Preparing an article for publication in an Institute of Physics Publishing journal using LaTeX 2$_\varepsilon$

Neil Scriven† and Romneya Robertson‡§

† Production Editor, Institute of Physics Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK

‡ Electronic Services Specialist, Institute of Physics Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK

Abstract. This document describes the preparation of an article using LaTeX 2$_\varepsilon$ and `iopart.cls` (the IOP LaTeX 2$_\varepsilon$ preprint class file). This class file is designed to help authors produce preprints in a form suitable for submission to any of the journals published by Institute of Physics Publishing.

Authors submitting to any IOP journal, i.e. to double-column journals as well as the single-column ones, should follow the guidelines set out here. On acceptance, their source code will be converted to the appropriate journal format at Institute of Physics Publishing. For the printed version, Times fonts (and Helvetica in double-column journals) will be used instead of the Computer Modern used in the preprint form.

§ To whom correspondence should be addressed (romneya.robertson@iop.org)

1. Introduction

Many authors use LaTeX to produce their typescripts and we can use the source code to produce the printed version; this gives more rapid publication with a smaller chance of typographical error.

We explain here the procedures and specific requirements for the preparation and presentation of text and illustrations for articles in LaTeX 2_ε using the IOPP class file `iopart.cls`. We also illustrate `iopart.cls` through its use in the creation of this document. The class file and accompanying documentation are available to all authors and copies can be obtained (free of charge)

- from the World Wide Web (`http://www.iop.org/Journals/texstyle`) by downloading zipped files for PCs or tar compressed format files for Unix
- from the World Wide Web by using our Author Enquiry Service (`http://www.iop.org/Journals/AES`) to request that the files be sent on disk
- by contacting the Electronic Services Specialist, Institute of Physics Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK (`esub@ioppublishing.co.uk`) and requesting the files be sent by e-mail or on $3\frac{1}{2}$ inch PC or Macintosh disk

There are 10 and 12 point versions of the style, but the 12pt version should be used for preprints and is selected by opening the file with the initial line:

```
\documentclass[12pt]{iopart}
```

If the `[12pt]` is omitted the article will be set in 10pt type (i.e. in the same size type as in the printed journal). The 12pt version of the style gives a 'preprint' form with a page width and type size 1.2 times larger than that for normal single-column journals with extra spacing between lines. The page depth is less than 1.2 times the normal page depth so that articles will fit on the page on both A4 and Letter paper. This form is the one required for the initial submission of a typescript for refereeing and copy editing. Authors need not aim to optimize the line and page breaks as they will inevitably change when converted to the final format for printing.

The 10 pt version has the same page dimensions and type sizes as a single-column journal and shows approximately how the text would appear in print. It can also be used to produce camera-ready copy for journal special issues.

Other compatible LaTeX 2_ε packages can be used if they are available in the normal distribution of LaTeX 2_ε; if it is essential to use a non-standard package then the extra files needed to process the article must also be sent in. Authors should be aware that the final version will be printed on a different page size and using different fonts to the preprint version so that any special effects used should not contain material that is not easily scalable.

We recommend that authors use the IOPP LaTeX 2_ε class file; however articles prepared using almost any version of TeX or LaTeX can be handled ($\mathcal{AMS}$TeX, L$\mathcal{AMS}$TeX, PHYZZX, etc) and authors not using the IOPP style files can submit their source code in the way described below. Alterations to the source code will be made in-house by the Production Department in order to conform to IOPP house style and journal format.

We aim to maintain our normal standards for articles published from TEX and LATEX files so we reserve the right to make small alterations to clarify and improve the English where necessary and to put the article into IOPP house style.

1.1. Double-column journals

Authors writing for double-column journals should also use the IOPP preprint macros. Conversion from the single-column format to the double-column output required for printing will be done by the Production Department at Institute of Physics Publishing.

2. Submitting new articles

2.1. Sending in files for submission to internally refereed journals

Articles for consideration for publication in the journals listed in table 1 may be submitted electronically without the need to supply hard copies of the manuscript. Those journals are refereed internally. Articles for consideration by all other IOPP journals must be submitted in hard copy form. Electronic files can then be sent in on acceptance or when requested by the editor.

Authors are asked to prepare their articles using the 12pt style and submit by World Wide Web upload, e-mail, FTP or on PC or Mac floppy disk. Please send all files necessary to reproduce your article, including the article itself and all figure files. Combine all your files into a single archive using a compression or archiving program. Utilities like WinZIP or StuffIt will both archive and compress your files. Alternatively you could archive your files using a program like TAR and compress the resulting file using gzip.

2.2. By World Wide Web upload

Users of Netscape (version 2 or higher) or Internet Explorer (version 4 or higher) can submit using our World Wide Web upload form. This can be found at `http://www.iop.org/Journals/authorsubs` Complete the on-line form with information about your submission and then upload your article in one of two ways.

(i) Having created a single compressed file containing an archive of your text and graphics files, use the 'Browse...' button on the form to select that file.

(ii) If your article has already been posted to the LANL e-print archive, select the archive name and enter the e-print number. (*Note*: We cannot download your paper from the LANL e-print server until it has been publicly released, usually by 10 pm on the day you submitted it there.) Use the 'Transfer File' button at the bottom of the form to submit your file.

2.3. By E-mail

Files should be sent to the relevant journal mailbox (see table 1). Please send articles as attachments to e-mail messages. Any additional files such as figure files should be combined into a single archive with the article file as described in section 2.1. All information about the submission should be included in the main body of the message. This must include:

- Your full name
- The name of the journal to which you are submitting
- The full title of the article
- The full list of authors
- The article type (e.g. Paper, Letter to the Editor etc.)
- The status of the article (i.e. new revised or accepted)
- Your postal address
- Your e-mail address
- Your telephone number
- Your fax number (if applicable)
- The article file format (i.e. LaTeX 2_ε)
- The number of separate figure files

2.4. By FTP

Create a file named `readme.txt` containing all your submission information (e.g. your name, the name of the journal you are submitting to etc. See section 2.3 for full list). Create a single compressed file containing an archive of your text and graphics files along with the file `readme.txt`. Files should be sent by anonymous FTP to `ftp.iop.org`. Please logon with the username *anonymous* and use your e-mail address as the password. Change to the directory `/incoming` and then change to the directory of the journal to which you wish to submit and upload your files. Please do not create any new directories on our server. Your files will remain in the `/incoming` directory for no more than 90 minutes before they are moved to a secure location.

2.5. On Floppy Disk

Files may be sent in on 3.5 inch PC or Apple Macintosh formatted disk. Please include a file named `readme.txt` containing all your submission information as described above.

3. Preparing your article

Using LaTeX with the `iopart` class file provides a simple way of producing an article in a form suitable for publication in one of the IOPP journals. Authors may add their

Table 1. E-mail addresses for all the journals to which authors can submit electronically.

Journal	E-mail address
Journal of Physics A: Mathematical and General	jphysa@ioppublishing.co.uk
Journal of Physics B: Atomic, Molecular and Optical Physics	jphysb@ioppublishing.co.uk
Journal of Physics: Condensed Matter	jpcm@ioppublishing.co.uk
Journal of Physics D: Applied Physics	jphysd@ioppublishing.co.uk
Journal of Physics G: Nuclear and Particle Physics	jphysg@ioppublishing.co.uk
Classical and Quantum Gravity	cqg@ioppublishing.co.uk
Combustion Theory and Modelling	ctm@ioppublishing.co.uk
European Journal of Physics	ejp@ioppublishing.co.uk
Inverse Problems	ip@ioppublishing.co.uk
High Performance Polymers	hpp@ioppublishing.co.uk
Journal of Micromechanics and Microengineering	jmm@ioppublishing.co.uk
Journal of Optics A: Pure and Applied Optics	jopa@ioppublishing.co.uk
Journal of Optics B: Quantum and Semiclassical Optics	jopb@ioppublishing.co.uk
Measurement Science and Technology	mst@ioppublishing.co.uk
Nanotechnology	nano@ioppublishing.co.uk
Nonlinearity	non@ioppublishing.co.uk
New Journal of Physics	njp@ioppublishing.co.uk
Physics Education	ped@ioppublishing.co.uk
Physics in Medicine and Biology	pmb@ioppublishing.co.uk
Physiological Measurement	pmea@ioppublishing.co.uk
Plasma Physics and Controlled Fusion	ppcf@ioppublishing.co.uk
Reports on Progress in Physics	rop@ioppublishing.co.uk
Semiconductor Science and Technology	sst@ioppublishing.co.uk
Superconductor Science and Technology	sust@ioppublishing.co.uk
Waves in Random Media	wrm@ioppublishing.co.uk

own macros at the start of an article provided they do not overwrite existing definitions and that they send copies of their new macros with their text file. `iopart` can be used with other package files such as those loading the AMS extension fonts `msam` and `msbm` (these fonts provide the blackboard bold alphabet and various extra maths symbols as well as symbols useful in figure captions); an extra style file `iopams.sty` is provided to load these packages and provide extra definitions for bold Greek letters.

In preparing your article you are requested to follow these guidelines as closely as possible; this will minimize the amount of file editing required and will hasten the production process. This is particularly important with regard to the reference list.

The file name can be up to eight characters long with the suffix `.tex`. Please use files names that are likely to be unique, and include commented material to identify the journal, author and reference number if known. The first non-commented line should be `\documentclass[12pt]{iopart}` to load the preprint class file. Other standard predeclared option files can be included in square brackets; copies of any non-standard options must be sent in with the source code. Omitting `[12pt]` produces an article with the normal journal page and type sizes. Macros for the individual paper not included in a style file should be inserted in the preamble to the paper with comments to describe any complex or non-obvious ones. The start of the article text is signalled by `\begin{document}`. Authors of very long articles may find it convenient to separate their article into a series of files each containing a section, each of which is called in turn by the primary file.

4. The title and abstract page

The code for setting the title page information is slightly different from the normal default in LaTeX.

4.1. Titles and article types

The title is set in bold unjustified type using the command `\title{#1}`, where `#1` is the title of the article. The first letter of the title should be capitalized with the rest in lower case. Mathematical expressions within the title may be left in light-face type rather than bold because the Computer Modern bold maths and symbol fonts may not be available at the size required for the title. The final printed version will have bold mathematical expressions in the title. If the title is unsuitable for use as a running head a short form can be provided as an optional argument (in square brackets) before the full title, i.e. `\title[Short title]{Full title}`. A short title is required when the title itself is too long to be used as the short title or when the title contains a footnote.

For article types other than papers the IOPP class file, `iopart.cls`, allows a generic heading `\article[Short title]{TYPE}{Full title}` and the specific definitions given in table 2. In each case (apart from Letters to the Editor) an optional argument can be used immediately after the control sequence name to specify the short title; where no short title is given the full title will be used as the running head at the top of each page apart from the first. For Letters no short title is required as the running head is automatically defined to be *Letter to the Editor*. The generic heading could be used for articles such as those presented at a conference or workshop, e.g.

```
\article[Short title]{WORKSHOP ON HIGH-ENERGY PHYSICS}{Title}
```

4.2. Authors' names and addresses

The next information required is the list of authors' names and their affiliations. For the authors' names type `\author{#1}`, where `#1` is the list of all authors' names. The style for the names is initials then surname, with a comma after all but the last two names,

Table 2. Types of article defined in the `iopart.cls` class file.

Command	Type	Heading on first page
`\title{#1}`	Paper	—
`\review{#1}`	Review	REVIEW
`\topical{#1}`	Topical review	TOPICAL REVIEW
`\comment{#1}`	Comment	COMMENT
`\note{#1}`	Note	NOTE
`\paper{#1}`	Paper	—
`\prelim{#1}`	Preliminary communication	PRELIMINARY COMMUNICATION
`\rapid{#1}`	Rapid communication	RAPID COMMUNICATION
`\letter{#1}`	Letter	LETTER TO THE EDITOR
`\article{#1}{#2}`	Other articles	Whatever is entered as `#1`

which are separated by 'and'. Initials should *not* have full stops. First names may be used if desired. If the authors are at different addresses one of the symbols †, ‡, §, ‖, ¶, $^+$, *, ♯ should be used after each surname to reference an author to his/her address. The symbols should be used in the order given. If an author has additional information to appear as a footnote, such as a permanent address, and the footnote symbols are not being used to identify an address, the footnote should be entered after the surname as a normal LaTeX footnote, without specifying a sign. Where footnote symbols are being used to indicate which address the author is at, the symbol used for a footnote should be the next one from the list given above and has to be selected individually using the command `\footnote[<num>]{Text of footnote}`, where `<num>` is a number representing the position of the desired symbol in the list above, i.e. 1 for †, 2 for ‡, etc.

The addresses of the authors' affiliations follow the list of authors. Each address is set by using `\address{#1}` with the address as the single parameter in braces. If there is more than one address then the appropriate symbol should come at the start of the address.

Please also add the corresponding author's e-mail address if applicable. This is done by inserting the command `\ead{#1}` before the command `\maketitle` where `#1` is the e-mail address. See section 4.6 for sample coding. For more than one e-mail address, please use the command `\eads{\mailto{#1}, \mailto{#2}}` with `\mailto` surrounding each e-mail address. These macros allow us to convert e-mail addresses to 'mailto' links when articles are published on our website.

4.3. The abstract

The abstract follows the addresses and should give readers concise information about the content of the article and indicate the main results obtained and conclusions drawn. It should be complete in itself with no table numbers, figure numbers or references included and should not normally exceed 200 words. To indicate the start of the abstract type `\begin{abstract}` followed by the text of the abstract (not in braces). The abstract should normally be restricted to a single paragraph and is terminated by the command `\end{abstract}`

4.4. Subject classification numbers

Following the abstract come any Physics and Astronomy Classification System (PACS) codes or American Mathematical Society (AMS) classification scheme numbers. The command `\pacs{#1}`, with the subject classification numbers from the Physics and Astronomy Classification Scheme as the parameter, defines the subject area of the paper (or for a single number `\pacno{#1}`). If PACS numbers are not readily available, *Physics Abstracts* classification scheme numbers can be given instead. If this command is omitted the classification numbers for indexing will be allocated by IOPP staff. It is unnecessary to supply PACS numbers for *Inverse Problems* and *Physics in Medicine and Biology*. AMS classification numbers may be given as well as, or instead of, PACS numbers for mathematical articles, they are specified using the command `\ams{#1}`. After any classification numbers the command `\submitto{#1}` can be inserted, where `#1` is the journal name written in full or the appropriate control sequence as given in B1. This will print a line indicating that the article has been submitted to one of the Institute of Physics journals. The command is not essential to the running of the file.

4.5. Making a separate title page

The command `\maketitle` forces a page break after the point where it is inserted and so to keep the header material on a separate page from the body of the text insert `\maketitle` or `\newpage` after the classification codes or the end of the abstract. If `\maketitle` is not included the text of the article will start immediately after the abstract.

4.6. Sample coding for the start of an article

The code for the start of a title page of a typical paper might read:

```
\documentclass[12pt]{iopart}
\begin{document}
\title[The anomalous magnetic moment of the
neutrino]{The anomalous magnetic moment of the
neutrino and its relation to the solar neutrino problem}

\author{P J Smith\dag, T M Collins\ddag,
R J Jones\ddag\footnote[3]{Present address:
Department of Physics, University of Bristol, Tyndalls Park Road,
Bristol BS8 1TS, UK.} and Janet Williams\P}
```

```
\address{\dag\ Mathematics Faculty, Open University,
Milton Keynes MK7~6AA, UK}
\address{\ddag\ Department of Mathematics,
Imperial College, Prince Consort Road, London SW7~2BZ, UK}
\address{\P\ Department of Computer Science,
University College London, Gower Street, London WC1E~6BT, UK}

\ead{williams@ucl.ac.uk}

\begin{abstract}
...
\end{abstract}

\submitto{\JPG}
\pacs{1315, 9440T}

\maketitle
```

4.7. AMS macros

Please do not use the style file `amsmath.sty` (part of the AMSTeX package) in conjunction with `iopart.cls`. This will result in several errors. To make use of the macros defined in `amsmath.sty`, we have provided the file `setstack.sty` which reproduces the following useful macros from `amsmath.sty`:

```
\overset
\underset
\sideset
\substack
\boxed
\leftroot
\uproot
\dddot
\ddddot
\varrow
\harrow
```

5. The text

5.1. Sections, subsections and subsubsections

The text of papers and reviews, but not comments or letters, should be divided into sections, subsections and, where necessary, subsubsections. To start a new section, end the previous paragraph and then include `\section` followed by the section heading within braces. Numbering of sections is done *automatically* in the headings: sections will be numbered 1, 2, 3, etc, subsections will be numbered 2.1, 2.2, 3.1, etc, and subsubsections will be numbered 2.3.1, 2.3.2, etc. Cross references to other sections in the text should, where possible, be made using labels (see section 8) but can also be made manually. See section 6.7 for information on the numbering of displayed equations. Subsections and subsubsections are similar to sections but the commands are `\subsection` and `\subsubsection` respectively. Sections have a bold heading, subsections an italic heading and subsubsections an italic heading with the text following on directly.

```
\section{This is the section title}
\subsection{This is the subsection title}
```

The first section is normally an introduction, which should state clearly the object of the work, its scope and the main advances reported, with brief references to relevant results by other workers. In long papers it is helpful to indicate the way in which the paper is arranged and the results presented.

For articles not divided into sections, precede the start of the text (without leaving a blank line) with the command `\nosections`, which provides the appropriate space and causes the paragraph indentation to be cancelled for the first paragraph.

Footnotes should be avoided whenever possible. If required they should be used only for brief notes that do not fit conveniently into the text. The standard LaTeX macro `\footnote` should be used and will normally give an appropriate symbol; if a footnote sign needs to be specified directly `\footnote[<num>]{Text}` can be used instead where `<num>` is the number of the appropriate symbol as discussed in relation to authors (1 = `\dag`, 2 = `\ddag`, 3 = `\S`, etc).

5.2. Acknowledgments

Authors wishing to acknowledge assistance or encouragement from colleagues, special work by technical staff or financial support from organizations should do so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper. The command `\ack` sets the acknowledgments heading as an unnumbered section. For Letters `\ack` does not set a heading but leaves a line space and does not indent the next paragraph.

5.3. Appendices

Technical detail that it is necessary to include, but that interrupts the flow of the article, may be consigned to an appendix. Any appendices should be included at the end of the main text of the paper, after the acknowledgments section (if any) but before the reference list. If there are two or more appendices they will be called Appendix A,

Appendix B, etc. Numbered equations will be in the form (A.1), (A.2), etc, figures will appear as figure A1, figure B1, etc and tables as table A1, table B1, etc.

The command `\appendix` is used to signify the start of the appendixes. Thereafter `\section`, `\subsection`, etc, will give headings appropriate for an appendix. To obtain a simple heading of 'Appendix' use the code `\section*{Appendix}`. If it contains numbered equations, figures or tables the command `\appendix` should precede it and `\setcounter{section}{1}` must follow it.

5.4. Some matters of style

It will help your readers if your article is written in a clear, consistent and concise manner. The Production Department at Institute of Physics Publishing will try to make sure that your work is presented to its readers in the best possible way without sacrificing the individuality of your writing.

The main elements of consistency and style we look for are presented in the booklet *Notes for Authors* (available upon request from Institute of Physics Publishing, Dirac House, Temple Back, Bristol, BS1 6BE, UK or from our World Wide Web site (`http://www.iop.org/Journals/nfa/`). Some recommended points to note, however, are the following.

(i) Authors are often inconsistent in the use of 'ize' and 'ise' endings. We recommend using '-ize' spellings (diagonalize, renormalization, minimization, etc) but there are some common exceptions to this, for example: devise, promise and advise.

(ii) English spellings are preferred (colour, flavour, behaviour, tunnelling, artefact, focused, focusing, fibre, etc). We write of a computer program on disk; otherwise, we use 'programme' and 'disc'.

(iii) The words table, figure, equation and reference should be written in full and **not** contracted to Tab., fig., eq. and ref.

Please check your article carefully for accuracy, consistency and clarity before submission. Remember that your article will probably be read by many people whose native language is not English and who may not therefore be aware of many of the subtle meanings of words or idiomatic phases present in the English language. It therefore helps if you try and keep sentences as short and simple as possible.

6. Mathematics

6.1. Two-line constructions

The great advantage of LaTeX over other text processing systems is its ability to handle mathematics to almost any degree of complexity. However, in order to produce an article suitable for publication within a journal, authors should exercise some restraint on the constructions used. For simple fractions in the text the solidus `/`, as in $\lambda/2\pi$, should be used instead of `\frac` or `\over`, care being taken to use parentheses where necessary to avoid ambiguity, for example to distinguish between $1/(n-1)$ and $1/n-1$. Exceptions to this are the proper fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{3}{4}$, etc, which are better left in this form. In displayed equations horizontal lines are preferable to solidi provided the equation is kept within a height of two lines. A two-line solidus should be avoided where possible; the construction $(\ldots)^{-1}$ should be used instead; for example use:

$$\frac{1}{M_{\rm a}}\left(\int_0^\infty \mathrm{d}\omega\,\frac{|S_o|^2}{N}\right)^{-1}$$

instead of

$$\frac{1}{M_{\rm a}}\biggl/\int_0^\infty \mathrm{d}\omega\,\frac{|S_o|^2}{N}.$$

6.2. Roman and italic in mathematics

In mathematics mode LaTeX automatically sets variables in an italic font. In most cases authors should accept this italicization. However, there are some cases where it is better to use a Roman font; for instance, IOPP journals use a Roman d for a differential d, a Roman e for an exponential e and a Roman i for the square root of -1. To accommodate this and to simplify the typing of equations we have provided some extra definitions. `\rmd`, `\rme` and `\rmi` now gives Roman d, e and i respectively for use in equations, e.g. $\mathrm{i}x\mathrm{e}^{2x}\mathrm{d}x/\mathrm{d}y$ is obtained by typing `$\rmi x\rme^{2x}\rmd x/\rmd y$`.

Certain other common mathematical functions, such as cos, sin, det and ker, should appear in Roman type. LaTeX provides macros for most of these functions (in the cases above, `\cos`, `\sin`, `\det` and `\ker` respectively); we have also provided additional definitions for Tr, tr and O (`\Tr`, `\tr` and `\Or`, respectively).

Subscripts and superscripts should be in Roman type if they are labels rather than variables or characters that take values. For example in the equation

$$\epsilon_m = -g\mu_{\rm n}Bm$$

m, the z component of the nuclear spin, is italic because it can have different values whereas n is Roman because it is a label meaning nuclear ($\mu_{\rm n}$ is the nuclear magneton).

6.3. Alignment of mathematics

6.3.1. Alignment on the secondary margin. IOPP style for displayed mathematics in single-column journals is not to centre equations, as LaTeX normally does, but to have each equation indented to a secondary margin a fixed distance from the left-hand margin of the text, except for long equations that will just fit on one line, or need to be continued on subsequent lines, which start full left. Any continuation lines are indented the fixed amount. The macros in the IOPP preprint style automatically line equations up on the secondary margin unless they are set within double dollar signs. Thus the use of double dollar signs should be avoided and the alternative `\[ ... \]` should be used instead for unnumbered equations. The equation environment should normally be used for numbered single-line equations and the eqnarray array environment for multiline equations. It is then only necessary to indicate which lines should start full left and this is done by including `\fl` (full left) at the start of the lines. Thus the equations:

$$\phi_k(\vec{r}) = (2\pi)^{-3/2}\exp(\mathrm{i}\vec{k}\cdot\vec{r}) \tag{1}$$

$$N^+ = \exp(\tfrac{1}{2}\pi\nu)\Gamma(1-\mathrm{i}\nu). \tag{2}$$

are set with the code

```
\begin{eqnarray}
\phi_{k}(\vec{r})=(2\pi)^{-3/2} \exp(\rmi\vec{k}\bdot\vec{r}) \\
N^+=\exp(\case12\pi\nu)\Gamma(1-\rmi\nu).
\end{eqnarray}
```

Where an equation will not fit on a line if indented but would if it were not, then the equation is started full left and this is achieved simply by adding `\fl` to the start of the line. For example the equation

$$R_{\rho lm,\rho' l' m'}(E) = \frac{1}{r_0}\sum_{i,j}\langle\rho l m r_0 \mid \Phi_i\rangle\,[(H_\Omega + B) - ES_\Omega]^{-1}_{i,j}\,\langle\Phi_j \mid \rho' l' m' r_0\rangle. \tag{3}$$

does not fit on the line if indented to the secondary margin but fits in comfortably when full left.

For equations which do not fit on one line, even if started full left, the first line should be set full left with the turnover lines at the secondary margin. This is achieved by using the eqnarray environment and adding `\fl` at the start of the first line and `\\` at the end of each line (apart from the final line of the equation). Equations should be split at mathematically sound points, often at $=$, $+$ or $-$ signs or between terms multiplied together. The connecting signs are not repeated and appear only at the beginning of the turned-over line. A multiplication sign should be added to the start of turned-over lines where the break is between two multiplied terms. Where an equation is broken at an equals sign (or similar, i.e. $\equiv$, $\leq$, $\sim$, etc) the sign is made more prominent by aligning it to the left of the secondary margin; where it is a $+$, $-$ or $\times$ the sign goes to the right. Alignment to the left of the secondary margin is achieved by adding `\lo` in front of the sign (and enclosing the sign within braces if it consists of more than one character or control sequence, e.g. `\lo{:=}`). An example demonstrating these features is:

$$\begin{aligned}\langle\cos(q\Omega_s)\rangle &= \frac{1}{2}\int_0^\infty \frac{k_s(b)}{k_s^{\mathrm{tot}}}\{\cos[q\Omega_S^{\mathrm{o}}(b_f,R_x^s)] + \cos[q\Omega_S^{\mathrm{i}}(b_f,R_x^s)]\}2\pi b\,\mathrm{d}b \\ &= \sum_c \frac{(\mu_c^s)^2/|\Delta V_s'(R_\mathrm{c}^s)|}{\sum_n (R_n^s\mu_n^s)^2(1-V_n^s/E)^{1/2}/|\Delta_s'(R_n^s)|} \\ &\quad\times\frac{1}{2}\int_0^{b_{\max}}\{\cos[q\Omega_S^{\mathrm{o}}(b_f,R_\mathrm{c}^s)] + \cos[q\Omega_S^{\mathrm{i}}(b_f,R_\mathrm{c}^s)]\}b\,\mathrm{d}b/v_s(b,R_\mathrm{c}^s).\end{aligned} \tag{4}$$

where a simplified version of the code used is:

```
\begin{eqnarray}
\fl    <first line>  \nonumber\\
\lo=   <second line> \nonumber\\
```

```
\times <third line>
\end{eqnarray}
```

Note that alignment at the secondary margin normally takes precedence over aligning equals signs so there is usually no need to include any ampersands within the `eqnarray` environment.

6.3.2. Secondary alignment. While the primary alignment either on the secondary margin or full left is adequate in most cases there are examples where additional alignment is desirable. Firstly, for repeated series of short equations, secondly for equations with attached conditions and thirdly for connected series of equations with a short left-hand side which together occupy more than a full line but where each individual part is short. In these cases the `eqnarray` environment should be used; there will still be alignment at the secondary margin but ampersands should be positioned to provide the secondary alignment. For equations with conditions the space separating the longest part from its condition is provided by `\qquad`. Examples of equations requiring secondary alignment are:

$$A^{(3/2)} = A^{(+)} - A^{(-)} \qquad (I = \tfrac{3}{2}) \tag{5}$$

$$A^{(1/2)} = A^{(+)} + 2A^{(-)} \qquad (I = \tfrac{1}{2}) \tag{6}$$

$$A^{(0)} \qquad (\mathrm{otherwise}). \tag{7}$$

which is obtained with the code

```
\begin{eqnarray}
A^{(3/2)}=A^{(+)}-A^{(-)}&(I=\case32)\\
A^{(1/2)}=A^{(+)}+2A^{(-)}\qquad&(I=\case12)\\
A^{(0)}&({\rm otherwise}).
\end{eqnarray}
```

and

$$\begin{aligned} C(12) &= [\vec\pi(x)\cdot\vec\phi(x+r)] \\ &\simeq 1-\mathrm{const}\frac{r^2}{L^2}\int_r^L \frac{x\,\mathrm{d}x}{x^2}+\cdots \qquad (8) \\ &\simeq 1-\mathrm{const}\frac{r^2}{L^2}\ln\left(\frac{L}{r}\right)+\cdots. \qquad (9) \end{aligned}$$

for which the code is

```
\begin{eqnarray}
C(12)&=[\vec\pi(x)\cdot\vec\phi(x+r)]\nonumber\\
&\simeq 1-{\rm const}{r^2\over L^2}\int^L_r{x\, \rmd x\over
x^2}+\cdots\\
&\simeq 1-{\rm const}{r^2\over L^2}\ln\left({L\over r}\right)+\cdots.
\end{eqnarray}
```

6.4. Displayed equations in double-column journals

The way equations are displayed in the Institute of Physics Publishing double-column journals differs from that in single-column journals. However authors submitting to double-column journals can produce their equations as described above for single-column journals and conversion to the proper double-column format will take place here as proofs are being prepared.

6.5. Special characters for mathematics

Bold italic characters are used in our journals to signify vectors (rather than using an upright bold or an over arrow). To obtain this effect use `\bi{#1}` within maths mode, e.g. $\boldsymbol{ABCdef}$. If upright bold characters are required in maths use `\mathbf{#1}` within maths mode, e.g. $\mathbf{XYZabc}$. The calligraphic (script) uppercase alphabet is obtained with `\mathcal{AB}` or `\cal{CD}` ($\mathcal{ABCD}$).

The American Mathematical Society provides a series of extra symbol fonts to use with LaTeX and packages containing the character definitions to use these fonts. Authors wishing to use Fraktur or Blackboard Bold can include the appropriate AMS package (e.g. amsgen, amsfonts, amsbsy, amssymb) with a `\usepackage` command or add the command `\usepackage{iopams}` which loads the four AMS packages mentioned above and also provides definitions for extra bold characters (all Greek letters and some additional other symbols).

The package iopams uses the definition `\boldsymbol` in amsbsy which allows individual non-alphabetical symbols and Greek letters to be made bold within equations. The bold Greek lowercase letters are obtained with the commands `\balpha` ... `\bomega` (but note that bold eta is `\bfeta` rather than `\beta`) and the capitals with commands `\bGamma` ... `\bOmega`. Bold versions of the following symbols are predefined in iopams: bold partial `\bpartial`, bold 'ell' `\bell`, bold imath `\bimath`, bold jmath `\bjmath`, bold infinity `\binfty`, bold nabla `\bnabla`, bold centred dot `\bdot`, other characters are made bold using `\boldsymbol{\symbolname}`.

Table 3 lists some other macros for use in mathematics with a brief description of their purpose. Both `\ms` (medium space) and `\bs` (big space) can be used to provide extra spacing between lines of a displayed equation or table. This space may be necessary when several separate equations are within the same equation environment.

6.6. Miscellaneous points

Exponential expressions, especially those containing subscripts or superscripts, are clearer if the notation $\exp(\ldots)$ is used except for simple examples. For instance $\exp[\mathrm{i}(kx-\omega t)]$ and $\exp(z^2)$ are preferred to $\mathrm{e}^{\mathrm{i}(kx-\omega t)}$ and e^{z^2}, but e^2 is acceptable. Similarly the square root sign $\surd$ should only be used with relatively simple expressions, e.g. $\sqrt{2}$ and $\sqrt{a^2+b^2}$; in other cases the power 1/2 should be used.

It is important to distinguish between $\ln = \log_\mathrm{e}$ and $\lg = \log_{10}$. Braces, brackets

Table 3. Other macros defined in IOPP macros for use in maths.

Macro	Result	Description
Spaces		
`\fl`		Start line of equation full left
`\ms`		Spread out lines in displayed equations slightly (∼3pt)
`\bs`		Bigger space (∼6pt) to separate lines in displays
`\ns`		Small negative space between lines in displays
For symbols to left of 5 pica indent		
`\lo{#1}`	#1	Any symbol overhanging to left
`\eql`	$=$	Left overhanging equals sign
`\lsim`	$\sim$	Left overhanging tilde
`\lsimeq`	$\simeq$	Left overhanging approximately equals
`\lequiv`	$\equiv$	Left overhanging equivalent sign
Miscellaneous		
`\case{#1}{#2}`	$\tfrac{\#1}{\#2}$	Text style fraction in display
`\Tr`	Tr	Roman Tr (Trace)
`\tr`	tr	Roman tr (trace)
`\Or`	O	Roman O (of order of)
`\tdot{#1}`	$\dddot{x}$	Triple dot over character
`\lshad`	$\llbracket$	Text size left shadow bracket
`\rshad`	$\rrbracket$	Text size right shadow bracket

and parentheses should be used in the following order: $\{[(\ )]\}$. The same ordering of brackets should be used within each size. However, this ordering can be ignored if the brackets have a special meaning (e.g. if they denote an average or a function). Decimal fractions should always be preceded by a zero: for example 0.123 **not** .123. For long numbers commas are not inserted but instead a thin space is added after every third character away from the position of the decimal point unless this leaves a single separated character: e.g. 60 000, 0.123 456 78 but 4321 and 0.7325.

Equations that are referred to in the text should be numbered with the number on the right-hand side.

6.7. Equation numbering

LaTeX provides facilities for automatically numbering equations and these should be used where possible. Sequential numbering (1), (2), etc, is the default numbering system although, if the command `\eqnobysec` is included in the preamble, equation numbering by section is obtained, e.g. (2.1), (2.2), etc. In articles with several appendixes equation numbering by section is useful in the appendixes even when sequential numbering has been used throughout the main body of the text and is switched on by the `\appendix` command. Equation numbering by section *must* be used for *Reports on Progress in Physics*. When referring to an equation in the text, either put the equation number, in brackets, e.g. 'as in (2)', or spell out the word equation in full, e.g. 'if equation (2) is factorized'; do not use abbreviations such as eqn or eq. When cross-referencing is used, \ref{<label>} will produce '(<eqnum>)', \eref{<label>} produces 'equation (<eqnum>)' and \Eref{<label>} produces 'Equation (<eqnum>)', where <label> is the label to produce equation number <eqnum>.

If an equation number is centred between lines then the command \eqalign{...} can be used within the 'equation' environment. After \begin{equation} enclose the lines over which the number is to be centred within \eqalign{...} with \\ or \cr at the end of each line. Ampersands are unnecessary within the \eqalign but can be used for secondary alignment if necessary. The code

```
\begin{equation}
\eqalign{T_{11}&=(1+P_\e)I_{\uparrow\uparrow}-(1-P_\e)
I_{\uparrow\downarrow}\\
T_{-1-1}&=(1+P_\e)I_{\downarrow\downarrow}-(1-P_\e)
I_{\uparrow\downarrow}\\
S_{11}&=(3+P_\e)I_{\downarrow\uparrow}-(3-P_e)I_{\uparrow\uparrow}\\
S_{-1-1}&=(3+P_\e)I_{\uparrow\downarrow}-(3-P_\e)
I_{\downarrow\downarrow}}
\end{equation}
```

gives four equations with a centred number:

$$\begin{aligned} T_{11} &= (1+P_{\mathrm{e}})I_{\uparrow\uparrow} - (1-P_{\mathrm{e}})I_{\uparrow\downarrow} \\ T_{-1-1} &= (1+P_{\mathrm{e}})I_{\downarrow\downarrow} - (1-P_{\mathrm{e}})I_{\uparrow\downarrow} \\ S_{11} &= (3+P_{\mathrm{e}})I_{\downarrow\uparrow} - (3-P_{e})I_{\uparrow\uparrow} \\ S_{-1-1} &= (3+P_{\mathrm{e}})I_{\uparrow\downarrow} - (3-P_{\mathrm{e}})I_{\downarrow\downarrow} \end{aligned} \tag{10}$$

Note that the secondary alignment at the equals signs would not normally be necessary but is included here for demonstration purposes.

Sometimes it is useful to number equations as parts of the same basic equation. This can be accomplished by inserting the commands \numparts before the equations concerned and \endnumparts when reverting to the normal sequential numbering. The equations below show the previous equations numbered as separate parts using \numparts ... \endnumparts and the eqnarray environment

$$T_{11} = (1+P_{\mathrm{e}})I_{\uparrow\uparrow} - (1-P_{\mathrm{e}})I_{\uparrow\downarrow} \tag{11a}$$

$$T_{-1-1} = (1+P_{\mathrm{e}})I_{\downarrow\downarrow} - (1-P_{\mathrm{e}})I_{\uparrow\downarrow} \tag{11b}$$

$$S_{11} = (3+P_{\mathrm{e}})I_{\downarrow\uparrow} - (3-P_{e})I_{\uparrow\uparrow} \tag{11c}$$

$$S_{-1-1} = (3+P_{\mathrm{e}})I_{\uparrow\downarrow} - (3-P_{\mathrm{e}})I_{\downarrow\downarrow} \tag{11d}$$

6.8. Miscellaneous extra commands for displayed equations

The `\cases` command of Plain TEX is available for use with LATEX but has been amended slightly to increase the space between the equation and the condition. Equation (12) demonstrates simply the output from the `\cases` command

$$X = \begin{cases} 1 & \text{for } x \ge 0 \\ -1 & \text{for } x < 0 \end{cases} \tag{12}$$

The code used was:

```
\begin{equation}
\label{cases}
X=\cases{1&for $x \ge 0$\\
-1&for $x<0$\\}
\end{equation}
```

To obtain text style fractions within displayed maths the command `\case{#1}{#2}` can be used (see equations (2) and (5)) instead of the usual `\frac{#1}{#2}` command or `{#1 \over #2}`.

When two or more short equations are on the same line they should be separated by a 'qquad space' (`\qquad`), rather than `\quad` or any combination of `\,`, `\>`, `\;` and `\ `.

7. Referencing

Two different styles of referencing are in common use: the Harvard alphabetical system and the Vancouver numerical system. All the IOPP journals allow the use of the Harvard system but the numerical system should **not** be used in *Physics in Medicine and Biology*. Brief descriptions of the use of the two referencing systems are given below.

7.1. Harvard system

In the Harvard system the name of the author appears in the text together with the year of publication. As appropriate, either the date or the name and date are included within parentheses. Where there are only two authors both names should be given in the text; if there are more than two authors only the first name should appear followed by '*et al*' (which can be obtained by typing `\etal`). When two or more references to work by one author or group of authors occur for the same year they should be identified by including a, b, etc after the date (e.g. 1986a). If several references to different pages of the same article occur the appropriate page number may be given in the text, e.g. Kitchen (1982, p 39).

The reference list at the end of an article consists of an unnumbered section containing an alphabetical listing by authors' names and in date order for each author or group of identical authors. The reference list in the preprint style is started by including the command `\section*{References}` and then `\begin{harvard}`. There will be two basic types of entries within the reference list: (i) those to journal articles and (ii) those to books, conference proceedings and reports. For both of these types of references `\item[]` is required before the start of an individual reference. The reference list is completed with `\end{harvard}`. There is also a shortened form of the coding; `\section*{References}` and `\begin{harvard}` can be replaced by the single command `\References` and `\end{harvard}` can be shortened to `\endrefs`.

7.1.1. References to journal articles. A normal reference to a journal article contains three changes of font: the authors and date appear in Roman type, the journal title in italic, the volume number in bold and the page numbers in Roman again. A typical journal entry would be:

Cisneros A 1971 *Astrophys. Space Sci.* **10** 87

which would be obtained by typing, within the references environment

```
\item[] Cisneros A 1971 {\it Astrophys. Space Sci.} {\bf 10} 87
```

Features to note are the following.

(i) The authors should be in the form surname (with only the first letter capitalized) **followed** by the initials with **no** periods after the initials. Authors should be separated by a comma except for the last two which should be separated by 'and' with no comma preceding it. For journals that accept titles of articles in the reference list, the title should be in Roman (upright) lower case letters, except for an initial capital, and should follow the date.

(ii) The journal is in italic and is abbreviated. Appendix B gives a list of macros that will give the correct abbreviation for many of the common journals. If a journal has several parts denoted by different letters the part letter should be inserted after the journal in Roman type, e.g. *Phys. Rev.* A.

(iii) The volume number is bold; the page number is Roman. Both the initial and final page numbers should be given where possible. The final page number should be in the shortest possible form and separated from the initial page number by an en rule (`--`), e.g. 1203–14.

(iv) Where there are two or more references with identical authors, the authors' names should not be repeated but should be replaced by `\dash` on the second and following occasions. Thus

```
\item[]Davis R, Mann A K and Wolfenstein L 1989  {\it Ann. Rev. Nucl.
Part. Sci.} {\bf 39} 467
\item[]\dash 1990 Private communication
```

7.2. Electronic journal references

These do not always follow the conventional *year-journal-volume-page numbers* pattern. The journals may be electronic *and* print (e.g. *Phys. Rev.* D) or electronic only (e.g. *Living Reviews in Relativity*). Electronic journals with unique referencing systems are given below.

- *Phys. Rev. (parts A, C and D).* Each article has a six-digit unique reference number which is cited after the volume number. So, for example,

  [1] Carlip S and Vera R 1998 *Phys. Rev.* D **58** 011345

  Note that page numbers are no longer used.

- *Journal of High Energy Physics.* This journal is primarily electronic, with a print version for archive purposes. Papers are cited as per the following example.

  [1] Davies K and Brown G 1997 *J. High Energy Phys.* JHEP12(1997)002

  with no spaces, where JHEP is obvious, 12 is the month (December in this case), 1997 is the year and 002 is the paper number.

- *Living Reviews in Relativity.* This journal is electronic only. The short form for this journal is *Liv. Rev. Rel.* and papers are cited simply by a number consisting of year and article number. So, for example,

  [1] Gundlach C 1999 *Liv. Rev. Rel.* 1994-4

7.3. Preprint references

Since the introduction of the LANL preprint server this class of references has grown in importance. To reflect this and to maximize the number of hyperlinks available through IOPP's Hypercite service in our electronic journals, each preprint reference should be given in as much detail as possible. Such references should include authors, year of work and preprint number (preceded by the word *Preprint*). An example would be

[1] Harrison M 1999 Dipheomorphism-invariant manifolds *Preprint* hep-th/9909196

If the preprint has been published then the full published reference is given first and the preprint details can be added in brackets after, on a separate line. So, for example,

[1] Neilson D and Choptuik M 2000 *Class. Quantum Grav.* **17** 761
(Neilson D and Choptuik M 1998 *Preprint* gr-qc/9812053)

7.3.1. References to books, conference proceedings and reports. References to books, proceedings and reports are similar, but have only two changes of font. The authors and date of publication are in Roman, the title of the book is in italic, and the editors, publisher, town of publication and page number are in Roman. A typical reference to a book and a conference paper might be

Dorman L I 1975 *Variations of Galactic Cosmic Rays* (Moscow: Moscow State University Press) p 103
Caplar R and Kulisic P 1973 *Proc. Int. Conf. on Nuclear Physics (Munich)* vol 1 (Amsterdam: North-Holland/American Elsevier) p 517

which would be obtained by typing

```
\item[] Dorman L I 1975 {\it Variations of Galactic Cosmic Rays}
(Moscow: Moscow State University Press) p~103
\item[] Caplar R and Kulisic P 1973 {\it Proc. Int. Conf. on Nuclear
Physics (Munich)} vol~1 (Amsterdam: North-Holland/American
Elsevier) p~517
```

respectively.

Features to note are the following.

(i) Book titles are in italic and should be spelt out in full with initial capital letters for all except minor words. Words such as Proceedings, Symposium, International, Conference, Second, etc should be abbreviated to Proc., Symp., Int., Conf., 2nd, respectively, but the rest of the title should be given in full, followed by the date of the conference and the town or city where the conference was held. For Laboratory Reports the Laboratory should be spelt out wherever possible, e.g. *Argonne National Laboratory Report*.

(ii) The volume number as, for example, vol 2, should be followed by the editors, if any, in a form such as ed A J Smith and P R Jones. Use *et al* if there are more than two editors. Next comes the town of publication and publisher, within brackets and separated by a colon, and finally the page numbers preceded by p if only one number is given or pp if both the initial and final numbers are given.

Cross referencing between the text and the reference list is not necessary for alphabetic referencing in the Harvard system as adding or deleting a reference does not normally change any of the other references.

7.4. Numerical system

In the numerical system references are numbered sequentially throughout the text. The numbers occur within square brackets and one number can be used to designate several references. A numerical reference list in the preprint style is started by including the command \section*{References} and then \begin{thebibliography}{<num>}, where <num> is the largest number in the reference list (or any other number with the same number of digits). The reference list gives the references in numerical, not alphabetical, order and is completed by \end{thebibliography}. Short forms of the commands are again available: \Bibliography{<num>} can be used at the start of the references section and \endbib at the end. (Note that footnotes should not be part of a numerical reference system, but should be included in the text using the symbols †, ‡, etc.)

References to journals and books are similar to those in the Harvard system, except that two or more references with identical authors are spelt out in full, i.e. they are **not** replaced with \dash. When one number covers two or more separate references \nonum or \par\item[] should be included at the start of each reference in a group after the first. A typical numerical reference list might begin

[1] Dorman L I 1975 *Variations of Galactic Cosmic Rays* (Moscow: Moscow State University Press) p 103

[2] Caplar R and Kulisic P 1973 *Proc. Int. Conf. on Nuclear Physics (Munich)* vol 1 (Amsterdam: North-Holland/American Elsevier) p 517

[3] Cisneros A 1971 *Astrophys. Space Sci.* **10** 87

which would be obtained by typing

```
\item Dorman L I 1975 {\it Variations of Galactic Cosmic Rays}
```

```
(Moscow: Moscow State University Press) p~103
\item Caplar R and Kulisic P 1973 {\it Proc. Int. Conf.
on Nuclear Physics (Munich)} vol~1 (Amsterdam:
North-Holland/American Elsevier) p~517
\item Cisneros A 1971 {\it Astrophys. Space Sci.} {\bf 10} 87
```

The point to note is that this is identical to the entries in the Harvard system except that square brackets following `\item` are no longer required. If you are using LaTeX's cross-referencing system then `\item` would be replaced by `\bibitem{label}` corresponding to `\cite{label}` in the text (see section 8.1).

7.5. Reference lists

A complete reference should provide the reader with enough information to locate the article concerned and should consist of: name(s) and initials, date published, title of journal or book, volume number, editors, if any, and town of publication and publisher in parentheses for books, and finally the page numbers. Titles of journal articles may also be included. Up to twenty authors may be given in a particular reference; where there are more than twenty only the first should be given followed by '*et al*'. Abbreviations of the names of periodicals used by Institute of Physics Publishing are usually the same as those given in British Standard BS 4148: 1985. If an author is unsure of an abbreviation and the journal is not given in Appendix B, it is best to leave the title in full. The terms *loc. cit.* and *ibid.* should not be used. Unpublished conferences and reports should generally not be included in the reference list and articles in the course of publication should be entered only if the journal of publication is known. A thesis submitted for a higher degree may be included in the reference list if it has not been superseded by a published paper and is available through a library; sufficient information should be given for it to be traced readily.

8. Cross referencing

The facility to cross reference items in the text is very useful when composing articles the precise form of which is uncertain at the start and where revisions and amendments may subsequently be made. When using cross referencing, labels are given to elements in the text, for instance sections, figures, tables or equations and the elements may be referred to elsewhere in the text by using the label. When the article is first processed the labels are read in and assigned, e.g. 2.1 for a subsection or (4) for an equation number. When the article is processed a second or subsequent time the label assignments are read in at the start of the file and the correct values given in the text. LaTeX provides excellent facilities for doing cross-referencing and these can be very useful in preparing articles.

8.1. References

Cross referencing is useful for numeric reference lists because, if it is used, adding another reference to the list does not then involve renumbering all subsequent references. It is not necessary for referencing in the Harvard system where the final reference list is alphabetical and normally no other changes are necessary when a reference is added or deleted. Two passes are necessary initially to get the cross references right but once they are correct a single run is usually sufficient provided an `.aux` file is available and the file is run to the end each time. `\cite` and `\bibitem` are used to link citations in the text with their entry in the reference list; if the reference list contains an entry `\bibitem{label}`, then `\bibitem{label}` will produce the correct number in the reference list and `\cite{label}` will produce the number within square brackets in the text. `label` may contain alphabetic letters, or punctuation characters but must not contain spaces or commas. It is also recommended that the underscore character _ is not used in cross referencing. Thus labels for the form `eq:partial`, `fig:run1`, `eq:dy'`, etc, may be used. When several references occur together in the text `\cite` may be used with multiple labels with commas but no spaces separating them; the output will be the numbers within a single pair of square brackets with a comma and a thin space separating the numbers. Thus `\cite{label1,label2,label4}` would give $[1, 2, 4]$. Note that no attempt is made to sort the labels and no shortening of groups of consecutive numbers is done. Authors should therefore try to use multiple labels in the correct order.

The numbers for the cross referencing are generated in the order the references appear in the reference list, so that if the entries in the list are not in the order in which the references appear in the text then the numbering within the text will not be sequential. To correct this change the ordering of the entries in the reference list and then rerun *twice*.

8.2. Equation numbers, sections, subsections, figures and tables

Cross references can be made to equation numbers, sections, subsections, figures and tables or any numbered environment and this is a very useful feature when writing a document as its final structure is often not fully defined at the start. Thus a later section can be referred to by a label before its precise number is known and when it is defined there is no need to search back through the document to insert the correct value manually. For this reason the use of cross referencing can save considerable time.

Labels for equation numbers, sections, subsections, figures and tables are all defined with the `\label{label}` command and cross references to them are made with the `\ref{label}` command. The `\label` macro identifies the type of environment it is used in and converts `label` into the correct form for that type of environment, thus `\ref{label}` might give (2.3) for an equation number but 3.1 for a subsection and 2 for a figure or table number.

Any section, subsection, subsubsection, appendix or subappendix command defines

Table 4. Alternatives to the normal references \ref and the text generated by them. Note it is not normally necessary to include the word equation before an equation number except where the number starts a sentence. The versions producing an initial capital should only be used at the start of sentences.

Reference	Text produced
\eref{<label>}	equation (<num>)
\Eref{<label>}	Equation (<num>)
\fref{<label>}	figure <num>
\Fref{<label>}	Figure <num>
\sref{<label>}	section <num>
\Sref{<label>}	Section <num>
\tref{<label>}	table <num>
\Tref{<label>}	Table <num>

a section type label, e.g. 1, 2.2, A2, A1.2 depending on context. A typical article might have in the code of its introduction 'The results are discussed in section~\ref{disc}.' and the heading for the discussion section would be:

```
\section{Results}
\label{disc}
```

Labels to sections, etc, may occur anywhere within that section except within another numbered environment. Within a maths environment labels can be used to tag equations which are referred to within the text. An example of an equation with a label and a reference to it is:

```
\begin{equation}
X=a\cos\theta+ b\sin\phi. \label{cossin}
\end{equation}
Equation (\ref{cossin}) ...
```

which produces

$$X = a\cos\theta + b\sin\phi. \tag{13}$$

Equation (13) ...

In addition to the standard \ref{<label>} the abbreviated forms given in the table 4 are available for reference to standard parts of the text

9. Tables and table captions

Tables are numbered serially and referred to in the text by number (table 1, etc, **not** tab. 1). Each table should have an explanatory caption which should be as concise as possible. If a table is divided into parts these should be labelled (*a*), (*b*), (*c*), etc but there should be only one caption for the whole table, not separate ones for each part.

In the preprint style the tables may be included in the text or listed separately after the reference list starting on a new page.

9.1. The basic table format

The standard form for a table is:

```
\begin{table}
\caption{\label{label}Table caption.}
\begin{indented}
\item[]\begin{tabular}{@{}llll}
\br
Head 1&Head 2&Head 3&Head 4\\
\mr
1.1&1.2&1.3&1.4\\
2.1&2.2&2.3&2.4\\
\br
\end{tabular}
\end{indented}
\end{table}
```

Points to note are:

(i) The caption comes before the table. It should have a full stop at the end.

(ii) Tables are normally set in a smaller type than the text. The normal style is for tables to be indented in the same way as equations. This is accomplished by using `\begin{indented}` ... `\end{indented}` and putting `\item[]` before the start of the tabular environment. Omit these commands for any tables which will not fit on the page when indented.

(iii) The default alignment of columns should be aligned left and adding `@{}` omits the extra space before the first column.

(iv) Tables have only horizontal rules and no vertical ones. The rules at the top and bottom are thicker than internal rules and are set with `\br` (bold rule). The rule separating the headings from the entries is set with `\mr` (medium rule).

(v) Numbers in columns should be aligned on the decimal point; to help do this a control sequence `\lineup` has been defined which sets `\0` equal to a space the size of a digit, `\m` to be a space the width of a minus sign, and `\-` to be a left overlapping minus sign. `\-` is for use in text mode while the other two commands may be used in maths or text. (`\lineup` should only be used within a table environment after the caption so that `\-` has its normal meaning elsewhere.) See table 5 for an example of a table where `\lineup` has been used.

9.2. Simplified coding and extra features for tables

The basic coding format can be simplified using extra commands provided in the `iopart` class file. The commands up to and including the start of the tabular environment can be replaced by

Table 5. A simple example produced using the standard table commands and `\lineup` to assist in aligning columns on the decimal point. The width of the table and rules is set automatically by the preamble.

A	B	C	D	E	F	G
23.5	60	0.53	−20.2	−0.22	1.7	14.5
39.7	−60	0.74	−51.9	−0.208	47.2	146
123.7	0	0.75	−57.2	—	—	—
3241.56	60	0.60	−48.1	−0.29	41	15

Table 6. A table with headings spanning two columns and containing notes. To improve the visual effect a negative skip (`\ns`) has been put in between the lines of the headings. Commands set-up by `\lineup` are used to aid alignment in columns. `\lineup` is defined within the `\Table` definition.

			Separation energies	
Nucleus	Thickness ($\mathrm{mg\,cm^{-2}}$)	Composition	γ, n (MeV)	γ, 2n (MeV)
^{181}Ta	19.3 ± 0.1[a]	Natural	7.6	14.2
^{208}Pb	3.8 ± 0.8[b]	99% enriched	7.4	14.1
^{209}Bi	2.86 ± 0.01[b]	Natural	7.5	14.4

[a] Self-supporting.
[b] Deposited over Al backing.

```
\Table{\label{label}Table caption}
```

this also activates the definitions within `\lineup`. The final three lines can also be reduced to `\endTable` or `\endtab`. Similarly for a table which does not fit in when indented `\fulltable{\label{label}caption}` ... `\endfulltable` or `\endtab` can be used. LaTeX optional positional parameters can, if desired, be added after `\Table{\label{label}caption}` and `\fulltable{\label{label}caption}`.

`\centre{#1}{#2}` can be used to centre a heading `#2` over `#1` columns and `\crule{#1}` puts a rule across `#1` columns. A negative space `\ns` is usually useful to reduce the space between a centred heading and a centred rule. `\ns` should occur immediately after the `\\` of the row containing the centred heading (see code for table 6). A small space can be inserted between rows of the table with `\ms` and a half line space with `\bs` (both must follow a `\\` but should not have a `\\` following them).

Units should not normally be given within the body of a table but given in brackets following the column heading; however, they can be included in the caption for long column headings or complicated units. Where possible tables should not be broken over pages. If a table has related notes these should appear directly below the table rather than at the bottom of the page. Notes can be designated with footnote symbols (preferable when there are only a few notes) or superscripted small roman letters. The notes are set to the same width as the table and in normal tables follow after `\end{tabular}`, each note preceded by `\item[]`. For a full width

Table 7. Control sequences to describe lines and symbols in figure captions.

Control sequence	Output	Control sequence	Output
`\dotted`	$\cdots\cdots$	`\opencircle`	○
`\dashed`	- - - -	`\opentriangle`	△
`\broken`	– – –	`\opentriangledown`	▽
`\longbroken`	— — —	`\fullsquare`	■
`\chain`	— · —	`\opensquare`	□
`\dashddot`	— · · —	`\fullcircle`	●
`\full`	——	`\opendiamond`	◇

table `\noindent` should precede the note rather than `\item[]`. To simplify the coding `\tabnotes` can, if desired, replace `\end{tabular}` and `\endtabnotes` replaces `\end{indented}\end{table}`.

If all the tables are grouped at the end of a document the command `\Tables` is used to start a new page and set a heading 'Tables and table captions'.

10. Figures and figure captions

Figures may be included in an article as encapsulated PostScript files or using the LaTeX picture environment. Alternatively authors may send in high quality printed versions of their figures (fair copies) and attach copies of the fair copies to each typescript. The fair copies should be in black Indian ink or printing on tracing paper, plastic or white card or paper, or glossy photographs.

Each figure should have a brief caption describing it and, if necessary, interpreting the various lines and symbols on the figure. As much lettering as possible should be removed from the figure itself and included in the caption. If a figure has parts, these should be labelled (*a*), (*b*), (*c*), etc. Table 7 gives the definitions for describing symbols and lines often used within figure captions (more symbols are available when using the optional packages loading the AMS extension fonts).

Unless the figures files are incorporated into the text the captions should be listed at the end of the article.

10.1. Figure captions where figure files are not available

The command `\Figures` starts a new page and an unnumbered section with the heading 'Figure captions'. The captions should then be set with the commands:

```
\begin{figure}
\caption{\label{label}Figure caption.}
\end{figure}
```

or more simply

```
\Figure{\label{label}Figure caption.}
```

The caption should finish with a full stop and the printed version will be indented as in Institute of Physics Publishing single-column journals.

10.2. Inclusion of graphics files

If graphics files are available as encapsulated PostScript (EPS) files (or are created within the LaTeX picture environment) they may be included within the body of the text at an appropriate point using a standard graphics inclusion package. Authors should ensure EPS files meet the following criteria.

- The Bounding Box should indicate the area of the figure with a minimum of white space around it and not the dimensions of the page.
- Any fonts used should be from the standard PostScript set (Times, Helvetica, Courier and Symbol).
- Scanned images should be of 600 dpi resolution for line art (black and white) and 150 dpi resolution for grayscale or colour.
- Captions and labels (e.g. Figure 1) should not be included in the EPS file although part letters (e.g. (a)) are acceptable provided they are placed close or within the boundary of the figure.

The precise coding required will depend on the graphics package being used and the printer driver. We use a printer driver compatible with DVIPS but authors should avoid using special effects generated by including verbatim PostScript code within the LaTeX file with specials other than the standard figure inclusion ones.

Using the epsf package figures can be included using code such as:

```
\begin{figure}
\begin{center}
\epsfbox{file.eps}
\end{center}
\caption{\label{label}Figure caption}
\end{figure}
```

Appendix A. List of macros for formatting text, figures and tables

Table A1. Macros available for use in text. Parameters in square brackets are optional.

Macro name	Purpose
`\title[#1]{#2}`	Title of article and short title (optional)
`\paper[#1]{#2}`	Title of paper and short title (optional)
`\letter{#1}`	Title of Letter to the Editor
`\comment[#1]{#2}`	Title of Comment and short title (optional)
`\topical[#1]{#2}`	Title of Topical Review and short title (optional)
`\review[#1]{#2}`	Title of review article and short title (optional)
`\note[#1]{#2}`	Title of Note and short title (optional)
`\prelim[#1]{#2}`	Title of Preliminary Communication & short title
`\author{#1}`	List of all authors
`\article[#1]{#2}{#3}`	Type and title of other articles and short title (optional)
`\address{#1}`	Address of author
`\pacs{#1}`	PACS classification codes
`\pacno{#1}`	Single PACS classification code
`\ams{#1}`	American Mathematical Society classification code
`\submitto{#1}`	‘Submitted to’ message
`\maketitle`	Creates title page
`\begin{abstract}`	Start of abstract
`\end{abstract}`	End of abstract
`\nosections`	Inserts space before text when no sections
`\section{#1}`	Section heading
`\subsection{#1}`	Subsection heading
`\subsubsection{#1}`	Subsubsection heading
`\appendix`	Start of appendixes
`\ack`	Acknowledgments heading
`\References`	Heading for reference list
`\begin{harvard}`	Start of alphabetic reference list
`\end{harvard}`	End of alphabetic reference list
`\begin{thebibliography}{#1}`	Start of numeric reference list
`\end{thebibliography}`	End of numeric reference list
`\etal`	*et al* for text and reference lists
`\dash`	Rule for repeated authors in alphabetical reference list
`\nonum`	Unnumbered entry in numerical reference list

Table A2. Macros defined within `iopart.cls` for use with figures and tables.

Macro name	Purpose
`\Figures`	Heading for list of figure captions
`\Figure{#1}`	Figure caption
`\Tables`	Heading for tables and table captions
`\Table{#1}`	Table caption
`\fulltable{#1}`	Table caption for full width table
`\endTable`	End of table created with `\Table`
`\endfulltab`	End of table created with `\fulltable`
`\endtab`	End of table
`\br`	Bold rule for tables
`\mr`	Medium rule for tables
`\ns`	Small negative space for use in table
`\centre{#1}{#2}`	Centre heading over columns
`\crule{#1}`	Centre rule over columns
`\lineup`	Set macros for alignment in columns
`\m`	Space equal to width of minus sign
`\-`	Left overhanging minus sign
`\0`	Space equal to width of a digit

Appendix B. Control sequences for journal abbreviations

Table B1. Abbreviations for the IOPP journals.

Macro name	Short form of journal title	Years relevant
Current journals		
`\CQG`	Class. Quantum Grav.	
`\CTM`	Combust. Theory Modelling	
`\EJP`	Eur. J. Phys.	
`\HPP`	High Performance Polymers	
`\IP`	Inverse Problems	
`\JHEP`	J. High Energy Phys.	1999 and onwards
`\JMM`	J. of Michromech. and Microeng.	
`\JOA`	J. Opt. A: Pure and Applied Opt.	1998 and onwards
`\JOB`	J. Opt. B: Quantum and Semiclass. Opt.	1999 and onwards
`\JPA`	J. Phys. A: Math. Gen.	
`\jpb`	J. Phys. B: At. Mol. Opt. Phys.	1988 and onwards
`\JPCM`	J. Phys: Condens. Matter	1989 and onwards
`\JPD`	J. Phys. D: Appl. Phys.	
`\JPF`	J. Phys. F: Met. Phys.	
`\jpg`	J. Phys. G: Nucl. Part. Phys.	1989 and onwards
`\MSMSE`	Modelling Simul. Mater. Sci. Eng.	
`\MST`	Meas. Sci. Technol.	1990 and onwards
`\NET`	Network:Comput. Neural Syst.	
`\NJP`	New J. Phys.	1999 and onwards
`\NL`	Nonlinearity	
`\NT`	Nanotechnology	
`\PM`	Physiol. Meas.	
`\PMB`	Phys. Med. Biol.	
`\PPCF`	Plasma Physics and Controlled Fusion	
`\PSST`	Plasma Sources Sci. Technol.	
`\PUS`	Public Understand. Sci.	
`\RPP`	Rep. Prog. Phys.	
`\SST`	Semicond. Sci. Technol.	
`\SUST`	Supercond. Sci. Technol.	
`\WRM`	Waves in Random Media	
No Longer Published		
`\BIO`	Bioimaging	1998
`\DSE`	Distributed Systems Eng.	1993–1999
`\JO`	J. Opt.	1970–1998
`\JPB`	J. Phys. B: At. Mol. Phys.	1968–1987
`\JPC`	J. Phys. C: Solid State Phys.	1968–1988
`\JPE`	J. Phys. E: Sci. Instrum.	1968–1989
`\JPG`	J. Phys. G: Nucl. Phys.	1975–1988
`\PAO`	Pure and Applied Opt.	1992–1998
`\QO`	Quantum Opt.	1989–1994
`\QSO`	Quantum and Semiclass. Opt.	1995–1998

Table B2. Abbreviations for some more common non-IOPP journals.

Macro name	Short form of journal
`\AC`	Acta Crystallogr.
`\AM`	Acta Metall.
`\AP`	Ann. Phys., Lpz
`\APNY`	Ann. Phys., NY
`\APP`	Ann. Phys., Paris
`\CJP`	Can. J. Phys.
`\GRG`	Gen. Rel. Grav.
`\JAP`	J. Appl. Phys.
`\JCP`	J. Chem. Phys.
`\JJAP`	Japan. J. Appl. Phys.
`\JMMM`	J. Magn. Magn. Mater.
`\JMP`	J. Math. Phys.
`\JOSA`	J. Opt. Soc. Am.
`\JP`	J. Physique
`\JPhCh`	J. Phys. Chem.
`\JPSJ`	J. Phys. Soc. Japan
`\JQSRT`	J. Quant. Spectrosc. Radiat. Transfer
`\NC`	Nuovo Cimento
`\NIM`	Nucl. Instrum. Methods
`\NP`	Nucl. Phys.
`\PF`	Phys. Fluids
`\PL`	Phys. Lett.
`\PR`	Phys. Rev.
`\PRL`	Phys. Rev. Lett.
`\PRS`	Proc. R. Soc.
`\PS`	Phys. Scr.
`\PSS`	Phys. Status Solidi
`\PTRS`	Phil. Trans. R. Soc.
`\RMP`	Rev. Mod. Phys.
`\RSI`	Rev. Sci. Instrum.
`\SSC`	Solid State Commun.
`\SPJ`	Sov. Phys.–JETP
`\ZP`	Z. Phys.