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# Template for PRL/PRD Papers

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PACS numbers:

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When commands are referred to in this example file, they are always shown with their required arguments, using normal TeX format. In this format, `#1`, `#2`, etc. stand for required author-supplied arguments to commands. For example, in `\section{#1}` the `#1` stands for the title text of the author's section heading, and in `\title{#1}` the `#1` stands for the title text of the paper.

Line breaks in section headings at all levels can be introduced using \\. A blank input line tells TeX that the paragraph has ended. Note that top-level section headings are automatically uppercased. If a specific letter or word should appear in lowercase instead, you must escape it using `\lowercase{#1}` as in the word "via" above.

This file may be formatted in both the `preprint` and `twocolumn` styles. `twocolumn` format may be used to mimic final journal output. Either format may be used for submission purposes; however, for peer review and production, APS will format the article using the `preprint` class option. Hence, it is essential that authors check that their manuscripts format acceptably under `preprint`. Manuscripts submitted to APS that do not format correctly under the `preprint` option may be delayed in both the editorial and production processes.

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Footnotes are produced using the `\footnote{#1}` command. Most APS journal styles put footnotes into the bibliography. REVTeX 4 does this as well, but instead of interleaving the footnotes with the references, they are listed at the end of the references. Because the correct numbering of the footnotes must occur after the numbering of the references, an extra pass of LaTeX is required in order to get the numbering correct.

Inline math may be typeset using the `$` delimiters. Bold math symbols may be achieved using the `bm` package and the `\bm{#1}` command it supplies. For instance, a bold $\alpha$ can be typeset as `$\bm{\alpha}$` giving $\boldsymbol{\alpha}$. Fraktur and Blackboard (or open face or double struck) characters should be typeset using the `\mathfrak{#1}` and `\mathbb{#1}` commands respectively. Both are supplied by the `amssymb` package. For example, `$\mathbb{R}$` gives $\mathbb{R}$ and `$\mathfrak{G}$` gives $\mathfrak{G}$

In LaTeX there are many different ways to display equations, and a few preferred ways are noted below. Displayed math will center by default. Use the class option `fleqn` to flush equations left.

Below we have numbered single-line equations; this is the most common type of equation in *Physical Review*:

$$\chi_+(p) \lesssim [2|\mathbf{p}|(|\mathbf{p}|+p_z)]^{-1/2} \left( \begin{array}{c} |\mathbf{p}|+p_z \\ px+ip_y \end{array} \right) , \tag{1}$$

$$\left\{ 1\!\!1234567890abc123\alpha\beta\gamma\delta1234556\alpha\beta\frac{1\sum^a_b}{A^2} \right\}. \tag{2}$$

Note the open one in Eq. (2).

Not all numbered equations will fit within a narrow column this way. The equation number will move down automatically if it cannot fit on the same line with a one-line equation:

$$\left\{ ab12345678abc123456abcdef\alpha\beta\gamma\delta1234556\alpha\beta\frac{1\sum^a_b}{A^2} \right\}. \tag{3}$$

When the `\label{#1}` command is used [cf. input for Eq. (2)], the equation can be referred to in text without knowing the equation number that TeX will assign to it. Just use `\ref{#1}`, where `#1` is the same name that used in the `\label{#1}` command.

Unnumbered single-line equations can be typeset using the `\[`, `\]` format:

$$g^+g^+ \rightarrow g^+g^+g^+g^+ \dots ~,~~q^+q^+\rightarrow q^+g^+g^+ \dots ~.$$

Figures may be inserted by using either the `graphics` or `graphicx` packages. These packages both define the `\includegraphics{#1}` command, but they differ in how optional arguments for specifying the orientation, scaling, and translation of the figure. Fig. 1 shows a figure that is small enough to fit in a single column. It is embedded using the `figure` environment which provides both the caption and the imports the figure file.

Fig. 2 is a figure that is too wide for a single column, so instead the `figure*` environment has been used.

The heart of any table is the `tabular` environment which gives the rows of the tables. Each row consists of column entries separated by `&`'s and terminates with \\. The required argument for the `tabular` environment specifies how data are displayed in the columns. For instance, entries may be centered, left-justified, right-justified, aligned on a decimal point. Extra column-spacing may be be specified as well, although REVTeX 4

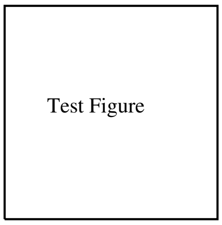


FIG. 1: A figure caption. The figure captions are automatically numbered.

sets this spacing so that the columns fill the width of the table. Horizontal rules are typeset using the `\hline` command. The doubled (or Scotch) rules that appear at the top and bottom of a table can be achieved enclosing the `tabular` environment within a `ruledtabular` environment. Rows whose columns span multiple columns can be typeset using the `\multicolumn{#1}{#2}{#3}` command (for example, see the first row of Table III).

Tables I-IV show various effects. Tables that fit in a narrow column are contained in a `table` environment. Table III is a wide table set with the `table*` environment. Long tables may need to break across pages. The most straightforward way to accomplish this is to specify the `[H]` float placement on the `table` or `table*` environment. However, the standard LaTeX $2_\varepsilon$ package `longtable` will give more control over how tables break and will allow headers and footers to be specified for each page of the table. A simple example of the use of `longtable` can be found in the file `summary.tex` that is included with the REVTeX 4 distribution.

There are two methods for setting footnotes within a table (these footnotes will be displayed directly below the table rather than at the bottom of the page or in the bibliography). The easiest and preferred method is just to use the `\footnote{#1}` command. This will automatically enumerate the footnotes with lowercase roman letters. However, it is sometimes necessary to have multiple entries in the table share the same footnote. In this case, there is no choice but to manually create the footnotes using `\footnotemark[#1]` and `\footnotetext[#1]{#2}`. `#1` is a numeric value. Each time the same value for `#1` is used, the same mark is produced in the table. The `\footnotetext[#1]{#2}` commands are placed after the `tabular` environment. Examine the LaTeX source and output for Tables I and II for examples.

*Physical Review* style requires that the initial citation of figures or tables be in numerical order in text, so don't cite Fig. 2 until Fig. 1 has been cited.

TABLE I: This is a narrow table which fits into a narrow column when using `twocolumn` formatting. Note that REVTeX 4 adjusts the intercolumn spacing so that the table fills the entire width of the column. Table captions are numbered automatically. This table illustrates left-aligned, centered, and right-aligned columns.

| Left[a] | Centered[b] | Right |
|:---|:---:|---:|
| 1 | 2 | 3 |
| 10 | 20 | 30 |
| 100 | 200 | 300 |

[a]Note a.
[b]Note b.

TABLE II: A table with more columns still fits properly in a column. Note that several entries share the same footnote. Inspect the LaTeX input for this table to see exactly how it is done.

| | $r_c$ (Å) | $r_0$ (Å) | $\kappa r_0$ | | $r_c$ (Å) | $r_0$ (Å) | $\kappa r_0$ |
|---|---|---|---|---|---|---|---|
| Cu | 0.800 | 14.10 | 2.550 | Sn[a] | 0.680 | 1.870 | 3.700 |
| Ag | 0.990 | 15.90 | 2.710 | Pb[b] | 0.450 | 1.930 | 3.760 |
| Au | 1.150 | 15.90 | 2.710 | Ca[c] | 0.750 | 2.170 | 3.560 |
| Mg | 0.490 | 17.60 | 3.200 | Sr[d] | 0.900 | 2.370 | 3.720 |
| Zn | 0.300 | 15.20 | 2.970 | Li[b] | 0.380 | 1.730 | 2.830 |
| Cd | 0.530 | 17.10 | 3.160 | Na[e] | 0.760 | 2.110 | 3.120 |
| Hg | 0.550 | 17.80 | 3.220 | K[e] | 1.120 | 2.620 | 3.480 |
| Al | 0.230 | 15.80 | 3.240 | Rb[c] | 1.330 | 2.800 | 3.590 |
| Ga | 0.310 | 16.70 | 3.330 | Cs[d] | 1.420 | 3.030 | 3.740 |
| In | 0.460 | 18.40 | 3.500 | Ba[e] | 0.960 | 2.460 | 3.780 |
| Tl | 0.480 | 18.90 | 3.550 | | | | |

[a]Here's the first, from Ref. 3.
[b]Here's the second.
[c]Here's the third.
[d]Here's the fourth.
[e]And etc.

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[1] Standard DØ detector reference:
V.M. Abazov *et al.* (D0 Collaboration), "The upgraded DØ detector," Nucl. Instrum. Methods Phys. Res. A **565**, 463 (2006).

[2] ** New ** DØ luminosity reference:
T. Andeen *et. al.*, FERMILAB-TM-2365 (2007).

[3] Particle Data Group reference:
W.-M. Yao *et al.*, Journal of Physics G **33**, 1 (2006).

[4] GEANT reference:

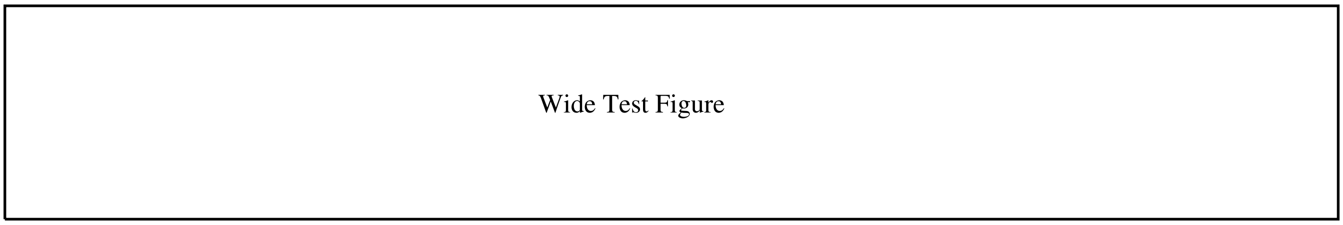


FIG. 2: Use the figure* environment to get a wide figure that spans the page in `twocolumn` formatting.

TABLE III: This is a wide table that spans the page width in `twocolumn` mode. It is formatted using the `table*` environment. It also demonstates the use of `\multicolumn` in rows with entries that span more than one column.

| | $D^1_{4h}$ | | $D^5_{4h}$ | |
|---|---|---|---|---|
| Ion | 1st alternative | 2nd alternative | lst alternative | 2nd alternative |
| K | $(2e)+(2f)$ | $(4i)$ | $(2c)+(2d)$ | $(4f)$ |
| Mn | $(2g)^a$ | $(a)+(b)+(c)+(d)$ | $(4e)$ | $(2a)+(2b)$ |
| Cl | $(a)+(b)+(c)+(d)$ | $(2g)^a$ | $(4e)^{\mathrm{a}}$ | |
| He | $(8r)^{\mathrm{a}}$ | $(4j)^{\mathrm{a}}$ | $(4g)^{\mathrm{a}}$ | |
| Ag | | $(4k)^{\mathrm{a}}$ | | $(4h)^{\mathrm{a}}$ |

[a]The $z$ parameter of these positions is $z \sim \frac{1}{4}$.

TABLE IV: Numbers in columns Three–Five have been aligned by using the "d" column specifier (requires the `dcolumn` package). Non-numeric entries (those entries without a ".") in a "d" column are aligned on the decimal point. Use the "D" specifier for more complex layouts.

| One | Two | Three | Four | Five |
|---|---|---|---|---|
| one | two | three | four | five |
| He | 2 | 2.77234 | 45672. | 0.69 |
| C[a] | C[b] | 12537.64 | 37.66345 | 86.37 |

[a]Some tables require footnotes.
[b]Some tables need more than one footnote.


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[5] PYTHIA reference:
T. Sjöstrand *et al.*, Comput. Phys. Commun. **135**, 238 (2001).

[6] CTEQ6 reference:
J. Pumplin *et al.*, JHEP **0207** 012 (2002) and D. Stump *et al.*, JHEP **0310** 046 (2003).

[7] LEP $\mathrm{CL}_S$ reference:
T. Junk, Nucl. Instrum. Methods A **434**, 435 (1999).

[8] DØ Bayesian reference:
I. Bertram *et al.*, FERMILAB-TM-2104 (2000).

[9] DØ cone-jet reference:
G.C. Blazey *et al.*, in *Proceedings of the Workshop: QCD and Weak Boson Physics in Run II,* edited by U. Baur, R.K. Ellis, and D. Zeppenfeld, Fermilab-Pub-00/297 (2000).