The “lead paragraph” is encapsulated with the \textit{LATEX} quotation environment and is formatted as a single paragraph before the first section heading. (The quotation environment reverts to its usual meaning after the first sectioning command.) Note that numbered references are allowed in the lead paragraph. The lead paragraph will only be found in an article being prepared for the journal \textit{Chaos}.

I. FIRST-LEVEL HEADING: THE LINE BREAK WAS FORCED via \\\n
This sample document demonstrates proper use of REV\TeX~4.2 (and LATEX 2\epsilon) in manuscripts prepared for submission to AAPM journals. Further information can be found in the documentation included in the distribution or available at \url{http://www.aapm.org} and in the documentation for REV\TeX~4.2 itself.

I.A. Second-level heading: Formatting

This file may be formatted in both the \texttt{preprint} (the default) and \texttt{reprint} styles; the latter format may be used to mimic final journal output. In addition, there is another option available, \texttt{lengthcheck}, which formats the document as closely as possible to an actual journal article, to facilitate the author’s performance of a length check. Either format may be used for submission purposes; however, for peer review and production, AAPM will format the article using the \texttt{preprint} class option. Hence, it is essential that authors check that their manuscripts format acceptably under \texttt{preprint}. Manuscripts submitted to AAPM that do not format correctly under the \texttt{preprint} option may be delayed in both the editorial and production processes.

The \texttt{widetext} environment will make the text the width of the full page, as on page 3. (Note the use of the \texttt{pageref} to get the page number right automatically.) The width-changing commands only take effect in \texttt{twocolumn} formatting. It has no effect if \texttt{preprint} formatting is chosen instead.

I.A.1. Third-level heading: Citations and Footnotes

Citations in text refer to entries in the Bibliography; they use the commands \texttt{cite} or \texttt{onlinecite}. Because REV\TeX uses the \texttt{natbib} package of Patrick Daly, its entire repertoire of commands are available in your document; see the \texttt{natbib} documentation for further details. The argument of \texttt{cite} is a comma-separated list of \texttt{keys}; a key may consist of letters and numerals. By default, AAPM citations are numerical;\textsuperscript{1} to give a textual citation, use \texttt{onlinecite}: (Refs. 2–4). REV\TeX “collapses” lists of consecutive numerical citations when appropriate. To illustrate, we cite several together\textsuperscript{1,3,5}, and once again (Refs. 1, 3–5). Note that, when numerical citations are used, the references were sorted into the same order they appear in the bibliography.

A reference within the bibliography is specified with a \texttt{bibitem} command, where the argument is the citation key mentioned above. \texttt{bibitem} commands may be crafted by hand or, preferably, generated by using \texttt{BibTeX}. The AAPM styles for REV\TeX 4 include \texttt{BibTeX} style file \texttt{aapmrev4-2.bst}, appropriate for numbered bibliography. REV\TeX 4 will automatically choose the style appropriate for the document’s selected class options: the default is numerical.

This sample file demonstrates a simple use of
II. MATH AND EQUATIONS

Inline math may be typeset using the \$ \textdollar\$ delimiters. Bold math symbols may be achieved using the \texttt{bm} package\textsuperscript{140} and the \texttt{\textbackslash bm\{#1\}} command it supplies. For instance, a bold \texttt{\textalpha} can be typeset as \texttt{\$\textbackslash bm\{\textalpha\}\textdollar\$} giving \texttt{\textalpha}. Fraktur and Blackboard (or open face or double struck) characters should be typeset using the \texttt{\textbackslash mathfrak\{#1\}} and \texttt{\textbackslash mathbb\{#1\}} commands respectively. Both are supplied by the \texttt{amssymb} package. For example, \texttt{\$\textbackslash mathbb\{R\}\textdollar\$} gives \texttt{\textR} and \texttt{\$\textbackslash mathfrak\{G\}\textdollar\$} gives \texttt{\textG}.

In \LaTeX\ there are many different ways to display equations, and a few preferred ways are noted below. Displayed math will flush left by default.

Below we have numbered single-line equations, the most common kind:

\[\chi_{+}(p) \lesssim \left|2|p|(|p|+p_z)\right|^{-1/2} \left(\frac{|p|+p_z}{px+i\gamma}\right),\]

\[\left\{1234567890abc123\alpha\beta\gamma\delta1234556\alpha\beta\sum_{A}^{a}\right\}.\]

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\textsuperscript{150} automatically if it cannot fit on the same line with a one-line equation:

\[\left\{ab1234567890abc123456abcdef\alpha\beta\gamma\delta1234556\alpha\beta\sum_{A}^{a}\right\}.

When the \texttt{\textbackslash 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 \texttt{\textbackslash ref\{#1\}}, where \texttt{#1} is the same name that used in the \texttt{\textbackslash label\{#1\}} command.

Unnumbered single-line equations can be typeset using the \texttt{\textbackslash[1, \textbackslash]} format:

\[g^{+}g^{+} \rightarrow g^{+}g^{+}g^{+}g^{+} \ldots, \quad q^{+}q^{+} \rightarrow q^{+}g^{+}g^{+} \ldots .\]

II.A. Multiline equations

Multiline equations are obtained by using the \texttt{eqnarray} environment. Use the \texttt{nonumber} command at the end of each line to avoid assigning a number:

\[\mathcal{M} = ig_{Z}^{2}(AE_{1}E_{2})^{1/2}(l_{i}^{2})^{-1}\delta_{\sigma_{1},-\sigma_{2}}(g_{\sigma_{2}}^{e})^{2}\chi_{-\sigma_{2}}(p_{2})
\times[e_{1},e_{1},\chi_{\sigma_{1}}(p_{1})].\]

\[\sum_{i<j}^{M}M_{g}^{\text{viol}}(2) \rightarrow g_{S}^{n-4}(Q^{2})^{N-2}(N^{2} - 1)
\times \left(\sum_{i<j} \left(\sum_{\text{perm}} 1 \right) \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \right).

Note: Do not use \texttt{\textbackslash label\{#1\}} on a line of a multiline equation if \texttt{\textbackslash nonumber} is also used on that line. Incorrect cross-referencing will result. Notice the use \texttt{\textbackslash text\{#1\}} for using a Roman font within a math environment.

To set a multiline equation without any equation numbers, use the \texttt{\textbackslash begin\{eqnarray*\}}, \texttt{\textbackslash end\{eqnarray*\}} format:

\[\sum_{i<j}^{M}M_{g}^{\text{viol}}(2) \rightarrow g_{S}^{n-4}(Q^{2})^{N-2}(N^{2} - 1)
\times \left(\sum_{i<j} \left(\sum_{\text{perm}} 1 \right) \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \right).

To obtain numbers not normally produced by the automatic numbering, use the \texttt{\textbackslash tag\{#1\}} command, where \texttt{#1} is the desired equation number. For example, to get an equation number of (2.6'),

\[g^{+}g^{+} \rightarrow g^{+}g^{+}g^{+}g^{+} \ldots, \quad q^{+}q^{+} \rightarrow q^{+}g^{+}g^{+} \ldots .\]

A few notes on \texttt{\textbackslash tag\{#1\}}. \texttt{\textbackslash tag\{#1\}} requires \texttt{amsmath}. The \texttt{\textbackslash tag\{#1\}} must come before the \texttt{\textbackslash label\{#1\}}, if any. The numbering set with \texttt{\textbackslash tag\{#1\}} is transparent to the automatic numbering in \LaTeX; therefore, the number must be known ahead of time, and it must be manually adjusted if other equations are added. \texttt{\textbackslash tag\{#1\}} works with both single-line and multiline equations. \texttt{\textbackslash tag\{#1\}} should only be used in exceptional case - do not use it to number all equations in a paper.

Note the equation number gets reset again:

\[g^{+}g^{+}g^{+} \rightarrow g^{+}g^{+}g^{+}g^{+}g^{+} \ldots, \quad q^{+}q^{+} \rightarrow q^{+}g^{+}g^{+} \ldots .\]

Enclosing single-line and multiline equations in \texttt{\textbackslash begin\{subequations\}} and \texttt{\textbackslash end\{subequations\}} will produce a set of equations that are “numbered” with letters, as shown in Eqs. (7a) and (7b) below:

\[
\sum_{i<j}^{M}M_{g}^{\text{viol}}(2) \rightarrow g_{S}^{n-4}(Q^{2})^{N-2}(N^{2} - 1)
\times \left(\sum_{i<j} \left(\sum_{\text{perm}} 1 \right) \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \right).

\[
\sum_{i<j}^{M}M_{g}^{\text{viol}}(2) \rightarrow g_{S}^{n-4}(Q^{2})^{N-2}(N^{2} - 1)
\times \left(\sum_{i<j} \left(\sum_{\text{perm}} 1 \right) \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \frac{1}{S_{12}} \right).
\]

Putting a \texttt{\textbackslash label\{#1\}} command right after the \texttt{\textbackslash begin\{subequations\}}, allows one to reference all the equations in a subequations environment. For example, the equations in the preceding subequations environment were Eqs. (7).
II. CROSS-REFERENCING

REV\TeX{} will automatically number sections, equations, figure captions, and tables. In order to reference them in text, use the \texttt{\label{#1}} and \texttt{\ref{#1}} commands. To reference a particular page, use the \texttt{\pageref{#1}} command.

The \texttt{\label{#1}} should appear in a section heading, within an equation, or in a table or figure caption. The \texttt{\ref{#1}} command is used in the text where the citation is to be displayed. Some examples: Section I on page 1, Table I, and Fig. 1.

IV. FIGURES AND TABLES

Figures and tables are typically “floats”; \TeX{} determines their final position via placement rules. \TeX{} isn’t always successful in automatically placing floats where you wish them.

Figures are marked up with the \texttt{figure} environment, the content of which imports the image using either the \texttt{graphics} or \texttt{graphix} packages. These packages both define the \texttt{\includegraphics} followed by the figure caption (\texttt{\caption}). The argument of the latter command should itself contain a \texttt{\label} command if you wish to refer to your figure with \texttt{\ref}.

Extra column-spacing may be be specified as well, although REV\TeX{} 4 sets this spacing so that the columns fill the width of the table. Horizontal rules are typeset using the \texttt{\hline} command. Non-numeric entries (those entries without a “.”) in a “d” column are aligned on a decimal point (\texttt{d}). (Table II illustrates complex layouts.)

The analog of the \texttt{figure} environment is \texttt{table}, which uses the same \texttt{\caption} command. However, you should type your caption command first within the \texttt{table} environment, instead of last as you did for \texttt{figure}.

The heart of any table is the \texttt{\hline} command if you wish to refer to your table with \texttt{\ref}.

The equation that follows is set in a wide format, i.e., it spans across the full page. The wide format is reserved for long equations that cannot be easily broken into four lines or less:

\begin{equation}
R^{(d)} = g_{\sigma_{2}} \left( \frac{[\Gamma^{Z}(3, 21)]_{\sigma_{1}}}{Q^{2}_{12} - M^{2}_{W}} + \frac{[\Gamma^{Z}(13, 2)]_{\sigma_{1}}}{Q^{2}_{13} - M^{2}_{W}} \right) + x_{W} Q_{e} \left( \frac{[\Gamma^{Z}(3, 21)]_{\sigma_{1}}}{Q^{2}_{12} - M^{2}_{W}} + \frac{[\Gamma^{Z}(13, 2)]_{\sigma_{1}}}{Q^{2}_{13} - M^{2}_{W}} \right).
\end{equation}

Table I This is a narrow table which fits into a text column when using \texttt{twocolumn} formatting. Note that REV\TeX{} 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.

<table>
<thead>
<tr>
<th>Left\textsuperscript{a}</th>
<th>Centered\textsuperscript{b}</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Note a.

\textsuperscript{b} Note b.

This is typed to show the output is in wide format. (Since there is no input line between \texttt{\begin{equation}} and this paragraph, there is no paragraph indent for this paragraph.)

Fig. 1 A figure caption. The figure captions are automatically numbered.

<table>
<thead>
<tr>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>Four</th>
<th>Five</th>
</tr>
</thead>
<tbody>
<tr>
<td>one</td>
<td>two</td>
<td>three</td>
<td>four</td>
<td>five</td>
</tr>
<tr>
<td>He</td>
<td>2</td>
<td>2.77234</td>
<td>45672.</td>
<td>0.69</td>
</tr>
<tr>
<td>C\textsuperscript{a}</td>
<td>C\textsuperscript{b}</td>
<td>12537.64</td>
<td>37.66345</td>
<td>86.37</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Some tables require footnotes.

\textsuperscript{b} Some tables need more than one footnote.
Fig. 2 Use the \texttt{figure*} environment to get a wide figure, spanning the page in \texttt{twocolumn} formatting.

The tables in this document illustrate various effects. Tables that fit in a narrow column are contained in a \texttt{table} environment. Table III is a wide table, therefore set with the \texttt{table*} environment. Lengthy tables may need to break across pages. A simple way to allow this is to specify the \texttt{[H]} float placement on the \texttt{table} or \texttt{table*} environment. Alternatively, using the standard \LaTeX\ package \texttt{longtable} gives more control over how tables break and allows headers and footers to be specified for each page of the table. An example of the use of \texttt{longtable} can be found in the file \texttt{summary.tex} that is included with the REV\TeX\ 4 distribution.

There are two methods for setting footnotes within a \texttt{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 \texttt{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, create the footnotes using \texttt{\footnotemark[#1]} and \texttt{\footnotetext[#1]{#2}}. \texttt{#1} is a numeric value. Each time the same value for \texttt{#1} is used, the same mark is produced in the table. The \texttt{\footnotetext[#1]{#2}} commands are placed after the \texttt{tabular} environment. Examine the \LaTeX\ source and output for Tables I and IV for an illustration.

All AAPM journals require that the initial citation of figures or tables be in numerical order. \LaTeX\’s automatic numbering of floats is your friend here: just put each \texttt{figure} environment immediately following its first reference (\texttt{\ref{fig:example}}), as we have done in this example file.

**Acknowledgments**

We wish to acknowledge the support of the author community in using REV\TeX, offering suggestions and encouragement, testing new versions, . . . .
Table III

This is a wide table that spans the page width in \texttt{twocolumn} mode. It is formatted using the \texttt{table*} environment. It also demonstrates the use of \texttt{multicolumn} in rows with entries that span more than one column.

<table>
<thead>
<tr>
<th>Ion</th>
<th>1st alternative</th>
<th>(D^1_{4h})</th>
<th>2nd alternative</th>
<th>(D^2_{4h})</th>
<th>1st alternative</th>
<th>(D^1_{4h})</th>
<th>2nd alternative</th>
<th>(D^2_{4h})</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>((2e) + (2f))</td>
<td>((4e))</td>
<td>((2e) + (2f))</td>
<td>((4f))</td>
<td>K</td>
<td>((2e) + (2f))</td>
<td>((4e))</td>
<td>((2a) + (2b))</td>
</tr>
<tr>
<td>Mn</td>
<td>((2g)^a)</td>
<td>((a) + (b) + (c) + (d))</td>
<td>((4e)^a)</td>
<td>((4g)^a)</td>
<td>Mn</td>
<td>((2g)^a)</td>
<td>((a) + (b) + (c) + (d))</td>
<td>((4e)^a)</td>
</tr>
<tr>
<td>Cl</td>
<td>((a) + (b) + (c) + (d))</td>
<td>((2g)^b)</td>
<td>((a) + (b) + (c) + (d))</td>
<td>((4e)^b)</td>
<td>Cl</td>
<td>((a) + (b) + (c) + (d))</td>
<td>((2g)^b)</td>
<td>((a) + (b) + (c) + (d))</td>
</tr>
<tr>
<td>He</td>
<td>((8x)^a)</td>
<td>((4j)^a)</td>
<td>((8x)^a)</td>
<td>((4j)^a)</td>
<td>He</td>
<td>((8x)^a)</td>
<td>((4j)^a)</td>
<td>((8x)^a)</td>
</tr>
<tr>
<td>Ag</td>
<td>((4k)^a)</td>
<td>((4k)^a)</td>
<td>((4k)^a)</td>
<td>((4k)^a)</td>
<td>Ag</td>
<td>((4k)^a)</td>
<td>((4k)^a)</td>
<td>((4k)^a)</td>
</tr>
</tbody>
</table>

\(^a\) The \(z\) parameter of these positions is \(z \sim \frac{1}{2}\).
\(^b\) This is a footnote in a table that spans the full page width in \texttt{twocolumn} mode. It is supposed to set on the full width of the page, just as the caption does.

Table IV

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.

<table>
<thead>
<tr>
<th>r_c (Å)</th>
<th>r_o (Å)</th>
<th>(\kappa_{r_0})</th>
<th>r_c (Å)</th>
<th>r_o (Å)</th>
<th>(\kappa_{r_0})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>0.800</td>
<td>14.10</td>
<td>2.550</td>
<td>0.680</td>
<td>1.870</td>
</tr>
<tr>
<td>Ag</td>
<td>0.990</td>
<td>15.90</td>
<td>2.710</td>
<td>0.450</td>
<td>1.930</td>
</tr>
<tr>
<td>Au</td>
<td>1.150</td>
<td>15.90</td>
<td>2.710</td>
<td>0.750</td>
<td>2.170</td>
</tr>
<tr>
<td>Mg</td>
<td>0.490</td>
<td>17.60</td>
<td>3.200</td>
<td>0.900</td>
<td>2.370</td>
</tr>
<tr>
<td>Zn</td>
<td>0.300</td>
<td>15.20</td>
<td>2.970</td>
<td>0.380</td>
<td>1.730</td>
</tr>
<tr>
<td>Cd</td>
<td>0.530</td>
<td>17.10</td>
<td>3.160</td>
<td>0.760</td>
<td>2.110</td>
</tr>
<tr>
<td>Hg</td>
<td>0.550</td>
<td>17.80</td>
<td>3.220</td>
<td>1.120</td>
<td>2.620</td>
</tr>
<tr>
<td>Al</td>
<td>0.230</td>
<td>15.80</td>
<td>3.240</td>
<td>1.330</td>
<td>2.800</td>
</tr>
<tr>
<td>Ga</td>
<td>0.310</td>
<td>16.70</td>
<td>3.330</td>
<td>1.420</td>
<td>3.030</td>
</tr>
<tr>
<td>In</td>
<td>0.460</td>
<td>18.40</td>
<td>3.500</td>
<td>0.960</td>
<td>2.460</td>
</tr>
<tr>
<td>Ti</td>
<td>0.480</td>
<td>18.90</td>
<td>3.550</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Here’s the first, from Ref. 1.
\(^b\) Here’s the second.
\(^c\) Here’s the third.
\(^d\) Here’s the fourth.
\(^e\) And etc.

Footnote to title of article.

Also at Physics Department, XYZ University.

Electronic mail: Second.Author@institution.edu.

\(^a\) Footnote to title of article.
\(^b\) Also at Physics Department, XYZ University.
\(^c\) Electronic mail: Second.Author@institution.edu.

\(^a\) Footnote to title of article.
\(^b\) Also at Physics Department, XYZ University.
\(^c\) Electronic mail: Second.Author@institution.edu.