\Omega\left|\widetilde{S}^{-1,0}_{a,-} W_2(\Omega,\Gamma_l)\right|\right|\right| \left|\left|u\right|\overset{\circ}\to W_2^{\widetilde{A}}(\Omega;\Gamma_r,T)\right|\right|.
\end{aligned}
\tag{9.26$'$}
$$

Some text after to test the below-display spacing.

```
\begin{align*}
\begin{split}|I_1|&=\left|\int_\Omega gRu\,d\Omega\right|\\
  &\le C_3\left[\int_\Omega\left(\int_{a}^x
  g(x\i,t)\,d\xi\right)^2d\Omega\right]^{1/2}\\
&\phantom{=}\times \left[\int_\Omega\left\{u^2_x+\frac{1}{k}
  \left(\int_{a}^x cu_t\,d\xi\right)^2\right\}
  c\Omega\right]^{1/2}\\
&\le C_4\left|\left|f\left|\widetilde{S}^{-1,0}_{a,-}
  W_2(\Omega,\Gamma_l)\right|\right|
  \left||u|\overset{\circ}\to W_2^{\widetilde{A}}
  (\Omega;\Gamma_r,T)\right|\right|.
\end{split}\\
\begin{split}|I_2|&=\left|\int_{0}^T \psi(t)\left\{u(a,t)
  -\int_{\gamma(t)}^a\frac{d\theta}{k(\theta,t)}
  \int_{a}^\theta c(\xi)u_t(\xi,t)\,d\xi\right\}dt\right|\\
&\le C_6\left|\left|f\int_\Omega
  \left|\widetilde{S}^{-1,0}_{a,-}
  W_2(\Omega,\Gamma_l)\right|\right|
  \left||u|\overset{\circ}\to W_2^{\widetilde{A}}
  (\Omega;\Gamma_r,T)\right|\right|.
\end{split}\tag{\theequation$'$}
\end{align*}
```

9.10.2 Multline

Numbered version:

$$\begin{multline}\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2] -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\ =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2 \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy \tag{9.27}\end{multline}$$

To test the use of `\label` and `\ref`, we refer to the number of this equation here: (9.27).

```
\begin{multline}\label{eq:E}
\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]
 -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\
 =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2
  \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy
\end{multline}
```

Unnumbered version:

$$\begin{multline*}\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2] -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\ =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2 \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy\end{multline*}$$

Some text after to test the below-display spacing.

```
\begin{multline*}
\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]
 -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\
 =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2
  \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy
\end{multline*}
```

And now an “unnumbered” version numbered with a literal tag:

$$\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]-2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\ =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2\int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy \tag*{[a]}$$

Some text after to test the below-display spacing.

```
\begin{multline*}\tag*{[a]}
\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]
 -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\
 =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2
  \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy
\end{multline*}
```

The same display with `\multlinegap` set to zero. Notice that the space on the left in the first line does not change, because of the equation number, while the second line is pushed over to the right margin.

$$\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]-2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\ =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2\int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy \tag*{[a]}$$

Some text after to test the below-display spacing.

```
{\setlength{\multlinegap}{0pt}
\begin{multline*}\tag*{[a]}
\int_a^b\biggl\{\int_a^b[f(x)^2g(y)^2+f(y)^2g(x)^2]
 -2f(x)g(x)f(y)g(y)\,dx\biggr\}\,dy \\
 =\int_a^b\biggl\{g(y)^2\int_a^bf^2+f(y)^2
  \int_a^b g^2-2f(y)g(y)\int_a^b fg\biggr\}\,dy
\end{multline*}}
```

9.10.3 Gather

Numbered version with `\notag` on the second line:

$$\begin{gather}
D(a,r)\equiv\{z\in\mathbf{C}\colon |z-a|<r\}, \tag{9.28}\\
\operatorname{seg}(a,r)\equiv\{z\in\mathbf{C}\colon \Im z= \Im a,\ |z-a|<r\},\notag\\
c(e,\theta,r)\equiv\{(x,y)\in\mathbf{C}\colon |x-e|<y\tan\theta,\ 0<y<r\}, \tag{9.29}\\
C(E,\theta,r)\equiv\bigcup_{e\in E}c(e,\theta,r). \tag{9.30}
\end{gather}$$

```
\begin{gather}
D(a,r)\equiv\{z\in\bold C\colon |z-a|<r\},\\
\operatorname{seg}(a,r)\equiv\{z\in\bold C\colon
\Im z= \Im a,\ |z-a|<r\},\notag\\
c(e,\theta,r)\equiv\{(x,y)\in\bold C
\colon |x-e|<y\tan\theta,\ 0<y<r\},\\
C(E,\theta,r)\equiv\bigcup_{e\in E}c(e,\theta,r).
\end{gather}
```

Unnumbered version.

$$\begin{gather*}
D(a,r)\equiv\{z\in\mathbf{C}\colon |z-a|<r\},\\
\operatorname{seg}(a,r)\equiv\{z\in\mathbf{C}\colon \Im z= \Im a,\ |z-a|<r\},\\
c(e,\theta,r)\equiv\{(x,y)\in\mathbf{C}\colon |x-e|<y\tan\theta,\ 0<y<r\},\\
C(E,\theta,r)\equiv\bigcup_{e\in E}c(e,\theta,r).
\end{gather*}$$

Some text after to test the below-display spacing.

```
\begin{gather*}
D(a,r)\equiv\{z\in\bold C\colon |z-a|<r\},\\
\operatorname{seg}(a,r)\equiv\{z\in\bold C\colon
\Im z= \Im a,\ |z-a|<r\},\\
c(e,\theta,r)\equiv\{(x,y)\in\bold C
 \colon |x-e|<y\tan\theta,\ 0<y<r\},\\
C(E,\theta,r)\equiv\bigcup_{e\in E}c(e,\theta,r).
\end{gather*}
```

9.10.4 Align

Numbered version:

$$\gamma_x(t) = (\cos tu + \sin tx, v), \tag{9.31}$$

$$\gamma_y(t) = (u, \cos tv + \sin ty), \tag{9.32}$$

$$\gamma_z(t) = \left(\cos tu + \frac{\alpha}{\beta}\sin tv, -\frac{\beta}{\alpha}\sin tu + \cos tv\right). \tag{9.33}$$

Some text after to test the below-display spacing.

```
\begin{align}
\gamma_x(t)&=(\cos tu+\sin tx,v),\\
\gamma_y(t)&=(u,\cos tv+\sin ty),\\
\gamma_z(t)&=\left(\cos tu+\frac\alpha\beta\sin tv,
  -\frac\beta\alpha\sin tu+\cos tv\right).
\end{align}
```

Unnumbered version:

$$\begin{aligned}
\gamma_x(t) &= (\cos tu + \sin tx, v),\\
\gamma_y(t) &= (u, \cos tv + \sin ty),\\
\gamma_z(t) &= \left(\cos tu + \frac{\alpha}{\beta}\sin tv, -\frac{\beta}{\alpha}\sin tu + \cos tv\right).
\end{aligned}$$

Some text after to test the below-display spacing.

```
\begin{align*}
\gamma_x(t)&=(\cos tu+\sin tx,v),\\
\gamma_y(t)&=(u,\cos tv+\sin ty),\\
\gamma_z(t)&=\left(\cos tu+\frac\alpha\beta\sin tv,
  -\frac\beta\alpha\sin tu+\cos tv\right).
\end{align*}
```

9.10.5 Align and split within gather

When using the `align` environment within the `gather` environment, one or the other, or both, should be unnumbered (using the `*` form), since having numbering for both the outer and inner environment would cause a conflict.

Automically numbered `gather` with `split` and `align*`:

$$\begin{split} \varphi(x,z) &=z-\gamma_{10}x-\sum_{m+n\ge2}\gamma_{mn}x^mz^n\\ &=z-Mr^{-1}x-\sum_{m+n\ge2}Mr^{-(m+n)}x^mz^n \end{split} \tag{9.34}$$

$$\begin{aligned} \zeta^0 &=(\xi^0)^2,\\ \zeta^1 &=\xi^0\xi^1,\\ \zeta^2 &=(\xi^1)^2, \end{aligned}$$

Here the `split` environment gets a number from the outer `gather` environment; numbers for individual lines of the `align*` are suppressed because of the star.

```
\begin{gather}
\begin{split} \varphi(x,z) &=z-\gamma_{10}x-\sum_{m+n\ge2}\gamma_{mn}x^mz^n\\
&=z-Mr^{-1}x-\sum_{m+n\ge2}Mr^{-(m+n)}x^mz^n \end{split}                  \\[6pt]
\begin{align*}
\zeta^0 &=(\xi^0)^2,\\    \zeta^1 &=\xi^0\xi^1,\\   \zeta^2 &=(\xi^1)^2,
\end{align*}
\end{gather}
```

The `*`-ed form of `gather` with the non-`*`-ed form of `align`.

$$\begin{split} \varphi(x,z) &=z-\gamma_{10}x-\sum_{m+n\ge2}\gamma_{mn}x^mz^n\\ &=z-Mr^{-1}x-\sum_{m+n\ge2}Mr^{-(m+n)}x^mz^n \end{split}$$

$$\zeta^0 =(\xi^0)^2, \tag{9.35}$$

$$\zeta^1 =\xi^0\xi^1, \tag{9.36}$$

$$\zeta^2 =(\xi^1)^2, \tag{9.37}$$

Some text after to test the below-display spacing.

```
\begin{gather*}
\begin{split} \varphi(x,z) &=z-\gamma_{10}x-\sum_{m+n\ge 2}\gamma_{mn}x^mz^n\\
&=z-Mr^{-1}x-\sum_{m+n\ge 2}Mr^{-(m+n)}x^mz^n \end{split}                  \\[6pt]
\begin{align}
\zeta^0&=(\xi^0)^2,\\  \zeta^1 &=\xi^0\xi^1,\\   \zeta^2 &=(\xi^1)^2,
\end{align}
\end{gather*}
```

9.10.6 Alignat

Numbered version:

$$V_i = v_i - q_i v_j, \qquad X_i = x_i - q_i x_j, \qquad U_i = u_i, \qquad \text{for } i \ne j; \tag{9.38}$$

$$V_j = v_j, \qquad X_j = x_j, \qquad U_j u_j + \sum_{i\ne j} q_i u_i. \tag{9.39}$$

Some text after to test the below-display spacing.

```
\begin{alignat}{3}
V_i & =v_i - q_i v_j, & \qquad X_i & = x_i - q_i x_j,
 & \qquad U_i & = u_i,  \qquad \text{for $i\ne j$;}\label{eq:B}\\
V_j & = v_j, & \qquad X_j & = x_j, & \qquad U_j & u_j + \sum_{i\ne j} q_i u_i.
\end{alignat}
```

Unnumbered version:

$$\begin{aligned} V_i &= v_i - q_i v_j, &\qquad X_i &= x_i - q_i x_j, &\qquad U_i &= u_i, \qquad \text{for } i \ne j; \\ V_j &= v_j, &\qquad X_j &= x_j, &\qquad U_j & u_j + \sum_{i\ne j} q_i u_i. \end{aligned}$$

Some text after to test the below-display spacing.

```
\begin{alignat*}3
V_i & =v_i - q_i v_j, & \qquad X_i & = x_i - q_i x_j,
 & \qquad U_i & = u_i,  \qquad \text{for $i\ne j$;} \\
V_j & = v_j, & \qquad X_j & = x_j, & \qquad U_j & u_j + \sum_{i\ne j} q_i u_i.
\end{alignat*}
```

The most common use for `alignat` is for things like

$$x = y \qquad \text{by (9.25)} \tag{9.40}$$

$$x' = y' \qquad \text{by (9.38)} \tag{9.41}$$

$$x + x' = y + y' \qquad \text{by Axiom 1.} \tag{9.42}$$

Some text after to test the below-display spacing.

```
\begin{alignat}{2}
x& =y && \qquad \text {by (\ref{eq:A})}\label{eq:C}\\
x'& = y' && \qquad \text {by (\ref{eq:B})}\label{eq:D}\\
x+x' & = y+y' && \qquad \text {by Axiom 1.}
\end{alignat}
```

The expanded version, `xalignat`:

$$x = y \qquad \text{by (9.40)} \tag{9.43}$$

$$x' = y' \qquad \text{by (9.41)} \tag{9.44}$$

$$x + x' = y + y' \qquad \text{by Axiom 1.} \tag{9.45}$$

Some text after to test the below-display spacing.

```
\begin{xalignat}{2}
x& =y && \text {by (\ref{eq:C})}\\
x'& = y' && \text {by (\ref{eq:D})}\\
x+x' & = y+y' && \text {by Axiom 1.}
\end{xalignat}
```

Appendix A: LaTeX tabular overview

Tables A.1 to A.15 show all characters available in standard LaTeX and some LaTeX commands. Table A.16 shows supplementary symbols, which become available with the `amssymb` option on the `\documentstyle` command.

α	`\alpha`	β	`\beta`	γ	`\gamma`	δ	`\delta`	ϵ	`\epsilon`
ε	`\varepsilon`	ζ	`\zeta`	η	`\eta`	θ	`\theta`	ϑ	`\vartheta`
ι	`\iota`	κ	`\kappa`	λ	`\lambda`	μ	`\mu`	ν	`\nu`
ξ	`\xi`	o	`o`	π	`\pi`	ϖ	`\varpi`	ρ	`\rho`
ϱ	`\varrho`	σ	`\sigma`	ς	`\varsigma`	τ	`\tau`	υ	`\upsilon`
ϕ	`\phi`	φ	`\varphi`	χ	`\chi`	ψ	`\psi`	ω	`\omega`
Γ	`\Gamma`	Δ	`\Delta`	Θ	`\Theta`	Λ	`\Lambda`	Ξ	`\Xi`
Π	`\Pi`	Σ	`\Sigma`	Υ	`\Upsilon`	Φ	`\Phi`	Ψ	`\Psi`
Ω	`\Omega`								

Table A.1: Greek Letters

$\pm$	`\pm`	$\cap$	`\cap`	$\diamond$	`\diamond`	$\oplus$	`\oplus`
$\mp$	`\mp`	$\cup$	`\cup`	$\bigtriangleup$	`\bigtriangleup`	$\ominus$	`\ominus`
$\times$	`\times`	$\uplus$	`\uplus`	$\bigtriangledown$	`\bigtriangledown`	$\otimes$	`\otimes`
$\div$	`\div`	$\sqcap$	`\sqcap`	$\triangleleft$	`\triangleleft`	$\oslash$	`\oslash`
$\ast$	`\ast`	$\sqcup$	`\sqcup`	$\triangleright$	`\triangleright`	$\odot$	`\odot`
$\star$	`\star`	$\vee$	`\vee`	$\lhd$	`\lhd`	$\bigcirc$	`\bigcirc`
$\circ$	`\circ`	$\wedge$	`\wedge`	$\rhd$	`\rhd`	$\dagger$	`\dagger`
$\bullet$	`\bullet`	$\setminus$	`\setminus`	$\unlhd$	`\unlhd`	$\ddagger$	`\ddagger`
$\cdot$	`\cdot`	$\wr$	`\wr`	$\unrhd$	`\unrhd`	$\amalg$	`\amalg`
$+$	`+`	$-$	`-`				

Table A.2: Binary Operation Symbols

$\leq$	`\leq`	$\geq$	`\geq`	$\equiv$	`\equiv`	$\models$	`\models`	$\prec$	`\prec`
$\succ$	`\succ`	$\sim$	`\sim`	$\perp$	`\perp`	$\preceq$	`\preceq`	$\succeq$	`\succeq`
$\simeq$	`\simeq`	$\mid$	`\mid`	$\ll$	`\ll`	$\gg$	`\gg`	$\asymp$	`\asymp`
$\parallel$	`\parallel`	$\subset$	`\subset`	$\supset$	`\supset`	$\approx$	`\approx`	$\bowtie$	`\bowtie`
$\subseteq$	`\subseteq`	$\supseteq$	`\supseteq`	$\cong$	`\cong`	$\Join$	`\Join`	$\sqsubset$	`\sqsubset`
$\sqsupset$	`\sqsupset`	$\neq$	`\neq`	$\smile$	`\smile`	$\sqsubseteq$	`\sqsubseteq`	$\sqsupseteq$	`\sqsupseteq`
$\doteq$	`\doteq`	$\frown$	`\frown`	$\in$	`\in`	$\ni$	`\ni`	$\propto$	`\propto`
$=$	`=`	$\vdash$	`\vdash`	$\dashv$	`\dashv`	$<$	`<`	$>$	`>`

Table A.3: Relation Symbols

$,$	`,`	$;$	`;`	$\colon$	`\colon`	$\ldotp$	`\ldotp`	$\cdotp$	`\cdotp`

Table A.4: Punctuation Symbols

$\leftarrow$	`\leftarrow`	$\longleftarrow$	`\longleftarrow`	$\uparrow$	`\uparrow`
$\Leftarrow$	`\Leftarrow`	$\Longleftarrow$	`\Longleftarrow`	$\Uparrow$	`\Uparrow`
$\rightarrow$	`\rightarrow`	$\longrightarrow$	`\longrightarrow`	$\downarrow$	`\downarrow`
$\Rightarrow$	`\Rightarrow`	$\Longrightarrow$	`\Longrightarrow`	$\Downarrow$	`\Downarrow`
$\leftrightarrow$	`\leftrightarrow`	$\longleftrightarrow$	`\longleftrightarrow`	$\updownarrow$	`\updownarrow`
$\Leftrightarrow$	`\Leftrightarrow`	$\Longleftrightarrow$	`\Longleftrightarrow`	$\Updownarrow$	`\Updownarrow`
$\mapsto$	`\mapsto`	$\longmapsto$	`\longmapsto`	$\nearrow$	`\nearrow`
$\hookleftarrow$	`\hookleftarrow`	$\hookrightarrow$	`\hookrightarrow`	$\searrow$	`\searrow`
$\leftharpoonup$	`\leftharpoonup`	$\rightharpoonup$	`\rightharpoonup`	$\swarrow$	`\swarrow`
$\leftharpoondown$	`\leftharpoondown`	$\rightharpoondown$	`\rightharpoondown`	$\nwarrow$	`\nwarrow`

Table A.5: Arrow Symbols

<table>
<tr><td>$\ldots$</td><td><code>\ldots</code></td><td>$\cdots$</td><td><code>\cdots</code></td><td>$\vdots$</td><td><code>\vdots</code></td><td>$\ddots$</td><td><code>\ddots</code></td><td>$\aleph$</td><td><code>\aleph</code></td></tr>
<tr><td>$\prime$</td><td><code>\prime</code></td><td>$\forall$</td><td><code>\forall</code></td><td>∞</td><td><code>\infty</code></td><td>$\hbar$</td><td><code>\hbar</code></td><td>$\emptyset$</td><td><code>\emptyset</code></td></tr>
<tr><td>$\exists$</td><td><code>\exists</code></td><td>∇</td><td><code>\nabla</code></td><td>$\surd$</td><td><code>\surd</code></td><td>$\Box$</td><td><code>\Box</code></td><td>$\triangle$</td><td><code>\triangle</code></td></tr>
<tr><td>$\Diamond$</td><td><code>\Diamond</code></td><td>$\imath$</td><td><code>\imath</code></td><td>$\jmath$</td><td><code>\jmath</code></td><td>ℓ</td><td><code>\ell</code></td><td>$\neg$</td><td><code>\neg</code></td></tr>
<tr><td>$\top$</td><td><code>\top</code></td><td>$\flat$</td><td><code>\flat</code></td><td>$\natural$</td><td><code>\natural</code></td><td>$\sharp$</td><td><code>\sharp</code></td><td>$\wp$</td><td><code>\wp</code></td></tr>
<tr><td>$\bot$</td><td><code>\bot</code></td><td>$\clubsuit$</td><td><code>\clubsuit</code></td><td>$\diamondsuit$</td><td><code>\diamondsuit</code></td><td>$\heartsuit$</td><td><code>\heartsuit</code></td><td>$\spadesuit$</td><td><code>\spadesuit</code></td></tr>
<tr><td>$\backslash$</td><td><code>\backslash</code></td><td>$\Re$</td><td><code>\Re</code></td><td>$\Im$</td><td><code>\Im</code></td><td>$\angle$</td><td><code>\angle</code></td><td>∂</td><td><code>\partial</code></td></tr>
<tr><td>$\|$</td><td><code>\|</code></td><td>$\mho$</td><td><code>\mho</code></td><td>$.$</td><td><code>.</code></td><td>$|$</td><td><code>|</code></td><td></td><td></td></tr>
</table>

Table A.6: Miscellaneous Symbols

$\sum$	`\sum`	$\prod$	`\prod`	$\coprod$	`\coprod`	$\int$	`\int`	$\oint$	`\oint`
$\bigcap$	`\bigcap`	$\bigcup$	`\bigcup`	$\bigsqcup$	`\bigsqcup`	$\bigvee$	`\bigvee`	$\bigwedge$	`\bigwedge`
$\bigodot$	`\bigodot`	$\bigotimes$	`\bigotimes`	$\bigoplus$	`\bigoplus`	$\biguplus$	`\biguplus`	$\oint$	`\oint`

Table A.7: Variable-sized Symbols

`\arccos`	`\cos`	`\csc`	`\exp`	`\ker`	`\limsup`	`\min`	`\sinh`
`\arcsin`	`\cosh`	`\deg`	`\gcd`	`\lg`	`\ln`	`\Pr`	`\sup`
`\arctan`	`\cot`	`\det`	`\hom`	`\lim`	`\log`	`\sec`	`\tan`
`\arg`	`\coth`	`\dim`	`\inf`	`\liminf`	`\max`	`\sin`	`\tanh`

Table A.8: Log-like Symbols

<table>
<tr><td>$($</td><td><code>(</code></td><td>$)$</td><td><code>)</code></td><td>$\uparrow$</td><td><code>\uparrow</code></td><td>$\Uparrow$</td><td><code>\Uparrow</code></td></tr>
<tr><td>$[$</td><td><code>[</code></td><td>$]$</td><td><code>]</code></td><td>$\downarrow$</td><td><code>\downarrow</code></td><td>$\Downarrow$</td><td><code>\Downarrow</code></td></tr>
<tr><td>$\{$</td><td><code>\{</code></td><td>$\}$</td><td><code>\}</code></td><td>$\updownarrow$</td><td><code>\updownarrow</code></td><td>$\Updownarrow$</td><td><code>\Updownarrow</code></td></tr>
<tr><td>$\lfloor$</td><td><code>\lfloor</code></td><td>$\rfloor$</td><td><code>\rfloor</code></td><td>$\lceil$</td><td><code>\lceil</code></td><td>$\rceil$</td><td><code>\rceil</code></td></tr>
<tr><td>$\langle$</td><td><code>\langle</code></td><td>$\rangle$</td><td><code>\rangle</code></td><td>$/$</td><td><code>/</code></td><td>$\backslash$</td><td><code>\backslash</code></td></tr>
<tr><td>$|$</td><td><code>|</code></td><td>$\|$</td><td><code>\|</code></td><td></td><td></td><td></td><td></td></tr>
</table>

Table A.9: Delimiters

$\rmoustache$	\rmoustache	$\lmoustache$	\lmoustache	$\rgroup$	\rgroup	$\lgroup$	\lgroup
$\arrowvert$	\arrowvert	$\Arrowvert$	\Arrowvert	$\bracevert$	\bracevert		

Table A.10: Large Delimiters

$\hat{a}$	\hat{a}	$\acute{a}$	\acute{a}	$\bar{a}$	\bar{a}	$\dot{a}$	\dot{a}	$\breve{a}$	\breve{a}
$\check{a}$	\check{a}	$\grave{a}$	\grave{a}	$\vec{a}$	\vec{a}	$\ddot{a}$	\ddot{a}	$\tilde{a}$	\tilde{a}

Table A.11: Math mode accents

ò	\`o	ó	\'o	ô	\^o	õ	\~o	ō	\=o	ȯ	\.o		
ŏ	\u{o}	ǒ	\v{o}	ő	\H{o}	Ç	\c{O}	ọ	\d{o}	o̲	\b{o}	o͡o	\t{oo}
œ	{\oe}	Œ	{\OE}	æ	{\ae}	Æ	{\AE}	å	{\aa}	Å	{\AA}		
ø	{\o}	Ø	{\O}	ł	{\l}	Ł	{\L}	¿	?`	¡	!`		

Table A.12: Accents and foreign language symbols in text mode

\tiny	Some text	\scriptsize	Some text
\footnotesize	Some text	\small	Some text
\normalsize	Some text	\large	Some text
\Large	Some text	\LARGE	Some text
\huge	Some text	\Huge	Some text

Table A.13: Font sizes — text mode only

\rm	Roman	\it	*Italic*	\sc	SMALL CAPS	\bf	**Bold Face**
\sl	*Slanted*	\sf	Sans Serif	\tt	`Typewriter`		

Table A.14: Font types

$\widetilde{abc}$	\widetilde{abc}	$\widehat{abc}$	\widehat{abc}	$\overleftarrow{abc}$	\overleftarrow{abc}
$\overrightarrow{abc}$	\overrightarrow{abc}	$\overline{abc}$	\overline{abc}	$\underline{abc}$	\underline{abc}
$\overbrace{abc}$	\overbrace{abc}	$\underbrace{abc}$	\underbrace{abc}	$\sqrt{abc}$	\sqrt{abc}
$\sqrt[n]{abc}$	\sqrt[n]{abc}	f'	f'	$\frac{abc}{xyz}$	\frac{abc}{xyz}

Table A.15: Some other constructs

$\boxdot$	\boxdot	$\boxplus$	\boxplus	$\boxtimes$	\boxtimes	$\square$	\square
$\blacksquare$	\blacksquare	$\centerdot$	\centerdot	$\lozenge$	\lozenge	$\blacklozenge$	\blacklozenge
$\circlearrowright$	\circlearrowright	$\circlearrowleft$	\circlearrowleft	$\rightleftharpoons$	\rightleftharpoons	$\leftrightharpoons$	\leftrightharpoons
$\boxminus$	\boxminus	$\Vdash$	\Vdash	$\Vvdash$	\Vvdash	$\vDash$	\vDash
$\twoheadrightarrow$	\twoheadrightarrow	$\twoheadleftarrow$	\twoheadleftarrow	$\leftleftarrows$	\leftleftarrows	$\rightrightarrows$	\rightrightarrows
$\upuparrows$	\upuparrows	$\downdownarrows$	\downdownarrows	$\upharpoonright$	\upharpoonright	$\downharpoonright$	\downharpoonright
$\upharpoonleft$	\upharpoonleft	$\downharpoonleft$	\downharpoonleft	$\rightarrowtail$	\rightarrowtail	$\leftarrowtail$	\leftarrowtail
$\leftrightarrows$	\leftrightarrows	$\rightleftarrows$	\rightleftarrows	$\Lsh$	\Lsh	$\Rsh$	\Rsh
$\rightsquigarrow$	\rightsquigarrow	$\leftrightsquigarrow$	\leftrightsquigarrow	$\looparrowleft$	\looparrowleft	$\looparrowright$	\looparrowright
$\circeq$	\circeq	$\succsim$	\succsim	$\gtrsim$	\gtrsim	$\gtrapprox$	\gtrapprox
$\multimap$	\multimap	$\therefore$	\therefore	$\because$	\because	$\doteqdot$	\doteqdot
$\triangleq$	\triangleq	$\precsim$	\precsim	$\lesssim$	\lesssim	$\lessapprox$	\lessapprox
$\eqslantless$	\eqslantless	$\eqslantgtr$	\eqslantgtr	$\curlyeqprec$	\curlyeqprec	$\curlyeqsucc$	\curlyeqsucc
$\preccurlyeq$	\preccurlyeq	$\leqq$	\leqq	$\leqslant$	\leqslant	$\lessgtr$	\lessgtr
$\backprime$	\backprime	$\risingdotseq$	\risingdotseq	$\fallingdotseq$	\fallingdotseq	$\succcurlyeq$	\succcurlyeq
$\geqq$	\geqq	$\geqslant$	\geqslant	$\gtrless$	\gtrless	$\sqsubset$	\sqsubset
$\sqsupset$	\sqsupset	$\vartriangleright$	\vartriangleright	$\vartriangleleft$	\vartriangleleft	$\trianglerighteq$	\trianglerighteq
$\trianglelefteq$	\trianglelefteq	$\bigstar$	\bigstar	$\between$	\between	$\blacktriangledown$	\blacktriangledown
$\blacktriangleright$	\blacktriangleright	$\blacktriangleleft$	\blacktriangleleft	$\vartriangle$	\vartriangle	$\blacktriangle$	\blacktriangle
$\triangledown$	\triangledown	$\eqcirc$	\eqcirc	$\lesseqgtr$	\lesseqgtr	$\gtreqless$	\gtreqless
$\lesseqqgtr$	\lesseqqgtr	$\gtreqqless$	\gtreqqless	$\Rrightarrow$	\Rrightarrow	$\Lleftarrow$	\Lleftarrow
$\veebar$	\veebar	$\barwedge$	\barwedge	$\doublebarwedge$	\doublebarwedge	$\angle$	\angle
$\measuredangle$	\measuredangle	$\sphericalangle$	\sphericalangle	$\varpropto$	\varpropto	$\smallsmile$	\smallsmile
$\smallfrown$	\smallfrown	$\Subset$	\Subset	$\Supset$	\Supset	$\Cup$	\Cup
$\Cap$	\Cap	$\curlywedge$	\curlywedge	$\curlyvee$	\curlyvee	$\leftthreetimes$	\leftthreetimes
$\rightthreetimes$	\rightthreetimes	$\subseteqq$	\subseteqq	$\supseteqq$	\supseteqq	$\bumpeq$	\bumpeq
$\Bumpeq$	\Bumpeq	$\lll$	\lll	$\ggg$	\ggg	$\circledS$	\circledS
$\pitchfork$	\pitchfork	$\dotplus$	\dotplus	$\backsim$	\backsim	$\backsimeq$	\backsimeq
$\complement$	\complement	$\intercal$	\intercal	$\circledcirc$	\circledcirc	$\circledast$	\circledast
$\circleddash$	\circleddash	$\ulcorner$	\ulcorner	$\urcorner$	\urcorner	$\llcorner$	\llcorner
$\lrcorner$	\lrcorner		\yen	$\checkmark$	\checkmark	$\circledR$	\circledR
$\maltese$	\maltese	$\lvertneqq$	\lvertneqq	$\gvertneqq$	\gvertneqq	$\nleq$	\nleq
$\ngeq$	\ngeq	$\nless$	\nless	$\ngtr$	\ngtr	$\nprec$	\nprec
$\nsucc$	\nsucc	$\lneqq$	\lneqq	$\gneqq$	\gneqq	$\nleqslant$	\nleqslant
$\ngeqslant$	\ngeqslant	$\lneq$	\lneq	$\gneq$	\gneq	$\npreceq$	\npreceq
$\nsucceq$	\nsucceq	$\precnsim$	\precnsim	$\succnsim$	\succnsim	$\lnsim$	\lnsim
$\gnsim$	\gnsim	$\nleqq$	\nleqq	$\ngeqq$	\ngeqq	$\precneqq$	\precneqq
$\succneqq$	\succneqq	$\precnapprox$	\precnapprox	$\succnapprox$	\succnapprox	$\lnapprox$	\lnapprox
$\gnapprox$	\gnapprox	$\nsim$	\nsim	$\varkappa$	\varkappa	$\varsubsetneq$	\varsubsetneq
$\varsupsetneq$	\varsupsetneq	$\nsubseteqq$	\nsubseteqq	$\nsupseteqq$	\nsupseteqq	$\subsetneqq$	\subsetneqq
$\supsetneqq$	\supsetneqq	$\varsubsetneqq$	\varsubsetneqq	$\varsupsetneqq$	\varsupsetneqq	$\subsetneq$	\subsetneq
$\supsetneq$	\supsetneq	$\nsubseteq$	\nsubseteq	$\nsupseteq$	\nsupseteq	$\nparallel$	\nparallel
$\nmid$	\nmid	$\nshortmid$	\nshortmid	$\nshortparallel$	\nshortparallel	$\nvdash$	\nvdash
$\nVdash$	\nVdash	$\nvDash$	\nvDash	$\nVDash$	\nVDash	$\ntrianglerighteq$	\ntrianglerighteq
$\ntrianglelefteq$	\ntrianglelefteq	$\ntriangleleft$	\ntriangleleft	$\ntriangleright$	\ntriangleright	$\nleftarrow$	\nleftarrow
$\nrightarrow$	\nrightarrow	$\nLeftarrow$	\nLeftarrow	$\nRightarrow$	\nRightarrow	$\nLeftrightarrow$	\nLeftrightarrow
$\nleftrightarrow$	\nleftrightarrow	$\divideontimes$	\divideontimes	$\varnothing$	\varnothing	$\nexists$	\nexists
$\mho$	\mho	$\backepsilon$	\backepsilon	$\beth$	\beth	$\gimel$	\gimel
$\daleth$	\daleth	$\lessdot$	\lessdot	$\gtrdot$	\gtrdot	$\ltimes$	\ltimes
$\rtimes$	\rtimes	$\shortmid$	\shortmid	$\shortparallel$	\shortparallel	$\smallsetminus$	\smallsetminus
$\thicksim$	\thicksim	$\thickapprox$	\thickapprox	$\approxeq$	\approxeq	$\succapprox$	\succapprox
$\precapprox$	\precapprox	$\curvearrowleft$	\curvearrowleft	$\curvearrowright$	\curvearrowright	$\digamma$	\digamma
$\hslash$	\hslash	$\hbar$	\hbar				

Blackboard Math	`$\Bbb A \Bbb B ...$`	$\mathbb{A}\ \mathbb{B}\ \mathbb{C}\ \mathbb{D}\ \mathbb{E}\ \mathbb{F}$
Fraktur	`$\frak A \frak b ...$`	$\mathfrak{A}\ \mathfrak{b}\ \mathfrak{F}\ \mathfrak{g}\ \mathfrak{M}\ \mathfrak{n}$

Table A.16: Supplementary AMS symbols (available with amssymb option to LaTeX users)

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