

# REVTeX 4.1 Author's Guide

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## I. INTRODUCTION

This is the author’s guide to REVTeX 4.1, the preferred submission format for all APS and AIP journals. This guide is intended to be a concise introduction to REVTeX 4.1. The documentation has been separated out into smaller units to make it easier to locate essential information.

The following documentation is also part of the REVTeX 4.1 distribution. Updated versions of these will be maintained at the REVTeX 4.1 homepage located at <http://authors.aps.org/revtex4/>.

- *APS Author Guide for REVTeX 4.1*
- *Author’s Guide to AIP Substyles for REVTeX 4.1*
- *REVTeX 4.1 Command and Options Summary*
- *What’s New in REVTeX 4.1*

This guide assumes a working REVTeX 4.1 installation. Please see the installation instructions included with the distribution.

### I.1. Changes in REVTeX 4.1

The REVTeX system for L<sup>A</sup>T<sub>E</sub>X began its development in 1986 and has gone through three major revisions since then. REVTeX 4 was released in August, 2001. Since that time, many user requests for new features were received. The main goals for REVTeX 4.1 are to incorporate this user feedback and provide support for the journals of the American Institute of Physics (AIP). It incorporates the following changes:

- **Added support for APS journal *Physical Review Special Topics – Physics Education Research*.**
- **Added support for AIP journals.** There is now an explicit `aip` society option along with support for AIP journals. Please see the *Author’s Guide to AIP Substyles for REVTeX 4.1*. In addition, REVTeX 4.1 provides an extensible system for the easy addition of new collections of journals.
- **Endnotes now ordered correctly.** Endnotes in the bibliography now appear in the correct order, interleaved with citations.
- **Multiple references in a single citation supported using a special starred (\*) argument to the `\cite` command.** One of the major new features in 4.1 made possible by the joint work on `natbib` 8.3. Multiple BibTeX entries can be combined into a single `\bibitem` command.
- **Free form text can be prepended and appended to a bibliographic entry using the special starred (\*) argument to the `\cite` command.** Often a citation in the bibliography will have explanatory text such as *See also* or *and references therein* before and after the actual citation. The new REVTeX 4.1 `\cite` command allows the specification of both text to precede and follow a citation.
- **Structured Abstracts.** Use of the `description` environment in abstracts now provides for “structured” abstracts.
- **Figures referring to videos now supported.** A “figure” may now be labeled as a **Video** by using the `video` environment. A frame from the video may be included in the figure and a URL to link the caption’s label to the online video also may be included. There is also a `\listofvideos` command.
- **Better support for arXiv.org in BibTeX** Three more BibTeX fields have been added: `SLACcitation`, `archivePrefix`, and `primaryClass` in addition to the existing field `eprint`.
- **Improved BibTeX bst files.** In addition to the new features above, numerous other improvements to the APS `bst` files have been made, including support for displaying journal article titles (using the new `longbibliography` option) and many fixes for *Reviews of Modern Physics*. Also, long author lists are no longer automatically truncated.
- **`\footnote` in `\widetext` and `table*` environments improved.** `\footnotes` in the `\widetext` or `table*` environments are now correctly placed and formatted.
- **Email addresses no longer print twice on papers less than one page long.**
- **`eqnarray` alignment improved.**
- **`\collaboration` can be used with the `groupedaddress` option now.**
- **letterpaper now ensured as default paper size.**
- **Table of Contents formatting improved.**
- **Support for the `longtable` package improved.**
- **`reftest` restored.**
- **Compatibility with the `geometry`, `lineno`, `lscap` and `colortbl` packages improved.** For line numbering, rather than using `lineno.sty` directly, the `linenumbers` class option should be used (this will call in `lineno.sty` with a proper set of default parameters).

- **hyperref fixes.** Improvements were to make footnotes work better with the `hyperref` package. In particular, table footnotes were fixed. More anchors for `hyperref` were also added (titlepage, abstract, and acknowledgements).
- **Documents can have more than 256 `\cite` commands now.**
- **`\listoffigures` and `\listoftables` fixed.**
- **Figure and table labels in captions now reflect proper APS style.**
- **RMP style files conform better to RMP style guidelines.**
- **Section heading upper-casing improved.**
- **Repeated characters at start of affiliation no longer disappear when using `groupedaddress` option.**
- **There have been many other bug fixes and improvements to the internal `ltxgrid` package as well.**

## I.2. REVTeX 4 Backwards Compatibility

Documents prepared under REVTeX 4 should process correctly under REVTeX 4.1. However, the formatting of the pages and, if using BibTeX, the references may change.

## I.3. Submitting to APS Journals

Authors using REVTeX 4.1 to prepare a manuscript for submission to *Physical Review Letters*, *Physical Review*, *Reviews of Modern Physics*, or other APS journals must also read the companion document *APS Author Guide for REVTeX 4.1* distributed with REVTeX and follow the guidelines detailed there.

The REVTeX 4.1 distribution includes both a template (`apstemplate.tex`) and a sample document (`apssamp.tex`). The template is a good starting point for a manuscript. In the following sections are instructions that should be sufficient for creating a paper using REVTeX 4.1.

Further information about submissions to the American Physical Society may be found at <http://publish.aps.org/>.

## I.4. Submitting to AIP Journals

REVTeX 4.1 includes support for the journals of the American Institute of Physics. The style files and authoring guides for these journals are distributed as part of REVTeX 4.1 distribution. The distribution includes both a template (`aiptemplate.tex`) and a sample document (`aipsamp.tex`). The template is a good starting point for a manuscript. In the following sections are instructions that should be sufficient for creating a paper using REVTeX 4.1.

More information may be found at <http://www.aip.org/pubservs/compuscript.html>. Please consult the *Author's Guide to AIP Substyles for REVTeX 4.1* for more information about submissions to AIP journals, AIP styles files, and other AIP-specific information.

## I.5. Contact Information

Any bugs, problems, or inconsistencies with REVTeX or the APS journal style files should be reported to REVTeX support at [revtex@aps.org](mailto:revtex@aps.org). Reports should include information on the error and a *small* sample document that manifests the problem if possible (please don't send large files!). Issues related to the AIP journal styles should be sent directly to [tex@aip.org](mailto:tex@aip.org).

## II. SOME L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> BASICS

REVTeX 4.1 must sometimes patch the underlying L<sup>A</sup>T<sub>E</sub>X kernel. This means that REVTeX 4.1 requires a fairly recent version of L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>. Versions prior to 2005/12/01 may not work correctly. REVTeX 4.1 will be maintained to be compatible with future versions of L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>.

### II.1. Useful L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> Markup

L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> markup is the preferred way to accomplish many basic tasks.

#### *Fonts*

Because REVTeX 4.1 is based upon L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>, it inherits all of the macros used for controlling fonts. Of particular importance are the L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> macros `\textit`, `\textbf`, `\texttt` for changing to an italic, bold, or typewriter font respectively. One should always use these macros rather than the lower-level T<sub>E</sub>X macros `\it`, `\bf`, and `\tt`. The L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> macros offer improvements such

TABLE I. L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> font commands

Text Fonts	
Font command	Explanation
<code>\textit{⟨text⟩}</code>	Italics
<code>\textbf{⟨text⟩}</code>	Boldface
<code>\texttt{⟨text⟩}</code>	Typewriter
<code>\textrm{⟨text⟩}</code>	Roman
<code>\textsl{⟨text⟩}</code>	Slanted
<code>\textsf{⟨text⟩}</code>	Sans Serif
<code>\textsc{⟨text⟩}</code>	Small Caps
<code>\textmd{⟨text⟩}</code>	Medium Series
<code>\textnormal{⟨text⟩}</code>	Normal Series
<code>\textup{⟨text⟩}</code>	Upright Series
Math Fonts	
<code>\mathit{⟨text⟩}</code>	Math Italics
<code>\mathbf{⟨text⟩}</code>	Math Boldface
<code>\mathtt{⟨text⟩}</code>	Math Typewriter
<code>\mathsf{⟨text⟩}</code>	Math Sans Serif
<code>\mathcal{⟨text⟩}</code>	Calligraphic
<code>\mathnormal{⟨text⟩}</code>	Math Normal
<code>\bm{⟨text⟩}</code>	Bold math for Greek letters and other symbols
<code>\mathfrak{⟨text⟩}</code> <sup>a</sup>	Fraktur
<code>\mathbb{⟨text⟩}</code> <sup>a</sup>	Blackboard Bold

<sup>a</sup> Requires `amsfonts` or `amssymb` class option

as better italic correction and scaling in super- and subscripts for example. Table I summarizes the font selection commands in L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>.

#### User-defined macros

L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> provides several macros that enable users to easily create new macros for use in their manuscripts:

- `\newcommand{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`
- `\newcommand*{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`
- `\renewcommand{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`
- `\renewcommand*{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`
- `\providecommand{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`
- `\providecommand*{⟨command⟩}[⟨narg⟩][⟨opt⟩]{⟨def⟩}`

Here `⟨command⟩` is the name of the macro being defined, `⟨narg⟩` is the number of arguments the macro takes, `⟨opt⟩` are optional default values for the arguments, and `⟨def⟩` is the actually macro definition. `\newcommand` creates a new macro, `\renewcommand` redefines a previously defined macro, and `\providecommand` will define a macro

TABLE II. L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> commands for special symbols and effects

Command	Symbol/Effect
<code>\textemdash</code>	—
<code>\textendash</code>	–
<code>\textexclamdown</code>	¡
<code>\textquestiondown</code>	¿
<code>\textquotedblleft</code>	“
<code>\textquotedblright</code>	”
<code>\textquoteleft</code>	‘
<code>\textquoteright</code>	’
<code>\textbullet</code>	•
<code>\textperiodcentered</code>	·
<code>\textvisiblespace</code>	␣
<code>\textcompworkmark</code>	Break a ligature
<code>\textcircled{⟨char⟩}</code>	Circle a character

only if it hasn’t been defined previously. The \*-ed versions are an optimization that indicates that the macro arguments will always be “short” arguments. This is almost always the case, so the \*-ed versions should be used whenever possible.

The use of these macros is preferred over using plain T<sub>E</sub>X’s low-level macros such as `\def`, `\edef`, and `\gdef`. APS authors must follow the *APS Author Guide for REV<sub>T</sub>E<sub>X</sub> 4.1* when defining macros.

#### Symbols

L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> has added some convenient commands for some special symbols and effects. These are summarized in Table II. See [3] for details.

L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> provides additional symbols in a separate package called `latexsym`. To use these symbols, include the package using:

```
\usepackage{latexsym}
```

#### II.2. Using L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> packages with REV<sub>T</sub>E<sub>X</sub>

Many L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> packages are available, for instance, on CTAN at <http://www.ctan.org/tex-archive/macros/latex/required/> and at <http://www.ctan.org/tex-archive/macros/latex/contrib/> or may be available on other distribution media, such as the T<sub>E</sub>X Live CD-ROM <http://www.tug.org/texlive/>. Some of these packages are automatically loaded by REV<sub>T</sub>E<sub>X</sub> 4.1 when certain class options are invoked and are, thus, “required.” They will either be distributed with REV<sub>T</sub>E<sub>X</sub> or are already included with a standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> distribution.

Required packages are automatically loaded by REVTeX on an as-needed basis. Other packages should be loaded using the `\usepackage` command. To load the `hyperref` package, the document preamble might look like:

```
\documentclass{revtex}
\usepackage{hyperref}
```

Some common (and very useful) L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> packages are *a priori* important enough that REVTeX 4.1 has been designed to be specifically compatible with them. A bug stemming from the use of one of these packages in conjunction with any of the APS journals may be reported by contacting REVTeX support.

**AMS packages** REVTeX 4.1 is compatible with and depends upon the AMS packages `amsfonts`, `amssymb`, and `amsmath`. In fact, REVTeX 4.1 requires use of these packages to accomplish some common tasks. See Section VI for more. REVTeX 4.1 requires version 2.0 or higher of the AMS-L<sup>A</sup>T<sub>E</sub>X package.

**array and dcolumn** The `array` and `dcolumn` packages are part of L<sup>A</sup>T<sub>E</sub>X's required suite of packages. `dcolumn` is required to align table columns on decimal points (and it in turn depends upon the `array` package).

**longtable** `longtable.sty` may be used for large tables that will span more than one page. REVTeX 4.1 dynamically applies patches to `longtable.sty` so that it will work in two-column mode.

**hyperref** `hyperref.sty` is a package by Sebastian Rahtz that is used for putting hypertext links into L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> documents. REVTeX 4.1 has hooks to allow e-mail addresses and URL's to become hyperlinks if `hyperref` is loaded.

**lineno** REVTeX 4.1 improves compatibility with `lineno.sty`. This package should only be loaded via the new `linenumbers` class option. See Section V.7 for more information.

**lscap** REVTeX 4.1 improves compatibility with `lscap.sty`.

**geometry** REVTeX 4.1 improves compatibility with `geometry.sty`.

**colortbl** REVTeX 4.1 improves compatibility with `colortbl.sty`.

Other packages will conflict with REVTeX 4.1 and should be avoided. Usually such a conflict arises because the package adds enhancements that REVTeX 4.1 already includes. Here are some common packages that clash with REVTeX 4.1:

**multicol** `multicol.sty` is a package by Frank Mittelbach that adds support for multiple columns. In fact, early versions of REVTeX 4.1 used `multicol.sty` for precisely this. REVTeX 4.1 incorporates its own support for multiple-column typesetting.

**cite** Donald Arseneau's `cite.sty` is often used to provide support for sorting a `\cite` command's arguments into numerical order and to collapse consecutive runs of reference numbers. REVTeX 4.1 has this functionality built-in already via the `natbib` package.

**mcite** REVTeX 4.1 already contains a lot of this functionality through its updated syntax for the `\cite` command and the latest `natbib` package.

**endfloat** The same functionality can be accomplished using the `endfloats` class option.

**float** `float.sty` provides a mechanism for creating new float classes with just a few commands. REVTeX 4.1 has limited compatibility with `float.sty`. If attempting to use this package, be sure to put any `\newfloat` commands after the `\begin{document}` line.

### III. THE DOCUMENT PREAMBLE

The preamble of a L<sup>A</sup>T<sub>E</sub>X document is the set of commands that precede the `\begin{document}` line. It contains a `\documentclass` line to load the REVTeX 4.1 class (*i.e.*, all of the REVTeX 4.1 macro definitions), `\usepackage` macros to load other macro packages, and other macro definitions.

#### III.1. The *documentclass* line

The basic formatting of the manuscript is controlled by setting *class options* using `\documentclass[<options>]{revtex4-1}`. The optional arguments that appear in the square brackets control the layout of the document. At this point, one only needs to choose:

- Either the `aps` (default) or `aip` society option
- One of the chosen society's journal styles such as `prl` or `apl`
- A layout option such as `preprint` (single-column formatting), `reprint` (an approximation to the selected journal's actual layout which may be one- or two-column depending on the journal), or `twocolumn`

Usually, one would want to use `preprint` for draft papers. Paper size options are also available as well. In particular, `a4paper` is available as well as the rest of the standard L<sup>A</sup>T<sub>E</sub>X paper sizes. A full list of class options is

given in the *REVTeX 4.1 Command and Options Summary*.

### III.2. Loading other packages

Other packages may be loaded into a REVTeX 4.1 document by using the standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> `\usepackage` command. For instance, to load the `graphics` package, one would use `\usepackage{graphics}`.

## IV. THE FRONT MATTER

After choosing the basic look and feel of the document by selecting the appropriate class options and loading in whatever other macros are needed, one is ready to move on to creating a new manuscript. After the preamble, be sure to put in a `\begin{document}` line (and put in an `\end{document}` as well). This section describes the macros REVTeX 4.1 provides for formatting the front matter of the article. The behavior and usage of these macros can be quite different from those provided in the L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> `article` class.

### IV.1. Setting the title

The title of the manuscript is simply specified by using the `\title{title}` macro. A `\\` may be used to put a line break in a long title.

### IV.2. Specifying a date

The `\date{<date>}` command outputs the date on the manuscript. Using `\today` will cause L<sup>A</sup>T<sub>E</sub>X to insert the current date whenever the file is run:

```
\date{\today}
```

### IV.3. Specifying authors and affiliations

The REVTeX 4.1 macros for specifying authors and their affiliations are designed to save labor for authors and during production. Authors and affiliations are arranged into groupings called, appropriately enough, *author groups*. Each author group is a set of authors who share the same set of affiliations. Author names are specified with the `\author` macro while affiliations (or addresses) are specified with the `\affiliation` macro. Author groups are specified by sequences of `\author` macros followed by `\affiliation` macros. An `\affiliation` macro applies to all previously specified `\author` macros which don't already have an affiliation supplied.

For example, if Bugs Bunny and Roger Rabbit are both at Looney Tune Studios, while Mickey Mouse is at Disney World, the markup would be:

```
\author{Bugs Bunny}
\author{Roger Rabbit}
\affiliation{Looney Tune Studios}
\author{Mickey Mouse}
\affiliation{Disney World}
```

The default is to display this as

Bugs Bunny and Roger Rabbit  
*Looney Tune Studios*  
Mickey Mouse  
*Disney World*

This layout style for displaying authors and their affiliations is chosen by selecting the class option `groupedaddress`. Journal styles usually default this option, so it need not be specified explicitly. The other major way of displaying this information is to use superscripts on the authors and affiliations. This can be accomplished by selecting the class option `superscriptaddress`. To achieve the display

Bugs Bunny,<sup>1</sup> Roger Rabbit,<sup>1,2</sup> and Mickey Mouse<sup>2</sup>  
<sup>1</sup>*Looney Tune Studios*  
<sup>2</sup>*Disney World*

one would use the markup

```
\author{Bugs Bunny}
\affiliation{Looney Tune Studios}
\author{Roger Rabbit}
\affiliation{Looney Tune Studios}
\affiliation{Disney World}
\author{Mickey Mouse}
\affiliation{Disney World}
```

Note that REVTeX 4.1 takes care of any commas and *and*'s that join the author names together and font selection, as well as any superscript numbering. Only the author names and affiliations should be given within their respective macros. See below for further information regarding the proper way to add footnotes to author names and affiliations.

There is a third class option, `unsortedaddress`, for controlling author/affiliation display. The default `groupedaddress` will actually sort authors into the appropriate author groups if one chooses to specify an affiliation for each author. The markup:

```
\author{Bugs Bunny}
\affiliation{Looney Tune Studios}
\author{Mickey Mouse}
\affiliation{Disney World}
\author{Roger Rabbit}
\affiliation{Looney Tune Studios}
```

will result in the same display as for the first case given above even though Roger Rabbit is specified after Mickey Mouse. To avoid Roger Rabbit being moved into the same author group as Bugs Bunny, use the `\unsortedaddress` option instead. In general, it is safest to list authors in the order they should appear and specify affiliations for multiple authors rather than one at a time. This will afford the most independence for choosing the display option. Finally, it should be mentioned that the affiliations for the `\superscriptaddress` are presented and numbered in the order that they are encountered. These means that the order will usually follow the order of the authors. An alternative ordering can be forced by including a list of `\affiliation` commands before the first `\author` in the desired order. Then use the exact same text for each affiliation when specifying them for each author.

If an author doesn't have an affiliation, the `\noaffiliation` macro may be used in the place of an `\affiliation` macro.

### *Collaborations*

A collaboration name can be specified with the `\collaboration` command. This is very similar to the `\author` command. In REVTeX 4.1, it can be used with both the `\superscriptaddress` and `\groupedaddress` class options. The `\collaboration` command should appear at the end of the list of authors. The collaboration name will be appear centered in parentheses between the list of authors and the list of affiliations. Because collaborations don't normally have affiliations, one needs to follow the `\collaboration` with `\noaffiliation`.

#### *Footnotes for authors, collaborations, affiliations or title*

Often one wants to specify additional information associated with an author, collaboration, or affiliation such as an e-mail address, an alternate affiliation, or some other ancillary information. REVTeX 4.1 introduces several new macros just for this purpose. They are:

- `\email[(optional text)]{e-mail address}`
- `\homepage[(optional text)]{URL}`
- `\altaffiliation[(optional text)]{affiliation}`
- `\thanks{miscellaneous text}`

In the first three, the *optional text* will be prepended before the actual information specified in the required argument. In the APS journal style files, `\email` and `\homepage` no longer have a default value. However, in

the AIP styles, each have a default text for their optional arguments ('Electronic address:' and 'URL:' respectively). The `\thanks` macro should only be used if one of the other three do not apply. Any author name can have multiple occurrences of these four macros. Note that unlike the `\affiliation` macro, these macros only apply to the `\author` that directly precedes it. Any `\affiliation` *must* follow the other author-specific macros. A typical usage might be as follows:

```
\author{Bugs Bunny}
\email[E-mail me at: ]{bugs@looney.com}
\homepage[Visit: ]{http://looney.com/}
\altaffiliation[Permanent address: ]
                    {Warner Brothers}
\affiliation{Looney Tunes}
```

This would result in the footnote "E-mail me at: bugs@looney.com, Visit: http://looney.com/, Permanent address: Warner Brothers" being attached to Bugs Bunny. Note that:

- Only an e-mail address, URL, or affiliation should go in the required argument in the curly braces.
- The font is automatically taken care of.
- An explicit space is needed at the end of the optional text if one is desired in the output.
- Use the optional arguments to provide customized text only if there is a good reason to.

The `\collaboration`, `\affiliation`, or even `\title` can also have footnotes attached via these commands. If any ancillary data (`\thanks`, `\email`, `\homepage`, or `\altaffiliation`) are given in the wrong context (e.g., before any `\title`, `\author`, `\collaboration`, or `\affiliation` command has been given), then a warning is given in the TeX log, and the command is ignored.

Duplicate sets of ancillary data are merged, giving rise to a single shared footnote. However, this only applies if the ancillary data are identical: even the order of the commands specifying the data must be identical. Thus, for example, two authors can share a single footnote indicating a group e-mail address.

Duplicate `\affiliation` commands may be given in the course of the front matter, without the danger of producing extraneous affiliations on the title page. However, ancillary data should be specified for only the first instance of any particular institution's `\affiliation` command; a later instance with different ancillary data will result in a warning in the TeX log.

It is preferable to arrange authors into sets. Within each set all the authors share the same group of affiliations. For each author, give the `\author` (and appropriate ancillary data), then follow this author group with the needed group of `\affiliation` commands.

If affiliations have been listed before the first `\author` macro to ensure a particular ordering, be sure that any later `\affiliation` command for the given institution is an exact copy of the first, and also ensure that no ancillary data is given in these later instances.

Each journal class option has a default behavior for the placement of these ancillary information footnotes. For instance, the `prb` option puts all such footnotes at the start of the bibliography while the `prl` journal styles displays them on the first page. One can override a journal style's default behavior by specifying explicitly the class option `bibnotes` (puts the footnotes at the start of the bibliography) or `nobibnotes` (puts them on the first page). Please consult the documentation for the various journal style files for further information.

#### *Specifying first names and surnames*

Many authors have names in which either the surname appears first or in which the surname is made up of more than one name. To ensure that such names are accurately captured for indexing and other purposes, the `\surname` macro should be used to indicate which portion of a name is the surname. Similarly, there is a `\firstname` macro as well, although usage of `\surname` should be sufficient. If an author's surname is a single name and written last, it is not necessary to use these macros. These macros do nothing but indicate how a name should be indexed. Here are some examples:

```
\author{Andrew \surname{Lloyd Weber}}
\author{\surname{Mao} Tse-Tung}
```

#### IV.4. The abstract

An abstract for a paper is specified by using the `abstract` environment:

```
\begin{abstract}
Text of abstract
\end{abstract}
```

Note that in REVTeX 4.1 the abstract must be specified before the `\maketitle` command and there is no need to embed it in an explicit minipage environment.

#### *Structured abstracts*

A new feature in REVTeX 4.1 is support for *structured abstracts*. A “structured” abstract is an abstract divided into labeled sections. For instance, *Physical Review C* would like authors to provide abstracts with sections summarizing the paper's **Background**, **Purpose**, **Method**, **Results**, and **Conclusions**. This can

be accomplished by using the `description` environment within the `abstract` environment. For example:

```
\begin{abstract}
\begin{description}
\item[Background] This part would describe the
context needed to understand what the paper
is about.
\item[Purpose] This part would state the purpose
of the present paper.
\item[Method] This part describe the methods
used in the paper.
\item[Results] This part would summarize the
results.
\item[Conclusions] This part would state the
conclusions of the paper.
\end{description}
\end{abstract}
```

#### IV.5. PACS codes

APS and AIP authors are asked to supply suggested PACS codes with their submissions. The `\pacs` macro is provided as a way to do this:

```
\pacs{23.23.+x, 56.65.Dy}
```

The actual display of the PACS numbers below the abstract is controlled by two class options: `showpacs` and `noshowpacs`. In particular, this is now independent of the `preprint` option. `showpacs` must be explicitly included in the class options to display the PACS codes.

#### IV.6. Keywords

A `\keywords` macro may also be used to indicate keywords for the article.

```
\keywords{nuclear form; yrast level}
```

This will be displayed below the abstract and PACS (if supplied). Like PACS codes, the actual display of the the keywords is controlled by two classoptions: `showkeys` and `noshowkeys`. An explicit `showkeys` must be included in the `\documentclass` line to display the keywords.

#### IV.7. Institutional report numbers

Institutional report numbers can be specified using the `\preprint` macro. If the `preprintnumbers` class option is specified, these will be displayed in the upper right corner of the first page. Multiple `\preprint` macros maybe supplied (space is limited though, so only three or less may actually fit). Please note that the `preprint` class option does not automatically invoke `preprintnumbers`.



## IV.8. maketitle

After specifying the title, authors, affiliations, abstract, PACS codes, and report numbers, the final step for formatting the front matter of the manuscript is to execute the `\maketitle` macro by simply including it:

```
\maketitle
```

The `\maketitle` macro must follow all of the macros listed above. The macro will format the front matter in accordance with the various class options that were specified in the `\documentclass` line (either implicitly through defaults or explicitly).

## V. THE BODY OF THE PAPER

For typesetting the body of a paper, REVTeX 4.1 relies heavily on standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> and other packages (particularly those that are part of AMS-L<sup>A</sup>T<sub>E</sub>X). Users unfamiliar with these packages should read the following sections carefully.

### V.1. Section headings

Section headings are input as in L<sup>A</sup>T<sub>E</sub>X. The output is similar, with a few extra features.

Four levels of headings are available in REVTeX:

```
\section{<title text>}
\subsection{<title text>}
\subsubsection{<title text>}
\paragraph{<title text>}
```

Use the starred form of the command to suppress the automatic numbering; e.g.,

```
\section*{Introduction}
```

To label a section heading for cross referencing, best practice is to place the `\label{<key>}` within the argument specifying the heading:

```
\section{\label{sec:intro}Introduction}
```

In some journal substyles, such as those of the APS, all text in the `\section` command is automatically set uppercase. If a lowercase letter is needed, use `\lowercase{x}`. For example, to use “He” for helium in a `\section{<title text>}` command, type `H\lowercase{e}` in `{<title text>}`.

Use `\protect\` to force a line break in a section heading. (Fragile commands must be protected in section headings, captions, and footnotes and `\` is a fragile command.)

## V.2. Paragraphs and General Text

Paragraphs always end with a blank input line. Because T<sub>E</sub>X automatically calculates linebreaks and word hyphenation in a paragraph, it is not necessary to force linebreaks or hyphenation. Of course, compound words should still be explicitly hyphenated, e.g., “author-prepared copy.”

Use directional quotes for quotation marks around quoted text (‘‘xxx’’), not straight double quotes (“xxx”). For opening quotes, use one or two backquotes; for closing quotes, use one or two forward quotes (apostrophes).

### V.3. One-column vs. two-column layouts

One of the hallmarks of *Physical Review* and many of the AIP journals is their two-column formatting. REVTeX 4.1 provides the `reprint` class option that provides for each journal class option a close approximation to the journal’s actual production formatting. Note that the `reprint` option will give either one or two-column formatting as appropriate for the particular journal. For most APS and AIP journals, the `reprint` option will take care of formatting the front matter (including the abstract) as a single column and will typeset the body in two columns. REVTeX 4.1 has its own built-in two-column formatting macros to provide well-balanced columns as well as reasonable control over the placement of floats in either one- or two-column modes. When drafting papers, it is common to use a one-column format. This is best achieved by using the `reprint` class option. Authors may override a particular journal’s formatting by using the lower level options `onecolumn` and `twocolumn`, but best practice is to stick with the `reprint` and `reprint` options.

Please note that the `reprint` class option is only an *approximation* of a journal’s final layout. Because of font differences, figure rescaling, and other factors, authors should not expect the `reprint` option to give fully accurate estimates of an article’s ultimate length after being typeset for the journal.

Occasionally it is necessary to change the formatting from two-column to one-column to better accommodate very long equations that are more easily read when typeset to the full width of the page. This is accomplished using the `widetext` environment:

```
\begin{widetext}
long equation goes here
\end{widetext}
```

In two-column mode, this will temporarily return to one-column mode, balancing the text before the environment into two short columns, and returning to two-column mode after the environment has finished. REVTeX 4.1

will also add horizontal rules to guide the reader’s eye through what may otherwise be a confusing break in the flow of text. The `widetext` environment has no effect on the output under the `preprint` class option because this already uses one-column formatting.

Use of the `widetext` environment should be restricted to the bare minimum of text that needs to be typeset this way. However, short pieces of paragraph text and/or math between nearly contiguous wide equations should be incorporated into the surrounding wide sections.

Low-level control over the column grid can be accomplished with the `\onecolumngrid` and `\twocolumngrid` commands. Using these, one can avoid the horizontal rules added by `widetext`. These commands should only be used if absolutely necessary. Wide figures and tables should be accommodated using the proper `*` environments.

#### V.4. Cross-referencing

REV<sub>T</sub>EX inherits the L<sub>A</sub>T<sub>E</sub>X<sub>2 $\epsilon$</sub>  features for labeling and cross-referencing section headings, equations, tables, and figures. This section contains a simplified explanation of these cross-referencing features. The proper usage in the context of section headings, equations, tables, and figures is discussed in the appropriate sections.

Cross-referencing depends upon the use of “tags,” which are defined by the user. The `\label{⟨key⟩}` command is used to identify tags for REV<sub>T</sub>EX. Tags are strings of characters that serve to label section headings, equations, tables, and figures that replace explicit, by-hand numbering.

Files that use cross-referencing (and almost all manuscripts do) need to be processed through REV<sub>T</sub>EX at least twice to ensure that the tags have been properly linked to appropriate numbers. If any tags are added in subsequent editing sessions, L<sub>A</sub>T<sub>E</sub>X will display a warning message in the log file that ends with ... **Rerun to get cross-references right.** Running the file through REV<sub>T</sub>EX again (possibly more than once) will resolve the cross-references. If the error message persists, check the labels; the same `{⟨key⟩}` may have been used to label more than one object.

Another L<sub>A</sub>T<sub>E</sub>X warning is **There were undefined references**, which indicates the use of a key in a `\ref` without ever using it in a `\label` statement.

REV<sub>T</sub>EX performs autonumbering exactly as in standard L<sub>A</sub>T<sub>E</sub>X. When the file is processed for the first time, L<sub>A</sub>T<sub>E</sub>X creates an auxiliary file (with the `.aux` extension) that records the value of each `⟨key⟩`. Each subsequent run retrieves the proper number from the auxiliary file and updates the auxiliary file. At the end of each run, any change in the value of a `⟨key⟩` produces a L<sub>A</sub>T<sub>E</sub>X warning message.

Note that with footnotes appearing in the bibliography, extra passes of L<sub>A</sub>T<sub>E</sub>X may be needed to resolve all cross-references. For instance, putting a `\cite` inside a `\footnote` will require at least three passes.

Using the `hyperref` package to create hyperlinked PDF files will cause reference ranges to be expanded to list every reference in the range. This behavior can be avoided by using the `hypernat` package available from [www.ctan.org](http://www.ctan.org).

#### V.5. Acknowledgments

Use the `acknowledgments` environment for an acknowledgments section. Depending on the journal sub-style, this element may be formatted as an unnumbered section title *Acknowledgments* or simply as a paragraph. Please note the spelling of “acknowledgments.”

```
\begin{acknowledgments}
The authors would like to thank...
\end{acknowledgments}
```

#### V.6. Appendices

The `\appendix` command signals that all following sections are appendices, so `\section{⟨title text⟩}` after `\appendix` will set `{⟨title text⟩}` as an appendix heading (an empty `{⟨title text⟩}` is permitted). For a single appendix, use a `\appendix*` followed by `\section{⟨title text⟩}` command to suppress the appendix letter in the section heading.

#### V.7. Line numbering

REV<sub>T</sub>EX 4.1 provides the `linenumbers` class option to enable line numbering. While it is possible to directly call in the `lineno.sty`, using the class option ensures that the default parameters needed to properly typeset the line numbers are set up correctly. It is still possible for authors to override parameters such as `\linenumbersep` as usual, however.

## VI. MATH AND EQUATIONS

### VI.1. Math in text

Not surprisingly, REV<sub>T</sub>EX uses the T<sub>E</sub>X math `$` delimiters for math embedded in text. For example, `$a^{\mathbf{z}}$` give  $a^{\mathbf{z}}$ . Within math mode, use `^{\langle math \rangle}` for superscripts and `_{\langle math \rangle}` for subscripts. If the braces after the `^` are omitted, T<sub>E</sub>X will superscript the next *token*

(generally a single character or command). Thus it is safest to use explicit braces `{}`.

As with text, math should not require extensive explicit vertical or horizontal motion commands, because  $\TeX$  calculates math spacing itself automatically. In particular, explicit spacing around relations (e.g., `=`) or operators (e.g., `+`) should be unnecessary. These suggestions notwithstanding, some fine-tuning of math is required in specific cases, see Chapter 18 in the  $\TeX$ book[1].

## VI.2. Text in math

There are times when normal, non-italic text needs to be inserted into a math expression. The `\text{<text>}` command is the preferred method of accomplishing this. It produces regular text *and* scales correctly in superscripts: `$y=x \text{ for } x_{e-p}$` gives “ $y = x$  for  $x_{e-p}$ ”. To use the `\text` command, the `amsmath` package must be loaded: include a `\usepackage{amsmath}` command in the document preamble or use the class option `amsmath`. Please note that REV $\TeX$  4.1 requires version 2.0 or higher of `amsmath`.

Other common alternatives may be less desirable. Using the standard L $\TeX$ 2 $\epsilon$  `\mbox{<text>}` will give normal text, including a hyphen, but will not scale correctly in superscripts: `$x_{\mbox{e-p}}$` gives “ $x_{e-p}$ ”. The `\rm` command only switches to Roman font for math letters. It does not, for example, handle hyphens correctly: `$x_{\rm{e-p}}$` gives “ $x_{e-p}$ ”. But note that `\textrm`, it does work: `$x_{\textrm{e-p}}$` gives “ $x_{e-p}$ ”.

## VI.3. Displayed equations

Equations are set centered in the column width or flush left depending on the selected journal substyle.

For the simplest type of displayed equation, a numbered, one-line equation, use the `equation` environment. REV $\TeX$  takes care of the equation number—the number will be set below the equation if necessary. Use `[...]` for a single, one-line unnumbered display equation.

Use the `eqnarray` environment when more than one consecutive equation occurs, putting each equation in a separate row of the environment, and using `\nonumber` before the row end (`\`) to suppress the equation number where necessary. If the equations are related to each other, align each on the respective relation operator (such as `=`).

When an equation is broken over lines or is continued over multiple relation operators, it is called a multi-line or continued equation, respectively; here, too, use the `eqnarray` environment.

For a continued equation, align each row on the relation operator just as with multiple equations, and use the `\nonumber` command to suppress auto-numbering on broken lines. Also, use the starred form of the row end (`\``*`) to prevent a pagebreak at that juncture.

Short displayed equations that can appear together on a single line separated by `\quad` space may be placed in a single `equation` environment.

As explained in Section V.3, occasionally in two-column mode a long equation, in order to fit it in the narrow column width, would need to be broken into so many lines that it would affect readability. Set it in a wide column using the `widetext` environment. Then return to the normal text width as soon as possible.

The sample file `apssamp.tex` illustrates how to obtain each of the above effects.

## VI.4. Numbering displayed equations

REV $\TeX$  4.1 automatically numbers equations. For single-line and multi-line equations, use the `equation` and `eqnarray` environments as described above. For unnumbered single-line equations, use the `[...]` construction. The command `\nonumber` will suppress the numbering on a single line of an `eqnarray`. For a multi-line equation with no equation numbers at all, use the `eqnarray*` environment.

A series of equations can be labeled with a lettered sequence, e.g., (3a), (3b), and (3c), by putting the respective `equation` or `eqnarray` environment within a `subequations` environment. The `amsmath` package (can be loaded with the `amsmath` class option) is required for this.

Use the command `\tag{<number>}` to produce an idiosyncratic equation number: (1'), for example. Numbers assigned by `\tag` are completely independent of REV $\TeX$ 's automatic numbering. The package `amsmath` is required for using the `\tag` command. Please note that the use of the `tag` command may conflict with the use of the `hyperref` package due an incompatibility between `amsmath` and `hyperref`.

To have REV $\TeX$  reset the equation numbers at the start of each section, use the `eqsecnum` class option in the document preamble.

See the sample file `apssamp.tex` for some examples.

## VI.5. Cross-referencing displayed equations

To refer to a numbered equation, use the `\label{<key>}` and `\ref{<key>}` commands. The `\label{<key>}` command is used within the referenced equation (on the desired line of the `eqnarray`, if a multi-line equation):

```

\begin{equation}
A=B \label{pauli}
\end{equation}
... It follows from Eq.~(\ref{pauli})
that this is the case ...
\begin{eqnarray}
A & = & B, \label{pauli2} \\
A' & = & B'
\end{eqnarray}

```

gives

$$A = B \quad (1)$$

... It follows from Eq. (1) that this is the case ...

$$A = B, \quad (2)$$

$$A' = B' \quad (3)$$

Please note the parentheses surrounding the `\ref` command. These are *not* provided automatically and, thus, must be explicitly incorporated.

Numbers produced with `\tag` can also be cross-referenced by adding a `\label` command after the `\tag` command.

Using a `\label` after `\begin{subequations}` to reference the *general* number of the equations in the `subequations` environment. For example, if

```

\begin{subequations}
\label{allequations} % notice location
\begin{eqnarray}
E&=mc^2, \label{equationa} \\
\\
E&=mc^2, \label{equationb} \\
\\
E&=mc^2, \label{equationc}
\end{eqnarray}
\end{subequations}

```

gives the output

$$E = mc^2, \quad (4a)$$

$$E = mc^2, \quad (4b)$$

$$E = mc^2, \quad (4c)$$

then Eq.~(\ref{allequations}) gives “Eq. (4)”.

**Note:** incorrect cross-referencing will result if `\label` is used in an unnumbered single-line equation (i.e., within the `\[` and `\]` commands), or if `\label` is used on a line of an `eqnarray` that is not being numbered (i.e., a line that has a `\nonumber`).

#### VI.6. Using the AMS packages `amsfonts`, `amssymb`, and `amsmath`

The American Mathematical Society’s AMS- $\LaTeX$  packages provided extra fonts, symbols, and math

markup that are quite convenient. REV $\TeX$  4.1 supports the use of these packages directly. To use the `amsfonts`, `amssymb`, and `amsmath` class options, AMS- $\LaTeX$  (and perhaps the additional AMS fonts) will need to be installed. Please note that REV $\TeX$  4.1 requires version 2.0 or higher of AMS- $\LaTeX$ . These packages can be downloaded from <http://www.ams.org/tex/>.

There are two class options for accessing the AMS fonts: `amsfonts` and `amssymb`. The `amsfonts` option defines the `\mathfrak` and `\mathbb` commands to switch to the Fraktur and Blackboard Bold fonts, respectively. These fonts are selected with the `\mathfrak` and `\mathbb` font-switching commands: `\mathfrak{G}` gives a Fraktur “ $\mathfrak{G}$ ” and `\mathbb{Z}` gives a Blackboard Bold “ $\mathbb{Z}$ ”. REV $\TeX$  does not currently support the use of the extra Euler fonts (the AMS fonts starting with `eur` or `eus`) or the Cyrillic fonts (the AMS fonts starting with `w`).

The `amssymb` class option gives all the font capabilities of the `amsfonts` class option and further defines the commands for many commonly used math symbols. These symbols will scale correctly in superscripts and other places. See the AMS- $\LaTeX$  documentation for the complete list of symbols available.

#### VI.7. Bold symbols in math

REV $\TeX$  4.1 uses the standard  $\LaTeX$  2 $\epsilon$  Bold Math (`\bm`) package as the basis for creating bold symbols in math mode. As usual, this requires an explicit `\usepackage{bm}` in the document preamble. The command `\bm{symbol}` makes `{symbol}` bold in math mode, ensuring that it is the correct size, even in superscripts. If the correct font in the correct size is not available then result is the `{symbol}` set at the correct size in lightface and a  $\LaTeX$  2 $\epsilon$  warning that says “No boldmath typeface in this size...”. Most bold special characters will require that the AMS fonts be installed and the `amsfonts` class option be invoked.

`\bm` is the proper means to get bold Greek characters—upper- and lowercase—and other symbols. The following will come out bold with `\bm`: normal math italic letters, numbers, Greek letters (uppercase and lowercase), small bracketing and operators, and `\mathcal`. Fraktur characters will come out bold in a `\bm`; however, Blackboard Bold requires using the `\mathbb` command rather than `\bm`. The `amsfonts` option adds support for bold math letters and symbols in smaller sizes and in superscripts when a `\bm{symbol}` is used. For example, `\pi^{\bm{\pi}}` gives a bold lowercase pi in the superscript position:  $\pi^\pi$ .

Note that `\bm{math}` is a fragile command and, thus, should be preceded by `\protect` in commands with moving arguments.

## VII. FOOTNOTES

L<sup>A</sup>T<sub>E</sub>X's standard `\footnote` command is available in REV<sub>T</sub>E<sub>X</sub> 4.1. The footnote text can either appear at the bottom of a page or as part of the bibliography. This choice can be controlled by two class options: `footinbib` and `nofootinbib`. REV<sub>T</sub>E<sub>X</sub> 4.1 defaults to the former. Specific journal options may select a different value than the default.

Please note that even if Bib<sub>T</sub>E<sub>X</sub> is not being used for the references, you may have to run Bib<sub>T</sub>E<sub>X</sub> if you are using footnotes without the `nofootinbib` option. The log file will contain errors about missing references such as `Note1` in this case and a file ending in `Notes.bib` will have been produced during the processing of the `TEX` file.

Note that in the latter case, the argument of the `\footnote` command is a moving argument in the sense of the *L<sup>A</sup>T<sub>E</sub>X User's Guide & Reference Manual*, Appendix C.1.3: any fragile command within that argument must be preceded by a `\protect` command.

The `\footnote` macro *should not* be used in the front matter for indicating author/affiliation relationships or to provide additional information about authors (such as an e-mail address). See Section IV.3 for the proper way to do this.

Finally, footnotes that appear in tables behave differently. They will be typeset as part of the table itself. See Section X.2 for details.

## VIII. CITATIONS AND REFERENCES

REV<sub>T</sub>E<sub>X</sub> 4.1 adds significant new functionality to REV<sub>T</sub>E<sub>X</sub> 4's typesetting of citations and references. The new functionality is designed to make it easier to use Bib<sub>T</sub>E<sub>X</sub> and produce the desired output in the reference section without having to edit Bib<sub>T</sub>E<sub>X</sub>'s output. The new features include:

- Endnotes created with the `\footnote` command are automatically interleaved with the bibliographic references. REV<sub>T</sub>E<sub>X</sub> 4 would typeset all endnotes at the end of the bibliography.
- Combining multiple references automatically into a single entry in the bibliography. REV<sub>T</sub>E<sub>X</sub> 4 required by-hand editing of Bib<sub>T</sub>E<sub>X</sub> output. This is achieved by prepending an asterisk (\*) to the reference's *key* in the `\cite` command. `\cite{{key1,*key2}}` would make a single entry in the bibliography by combining into one `\bibitem` the entries from the `.bib` file with keys *key1* and *key2*. See Section VIII.5 for more details.
- Text can be prepended or appended to an entry in the bibliography. REV<sub>T</sub>E<sub>X</sub> 4 required by-hand editing of the Bib<sub>T</sub>E<sub>X</sub> output. See Section VIII.6 for an example of how to do this.

Proper formatting of references requires Patrick Daly's `natbib` citation package. Bib<sub>T</sub>E<sub>X</sub> style files for APS and AIP journals are created using his `custom-bib` tool kit. From an author's point of view, all this means is that a proper REV<sub>T</sub>E<sub>X</sub> 4.1 installation requires having `natbib` (version 8.31a or higher) installed. It also means that the full set of `natbib` functionality is available from within REV<sub>T</sub>E<sub>X</sub> 4.1 (but see the *APS Author Guide for REV<sub>T</sub>E<sub>X</sub> 4.1* and *Author's Guide to AIP Substyles for REV<sub>T</sub>E<sub>X</sub> 4.1* for restrictions if submitting to an APS or AIP journal). The `natbib` documentation contains many examples; see in particular the `natnotes.tex` file for a convenient summary. Please also note that `natbib` 8.3 and later now gives an error (rather than merely a warning as in earlier versions) if you try to use a Bib<sub>T</sub>E<sub>X</sub> file that isn't compatible with author-year style citations with a journal style that requires author-year citations (such as *Reviews of Modern Physics*).

### VIII.1. Citing a reference

As in standard L<sup>A</sup>T<sub>E</sub>X, references are cited in text using the `\cite{key}` command and are listed in the bibliography using the `\bibitem{key}` command. The `\cite` macro enables REV<sub>T</sub>E<sub>X</sub> 4.1 to automatically number the references in the manuscript.

A typical example might be:

String theory\cite{GSW} attempts to provide a theory of everything.

The corresponding `\bibitem` would be:

`\bibitem{GSW} M.~Greene, J.~Schwarz, and E.~Witten, \textit{Superstring Theory: Introduction}, (Cambridge University Press, London, 1985).`

Journals differ in how the `\cite` will be displayed. Most APS journals display the citation in-line, as a number, enclosed in square brackets, *e.g.*, “String theory[1] attempts...” Other journals (most notably *Physical Review B*) instead use a number in a superscript: “String theory<sup>1</sup> attempts...” Selecting the journal substyle using a class option (such as `prb`) will invoke the appropriate style. In journal substyles using superscripts, the macro the `\onlinecite{key}` is necessary to get the number to appear on the baseline. For example, “String theory (see, for example, Ref.~\onlinecite{GSW})” will give the output “String theory (see, for example, Ref. 1).”

The `\onlinecite` command has the same semantics as `natbib`'s `\citealp` command.

A `\cite` command with multiple keys is formatted with consecutive reference numbers collapsed; *e.g.*, [1,2,3,5] will be output as [1–3,5]. To split the list over more than one line, use a % character immediately following a comma:

```
. . . \cite{a,b,c,d,e,f,%
g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z}
```

The % avoids unwanted spaces.

### VIII.2. Author/Year (Non-numeric) Citations

*Reviews of Modern Physics* uses a citation style based on the first author's last name and the year of the reference rather than a simple number. Support for this style of citing references is the primary reason REVTeX 4.1 uses the natbib package. natbib uses an optional argument to the \bibitem macro to specify what text to use for the \cite text:

```
\bibitem[⟨short-name⟩(⟨year⟩)⟨long-name⟩]
```

where ⟨short-name⟩ is the author name used in a parenthetical citation, ⟨long-name⟩ that used in a textual citation, and ⟨year⟩ is the year. More concretely, the \bibitem example above would appear as

```
\bibitem[Greene et al.(1985)Green,
Schwarz, and Witten]{GSW}
M.~Greene, J.~Schwarz, and E.~Witten,
\textit{Superstring Theory},
(Cambridge Press, London, 1985).
```

When the citation constitutes part of the grammar of the sentence, the \textcite{⟨key⟩} command may be used (analogous to the \onlinecite command above). Both \textcite and \onlinecite are built upon natbib's rich repertoire of macros (\citep, \citet, etc.). These macros are available in REVTeX 4.1; however, APS authors must follow the *APS Author Guide for REVTeX 4.1* guidelines regarding natbib's macros.

### VIII.3. Combined Author/Year and Numeric Citations

AIP's *Journal of Mathematical Physics* uses a combined author/year and numerical citation style. REVTeX 4.1 supports this referencing style. Please see the *Author's Guide to AIP Substyles for REVTeX 4.1* for more information about this style.

### VIII.4. Using BibTeX

The \bibitem entries can be coded by hand as above, of course, but the use of BibTeX with the new style files provided with REVTeX 4.1 makes it particularly simple to generate marked-up references that can, for instance, take advantage of packages like hyperref for linking. They also save the trouble of having to specify formatting like the italics for the book title in the above example. And, for those wishing to use author/year citations,

BibTeX will automatically generate the appropriate optional arguments for the \bibitem commands.

BibTeX is an adjunct to L<sup>A</sup>T<sub>E</sub>X that aids in the preparation of bibliographies. BibTeX allows authors to build up a database or collection of bibliography entries that may be used for many manuscripts. A BibTeX style file then specifies how to transform the entries into a proper \bibitem for a particular journal. Here we give a brief summary of how to get started with BibTeX. More details can be found in the L<sup>A</sup>T<sub>E</sub>X books listed in the references.

Selecting a journal style by using an appropriate class option will automatically select the correct BibTeX style file from those included in REVTeX 4.1. Four basic BibTeX style files are included: apsrev4-1.bst (APS journals using a numeric citation style, *i.e.*, all but RMP), apsrmp4-1.bst (author/year style citations for RMP), aipauth4-1.bst (AIP journal using an author/year citation style), and aipnum4-1.bst (AIP journals using a numeric citation style). In addition, there are "long" versions for each of these that add the titles of cited articles to the bibliography. The selection can be overridden by specifying an alternative .bst file using the standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> \bibliographystyle macro. This must appear in the preamble before the \begin{document} line in REVTeX 4.1 (this differs from standard L<sup>A</sup>T<sub>E</sub>X).

The BibTeX database files will contain entries such as:

```
@Book{GSW,
  author='M. Greene, J. Schwarz,
        E. Witten'',
  title='Superstring theory:
        Introduction'',
  publisher='Cambridge University
        Press'',
  address='London'',
  year='1985''
}
```

There are entry formats for articles, technical reports, e-prints, theses, books, proceedings, and articles that appear in books or proceedings. The styles provided with REVTeX 4.1 also allows URL's and e-print identifiers to be specified for any of the different entry types. There is also an additional "collaboration" field that can be used in addition to "author".

To actually create the bibliography in the manuscript, the \bibliography{⟨bib files⟩} macro is used. Here ⟨bib files⟩ is a comma-separated list of BibTeX bibliography database files, each with the .bib extension. The \bibliography macro should be placed at the location where the references are to appear (usually after the main body of the paper). When the manuscript is processed with L<sup>A</sup>T<sub>E</sub>X for the first time, the keys corresponding for the \cite macros used in the manuscript are written out to the .aux file. Then BibTeX should be run (if the

manuscript is called `paper.tex`, the command would be `bibtex paper`. This will produce a `.bbl` file containing all of the `\bibitem`'s for the manuscript. Subsequent runs of  $\text{\LaTeX} 2_{\epsilon}$  will call this file in to resolve the references.  $\text{\LaTeX} 2_{\epsilon}$  should be run repeatedly until all references are resolved.

The  $\text{BIB}\text{\TeX}$ -produced `\bibitem`'s created using the  $\text{REV}\text{\TeX}$  style files appear considerably more complex than the example given above. This is because the style files add in `\bibinfo`, `\bibnamefont`, `\eprint`, and `\url` macros for specifying additional formatting and tagging. The `\bibinfo` macro is mostly a do-nothing macro that serves merely to tag the information with the field information from the original entry in the  $\text{BIB}\text{\TeX}$  database. The `\eprint` and `\url` macros can be used to create the appropriate hyperlinks in target formats such as PDF.

For more information on using  $\text{BIB}\text{\TeX}$  with  $\text{\LaTeX}$ , see Sections 4.3.1 and C.11.3 of the  *$\text{\LaTeX}$  User's Guide & Reference Manual*[2], Section 13.2 of [4], or the online  $\text{BIB}\text{\TeX}$  manual `btndoc.tex` from <http://www.ctan.org/tex-archive/biblio/bibtex/distrib/doc/>.

*arXiv.org support in BibTeX*

$\text{REV}\text{\TeX}$  4.1 has better support for citing e-prints from [arXiv.org](http://arxiv.org). For instance, the `.bib` entry

```
@Unpublished{Ginsparg:1988ui,
  author   = "Ginsparg, Paul H.",
  title    = "{Applied Conformal Field Theory}",
  year     = "1988",
  eprint   = "hep-th/9108028",
  archivePrefix = "arXiv",
  SLACcitation = "%CITATION=HEP-TH/9108028;%"
}
```

will include the [arXiv.org](http://arxiv.org) e-print identifier as `arXiv:hep-th/9108028` and hyperlink it (if using `hyperref`). The newer format for [arXiv](http://arxiv.org) identifiers with primary classifications will produce output such as `arXiv:0905.1949 [hep-ph]`.

### VIII.5. Multiple references in a single bibliography entry

One of the most frequently requested features since the release of  $\text{REV}\text{\TeX}$  4 has been to allow more than one reference to appear in a single bibliography entry when using  $\text{Bib}\text{\TeX}$ . This can now be done in  $\text{REV}\text{\TeX}$  4.1 by using a starred (\*) argument to the `\cite` command. This requires the latest version of `natbib`, developed in conjunction with  $\text{REV}\text{\TeX}$  4.1, and the new `bst` files that come with  $\text{REV}\text{\TeX}$  4.1. To combine multiple references into a single `\bibitem`, precede the second, third, etc. citation keys in the `\cite` command with an asterisk

(\*). For example `\cite{bethe, *feynman, *bohr}` will combine the `\bibitem`s with keys `bethe`, `feynman`, and `bohr` into a single entry in the bibliography separated by semicolons.

### VIII.6. Prepending and/or appending text to a citation

The expanded syntax for the `\cite` command argument can also be used to specify text before and/or after a citation. For instance, a citation such as:

[19] A similar expression was derived in A. V. Andreev, *Phys. Rev. Lett.* 99, 247204 (2007) in the context of carbon nanotube p-n junctions. The only difference is that no integration over  $k_y$  is present there.

may be created by the following `\cite` command:

```
\cite*[{A similar expression was derived
in }] [{ in the context of carbon nanotube
p-n junctions. The only difference is that
no integration over  $k_y$  is present
there.}]andreev2007]
```

Please note the use of curly braces to enclose the text within the square brackets.

## IX. FIGURES AND ARTWORK

### IX.1. figure environment

Figures may be included into a  $\text{REV}\text{\TeX}$  4.1 manuscript by using the standard  $\text{\LaTeX} 2_{\epsilon}$  macros. It should be noted that  $\text{\LaTeX} 2_{\epsilon}$  includes several powerful packages for including the files in various formats. The two main packages are `graphics` and `graphicx`. Both offer a macro called `\includegraphics[(args)]{(filename)}`; they mainly differ in how arguments for controlling figure scaling, translation, and orientation are specified. For more information on the enhancements of the `graphicx` package, see [5] or the guide `grfguide.pdf` available at <http://www.ctan.org/tex-archive/macros/latex/required/graphics/>.  $\text{REV}\text{\TeX}$  4.1 no longer has the `epsf` class option, though the `epsfig` package provides a similar interface.

The `figure` environment should be used to add a caption to the figure and to allow  $\text{\LaTeX}$  to number and place the figures where they fit best.  $\text{\LaTeX}$  will label and automatically number the captions FIG. 1, FIG. 2, etc. For example:

```
\begin{figure}
  \includegraphics{fig1.eps}
```

```
\caption{\label{fig1}Text of first caption.}
\end{figure}
```

Note how the `\label{<key>}` command is used to cross-reference figures in text. The `\label{<key>}` command should be inserted inside the figure caption. As usual, the `\ref{<key>}` macro can then be used to refer to the label: “As depicted in FIG.~\ref{fig1}...”.

Figures are normally set to the width of the column in which they are placed. This means that in two-column mode, the figure will be placed in a single, narrow column. For wide figures, the `\figure*` environment should be used instead. This will place the figure across both columns (the figure usually will appear either at the top or the bottom of the following page).

Captions less than one line long are centered under the figure, otherwise they span the width of the figure.

Note that is unnecessary (and undesirable) to use explicit centering commands inside the float environments.

## IX.2. video environment

Papers often refer to multimedia material such as videos. The `video` environment is identical to the `figure` environment, but the caption will be labeled as a **Video** (with its own counter independent of figures). A URL can also be specified so that the caption label can be linked to the online video (if using the `hyperref` package). The included graphic (using `\includegraphics` from the `graphics` or `graphicx` package) would be a representation frame from the video. A `\listofvideos` is also provided. For example:

```
\begin{video}
\includegraphics{videoframe.jpg}
\setfloatlink{http://some.video.com/fun.mov}
\caption{\label{vid:interest}This is a video
of something fun.}
\end{video}
```

There is also a corresponding `\listofvideos` command.

## X. TABLES

Tables are very similar to figures. They should be input using the `table` environment as detailed below, and  $\LaTeX$  will label and number the captions TABLE 1, TABLE 2, etc. (or in whatever format required by the chosen journal substyle). Tables without captions won’t be numbered.

Each table must begin with `\begin{table}`, end with `\end{table}`. A caption can be specified using the `\caption{<text>}` command. Captions less than one line long are centered under the figure, otherwise they span

the width of the figure. To refer to the table via cross-referencing, a `\label{<key>}` command should appear within the `\caption`. Use the `\ref{<key>}` command to cite tables in text. The `table` environment will set the table to the width of the column. Thus, in two-column mode, the table will be confined to a single column. To set a table to the full width of the page, rather than the column, use the `table*` environment.

The heart of the table is the `tabular` environment. This will behave for the most part as in standard  $\LaTeX 2_{\epsilon}$  (please refer to Section 3.6.3 and Appendix C.10.2 of the  *$\LaTeX$  User’s Guide & Reference Manual* for more details about the `tabular` environment). Note that  $\ReVTeX$  4.1 no longer automatically adds double (Scotch) rules around tables. Nor does the `tabular` environment set various table parameters for column spacing as before. Instead, a new environment `ruledtabular` provides this functionality. This environment should surround the `tabular` environment:

```
\begin{table}
\caption{\label{<key>}....}
\begin{ruledtabular}
\begin{tabular}
...
\end{tabular}
\end{ruledtabular}
\end{table}
```

A basic table looks as follows:

```
\begin{table}
\caption{\label{tab:example}Text of table caption.}
\begin{ruledtabular}
\begin{tabular}{ll}
Heading 1 & Heading 2 \\
Cell 1 & Cell 2 \\
\end{tabular}
\end{ruledtabular}
\end{table}
```

The `quasitable` environment is no longer in  $\ReVTeX$  4.1. The standard `tabular` environment can be used instead because it no longer puts in the double rules.

### X.1. Aligning on a decimal point

Numerical columns should align on the decimal point (or decimal points if more than one is present). This is accomplished by again using a standard  $\LaTeX 2_{\epsilon}$  package, `dcolumn` which must be loaded in the manuscript’s preamble:

```
\usepackage{dcolumn}
```

Once this package is loaded, the column specifier ‘d’ can be used in the table’s `tabular{<preamble>}` environment



preamble. The ‘d’ should be used for simple numeric data with a single decimal point. The entry of a d column is typeset in math mode; do not insert any \$ math delimiters into a ‘d’ column. Items without a decimal point are simply set in math mode, centered. If text is required in the column, use `\text` or `\mbox` as appropriate. If multiple decimal points are present then the last is used for alignment. To escape from the ‘d’ column use `\multicolumn` as usual. See the sample file `apssamp.tex` for examples.

## X.2. Footnotes in Tables

Footnotes in a table are labeled *a*, *b*, *c*, etc. They can be specified by using the L<sup>A</sup>T<sub>E</sub>X `\footnote` command. Furthermore, `\footnotemark` and `\footnotetext` can be used so that multiple entries can refer to the same footnote. The footnotes for a table are typeset at the bottom of the table, rather than at the bottom of the page or at the end of the references. The arguments for `\footnotemark` and `\footnotetext` should be numbers 1, 2, . . . . The journal style will convert these to letters. See sample file `apssamp.tex` for examples and explanations of use.

## X.3. Dealing with Long Tables

By default, tables are set in a smaller size than the text body (`\small`). The `\squeezetable` declaration makes the table font smaller still (`\scriptsize`). Thus, putting the `\squeezetable` command before the `\begin{table}` line in a table will reduce the font size. If this isn’t sufficient to fit the table on a page, the standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> `longtable` package may be used. The scope of the `\squeezetable` command must be limited by enclosing it with a group:

```
\begingroup
\squeezetable
\begin{table}
[... ]
\end{table}
\endgroup
```

Tables are normally set to the width of the column in which they are placed. This means that in two-column mode, the table will be placed in a single, narrow column. For wide tables, the `\table*` environment should be used instead. This will place the table across both columns (the table usually will appear either at the top or the bottom of the following page).

To break tables across pages, REV<sub>T</sub>E<sub>X</sub> 4.1 requires adding to the table a float placement option of [H] (meaning put the table “here” and effectively “unfloating” the table) to the `\begin{table}` command. The commands

`\*` and `\samepage` can be used to control where the page breaks occur (these are the same as for the `eqnarray` environment).

Long tables are more robustly handled by using the `longtable.sty` package included with the standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> distribution (put `\usepackage{longtable}` in the preamble). This package gives precise control over the layout of the table. The REV<sub>T</sub>E<sub>X</sub> 4.1 package contains patches that enable the `longtable` package to work in two-column mode. Of course, a table set in two-column mode needs to be narrow enough to fit within the column. Otherwise, the columns may overlap. REV<sub>T</sub>E<sub>X</sub> 4.1 provides an additional environment `longtable*` which allows a longtable to span the whole page width. Currently, the `longtable*` and `ruledtabular` environments are incompatible. In order to get the double (Scotch) rule, it is necessary to add the `\hline\hline` manually (or define `\endfirsthead` and `\endlastfoot` appropriately). For more documentation on the `longtable` environment and on the package options of the `longtable` package, please see the documentation available at <http://www.ctan.org/macros/latex/required/tools/longtable.dtx> or refer to [4].

## XI. PLACEMENT OF FIGURES, TABLES, AND OTHER FLOATS

By default, figures and tables (and any other “floating” environments defined by other packages) float to the top or bottom of the page using the standard L<sup>A</sup>T<sub>E</sub>X float placement mechanism. Initially, each `figure` or `table` environment should be put immediately following its first reference in the text; this will usually result in satisfactory placement on the page. An optional argument for either environment adjusts the float placement. For example:

```
\begin{figure}[<placement>]
...
\end{figure}
```

where `<placement>` can be any combination of `htbp!`, signifying “here”, “top”, “bottom”, “page”, and “as soon as possible”, respectively. The same placement argument may be added to a `\begin{table}`. For more details about float placement, see the instructions in the *L<sup>A</sup>T<sub>E</sub>X User’s Guide & Reference Manual*, Appendix C.9.1.

In two-column mode, a page may contain both a `widetext` environment and a float. REV<sub>T</sub>E<sub>X</sub> 4.1 may not always be able to automatically put the float in the optimal place. For instance, a float may be placed at the bottom of a column just before the `widetext` begins. To work around this, try moving the float environment below the `widetext` environment. Alternative `<placements>` may also alleviate the problem.

`figure` and `table` environments should not be enclosed in a `widetext` environment to make them span the page to accommodate wide figures or tables. Rather, the `figure*` or `table*` environments should be used instead.

Sometimes in  $\text{\LaTeX}$  the float placement mechanism breaks down and a float can't be placed. Such a "stuck" float may mean that it and all floats that follow are moved to the end of the job (and if there are too many of floats, the fatal error `Too many unprocessed floats` will occur).  $\text{REVTeX}$  4.1 provides the class option `floatfix` which attempts to invoke emergency float processing to avoid creating a "stuck" float.  $\text{REVTeX}$  4.1 will provide a message suggesting the use of `floatfix`. If `floatfix` doesn't work or if the resulting positioning of the float is poor, the float should be repositioned by hand.

$\text{REVTeX}$  4.1 offers an additional possibility for placing the floats. By using either the `endfloats` or the `endfloats*` class option all floats may be held back (using an external file) and then set elsewhere in the document using the the commands `\printtables` and `\printfigures`, placed where the tables and figures are to be printed (usually at the end of the document). (This is similar to the standard `\printindex` command). Using a `*`-form of the commands (`\printfigures*` and `\printtables*`) will begin the figures or tables on a new page. Alternatively, the option `endfloats*` may be used to change the behavior of the non-`*`-forms so that every float will appear on a separate page at the end.

Without one of the `endfloats` class options, these float placement commands are silently ignored, so it is always safe to use them. If one of the `endfloats` class options is given, but the `\printtables` command is missing, the tables will be printed at the end of the document. Likewise, if `\printfigures` is missing, the figures will be printed at the end of the document. Therefore it is also safe to omit these commands as long as  $\text{REVTeX}$ 's default choices for ordering figures and tables are satisfactory.

The `endfloats` option (or perhaps some journal sub-style that invokes it), requires explicit `\begin{figure}`, `\end{figure}`, `\begin{table}`, and `\end{table}` lines. In particular, do *not* define typing shortcuts for table and figure environments, such as

```
\def\bt{\begin{table}}% Incompatible!
\def\et{\end{table}}%
```

Please note that it is generally undesirable to have all floats moved to the end of the manuscript. APS no longer requires this for submissions. In fact, the editors and referees will have an easier time reading the paper if the floats are set in their normal positions.

## XII. ROTATING FLOATS

Often a figure or table is too wide to be typeset in the standard orientation and it is necessary to rotate the float 90 degrees.  $\text{REVTeX}$  4.1 provides a new environment `turnpage` as an easy means to accomplish this. The `turnpage` environment depends on one of the packages `graphics` or `graphicx` being loaded. To use the `turnpage` environment, simply enclose the `figure` or `table` environment with the `turnpage` environment:

```
\documentclass[...]{revtex4}
\usepackage{graphicx}
[...]
\begin{turnpage}
\begin{figure} or \begin{table}
[...]
\end{figure} or \end{table}
\end{turnpage}
```

A `turnpage` float will be typeset on a page by itself. Currently, there is no mechanism for breaking such a float across multiple pages.

## XIII. $\text{REVTeX}$ 4.1 SYMBOLS AND THE `REVSymb4-1` PACKAGE

Symbols made available in earlier versions of  $\text{REVTeX}$  are defined in a separate package, `revsymb4-1`, so that they may be used with other classes. This might be useful if, say, copying text from a  $\text{REVTeX}$  document to a non- $\text{REVTeX}$  document.  $\text{REVTeX}$  4.1 automatically includes these symbols so it is not necessary to explicitly call them in with a `\usepackage` statement.

Table III summarizes the symbols defined in this package. Note that `\overcirc`, `\overdots`, and `\corresponds` are no longer in  $\text{REVTeX}$  4.1. Use `\mathring` (standard in  $\text{\LaTeX} 2_{\epsilon}$ ), `\dddot` (with the `amsmath` package loaded), and `\triangleq` (with the `amssymb` class option) respectively. `\succsim`, `\precsim`, `\lesssim`, and `\gtrsim` are also defined either in `amsmath` or `amssymb`. The AMS versions of these commands will be used if the appropriate AMS package is loaded.

## XIV. OTHER $\text{REVTeX}$ 4.1 FEATURES

### XIV.1. Job-specific Override Files

$\text{REVTeX}$  4.1 allows manuscript-specific macro definitions to be put in a file separate from the main  $\text{\TeX}$  file. One merely creates a file with the same basename as the  $\text{\TeX}$  file, but with the extension `.rty`. Thus, if the  $\text{\TeX}$  file is named `man.tex`, the macro definitions would go in `man.rty`. Note that the `.rty` file should be in the same

TABLE III. Special REV $\TeX$  4.1 symbols, accents, and bold-faced parentheses defined in `revsymb.sty`

<code>\lambdabar</code>	$\bar{\lambda}$	<code>\openone</code>	$\mathbb{1}$
<code>\altsuccsim</code>	$\succsim$	<code>\altprecsim</code>	$\prec\sim$
<code>\alt</code>	$\sphericalangle$	<code>\agt</code>	$\sphericalangle$
<code>\tensor x</code>	$\otimes$	<code>\overstar x</code>	$\overset{*}{x}$
<code>\loarrow x</code>	$\xrightarrow{\downarrow}$	<code>\roarrow x</code>	$\xrightarrow{\uparrow}$
<code>\biglb ( \bigrb )</code>	$()$	<code>\Biglb ( \Bigrb )</code>	$\bigcirc$
<code>\bigglb ( \biggrb )</code>	$\bigcirc$	<code>\Bigglb ( \Biggrb )</code>	$\bigcirc$

directory as the  $\TeX$  file. APS authors should follow the guidelines in the *APS Author Guide for REV $\TeX$  4.1*

when submitting. Similarly, AIP authors should refer to the *Author's Guide to AIP Substyles for REV $\TeX$  4.1*

- 
- [1] D.E. Knuth, *The  $\TeX$ book*, (Addison-Wesley, Reading, MA, 1986).
  - [2] L. Lamport,  *$\LaTeX$ , a Document Preparation System*, (Addison-Wesley, Reading, MA, 1996).
  - [3] H. Kopka and P. Daly, *A Guide to  $\LaTeX\ 2_{\epsilon}$* , (Addison-Wesley, Reading, MA, 1995).
  - [4] M. Goossens, F. Mittelbach, and A. Samarin, *The  $\LaTeX$  Companion*, (Addison-Wesley, Reading, MA, 1994).
  - [5] M. Goossens, S. Rahtz, and F. Mittelbach, *The  $\LaTeX$  Graphics Companion*, (Addison-Wesley, Reading, MA, 1997).
  - [6] S. Rahtz, M. Goossens, *et al.*, *The  $\LaTeX$  Web Companion*, (Addison-Wesley, Reading, MA, 1999).