Reviews of Modern Physics Style Guide

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I. INTRODUCTION

This guide is intended to help authors who are preparing ReVTeχ compuscripts for publication in *Reviews of Modern Physics*. The same stylistic guidelines apply, of course, in the preparation of typed copy for the journal. The editorial staff at *RMP* and the production staff at the American Institute of Physics appreciate your effort to follow our style in preparing your article. We all stand to gain from it—you in speedier publication and greater accuracy, and we in ease of production.

A style macro package is available at the *RMP* website,

http://rmp.aps.org/authors.html

You will also find posted on this website a sample paper prepared in ReVTeχ.

ReVTeχ is the LaTeχ macro used to produce the standard layout and style of all American Physical Society journals, including the *Physical Review* journals and *Reviews of Modern Physics*. It enables an author to submit a file from which proof can be generated directly, without rekeyboarding.

Below is a description of the features of *RMP* style, many of which are taken care of automatically by the style files. In addition, you will find some remarks on the rationale behind this style and advice on preparing tables, figures, and equations.

Two appendices complete the Style Guide. The first is a short paper, ''Writing a Better Scientific Article,'' with a special subsection intended for authors whose first language is not English. The second is a list of journal titles with their standard abbreviations for use in references.

When your article is ready, send the compuscript electronically to rmptex@aps.org. PostScript figures may also be sent electronically as separate files, named in this style: authorname_fig01.eps. Do not embed the figures in the text.

Reviews of Modern Physics also has an ftp site to which you can transfer your file. Contact the editorial office for the address and procedure.

Alternatively, you can send hard copies of your text and/or figures to the *RMP* editorial office, University of Washington, Department of Physics, Physics/Astronomy Building B42, Box 351560, Seattle, WA 98195-1560. Group the figures and tables at the end of the manuscript.

We look forward to receiving your article.

II. PRELIMINARY MATTER

The appropriate ReVTeχ macro is given on the right.

A. Header

Begin your text file with this header:

\documentstyle[preprint,rmp,aps]{revtex}

B. Title \title{ }

Begin the first word with a capital letter; thereafter capitalize only proper or trade names and chemical symbols. Words may be used in place of greek symbols in titles. The use of nonstandard abbreviations and acronyms is not allowed.

C. Author(s) \author{ }

If there are multiple authors, they should be ranged one above the other. Capitalize the first letter of each name, but not the whole name. Authors should use the same form of their names in all publications (not A. L. Smith in one and Ann Smith in another) so that in author indexes like the *Science Citation Index* all of their work will appear in one place.

D. Affiliation(s) \address{ }

Write out the names and postal addresses of all institutions in full, followed either by city, state, and zip code, if in the U.S., or by postal code, city, and country, if not the U.S. Do not include box numbers or street addresses.

If an author has more than one affiliation, each should begin a new line, without linespaces between the lines. E-mail addresses may be given as unnumbered footnotes (\footnote{}), beginning ''Electronic address:''

E. Abstract \begin{abstract} ... \end{abstract}

The abstract should be a concise summary of the subjects treated in the paper. It will be used as a basis for indexing and will also be published separately from the article in at least one abstract journal. Therefore it should be completely self-contained (no footnotes or numbered references) and should avoid the use of ''I'' or ''we.'' Substitute ''the author(s)'' or passive constructions for the first person. The abstract should consist of no more than one paragraph. The first line should not be indented.

F. Contents \tableofcontents

The contents page is generated automatically by the ReVTeχ macro. Every titled section and subsection of the paper will be listed here, using exactly the same wording as is used where it appears in the text. There is no need to give manuscript page numbers; printed page numbers will be filled in when the proofs are paginated.

CONTENTS

Note that the words ''Table of'' do not appear in the heading ''Contents.'' Unnumbered sections like Acknowledgments and References begin flush with the left margin.

G. List of symbols and/or acronyms

The inclusion of a list of symbols is optional. If you choose to have one, it precedes the References and is an unnumbered section. Arrange the list alphabetically, giving the roman alphabet first (all capitals, then all lower case), then the greek alphabet. Each symbol should begin flush with the left-hand margin and be in italics. The definition of each symbol begins ten spaces in from the left margin with a lower-case letter (proper names, of course, should be capitalized). If the full definition will not fit on one line, the additional lines should also begin ten spaces from the left margin.

III. SECTION HEADINGS

There are four types or ''levels'' of headings. The rmp.sty macro generates the correct font and style for each level. All begin flush with the left-hand margin (not centered) and are set off from the text by two line spaces above and one line space below. No period follows them. The following list shows the four different levels and the appropriate style for each. Consult a recent issue of *Reviews of Modern Physics* for further examples.

Level One

I. PRINCIPAL HEADING **section**{ }

All capital letters. The macro numbers these headings automatically with a roman numeral and a period and uses a boldface type font.

Level Two

A. First subheading **subsection**{ }

First word capitalized, preceded by a roman capital letter and a period. Boldface.

Level Three

1. Second subheading \subsubsection{ }

First word capitalized, preceded by an arabic numeral and a period.

Level Four

a. Third subheading. {\it. a. Heading}

First letter capitalized, preceded by a lowercase letter and a period. Italics. Heading must be preceded by a blank line.

IV. NUMBERING OF FIGURES, TABLES, AND EQUATIONS

A. Figure numbering

Figures are numbered consecutively throughout the whole paper (not by section), using arabic numbers (1, 2, 3, etc.). Parts of figures are labeled (a), (b), (c), etc., with parentheses enclosing the letter. If a figure occurs in an appendix, it should be numbered to continue the sequence from the final figure shown in the main body of the paper.

When you cite a figure, use the abbreviation ''Fig.'' except at the beginning of a sentence:

As can be seen in Fig. 5, the optimum ...
Figure 7(a) shows the optimum ...

Be sure to cite every figure in the text.

B. Table numbering

Tables are numbered with roman numerals (I, II, III, etc.), in order of appearance in the text. Be sure that there is a citation in the text for every table.

C. Equation numbering

Equations that are set off from the text (displayed) may be numbered either consecutively throughout the whole paper or by section. Numbering by sections refers only to the large main sections, that is, to those with Level One headings labeled by roman numerals. Do not break down the numbering of equations into smaller subsections.

To label by section, translate the roman numeral of the section head into an arabic number, follow this by a decimal point, then give the equation number. The

whole is enclosed by parentheses. Thus the first equation in Sec. II would be labeled Eq. (2.1), the second would be Eq. (2.2), etc.

Equations in appendices are numbered (A1), (A2), (A3), etc. For more details, see Sec. VI on appendices. The equation number is usually placed within parentheses, at the extreme right of the displayed equation, on a level with its bottom line.

When referring to a numbered equation, use the abbreviation ''Eq.'' except at the beginning of a sentence:

It follows from Eq. (31) that ...

Equation (1.20) illustrates ...

When referring to more than one equation, give each equation number its own set of parentheses, e.g., ''Expanding Eqs. (1.20)–(1.23), we obtain ....''

For more details on displayed equations, see Sec. XV.C.

V. ACKNOWLEDGMENTS

\section*{Acknowledgments}

The acknowledgment section follows the main body of the paper and precedes any appendices. A principal heading (Level One) is used for this section, but the section is not numbered. Note that ''Acknowledgments'' is spelled without an *e* between the *g* and the *m*. One paragraph is suggested, with acknowledgment of financial support listed at the end. *Reviews of Modern Physics* copy editors have been instructed to delete any thanks directed to referees, associate editors, or journal staff for the performance of their editorial duties.

VI. APPENDICES

Appendices are placed after the acknowledgments section and before the listing of references. They must have a heading (Level One), which may be in a variety of styles, illustrated below:

APPENDIX: SURVEY OF RESULTS

\appendix \section*{Survey of Results}

APPENDIX A: SURVEY OF RESULTS

\appendix \section{Survey of Results}

APPENDIX **\appendix**

If there are subheadings within an appendix, they are numbered with arabic numbers, in the style of Level Two.

Displayed equations in a first or only appendix are numbered (A1), (A2), ... Equations in a second appendix are then numbered (B1), (B2), etc. Note that the letter and number are not separated by a space, dash, or period.

VII. SUPPLEMENTARY MATERIAL NOT IN APPENDICES

Occasionally authors wish to include in the text material that may not be of interest to all readers, and to indicate that such material may be skipped over by the general reader. Journals published at the American Institute of Physics are no longer permitted to compose this material in a smaller typeface, or to flag the beginnings of such paragraphs with a black dot. If the material is not long enough to warrant an appendix, the author is urged to consider other alternatives—including it as part of the regular text, putting it in a footnote, or omitting it altogether.

Very long tables, computer programs, multimedia, and color figure files may be deposited in the Physics Auxiliary Publication Service (PAPS) or its electronically accessible depository, E-PAPS, and the reader referred to them by means of a footnote. This service, managed by the American Institute of Physics, supplies to interested readers material that is supplementary to papers published in The American Physical Society and American Institute of Physics journals but that may be too lengthy or of too limited reader interest to be published in full in the journal. Information about E-PAPS can be obtained from the Editorial Office on request, or via the World Wide Web at the URL ⟨http://www.aip.org/epaps⟩.

VIII. REFERENCES

Reviews of Modern Physics arranges the reference sections of its papers alphabetically by author. This enables the reader to scan the list of references easily and to see at a glance when the work of one person or group is represented by several articles.

Since the references are not numbered, citations to them in the text must identify them by authors' names and year of publication. While some contributors to the journal have complained that this form of reference is cumbersome, we believe that it actually saves the reader time by giving the essential information—author and year—where the work is mentioned, thus sparing the reader the effort of turning to the end of the paper to decode each reference number. In a typical review paper, with 200 or more references, this saving becomes nontrivial.

A. Citations in the text

The authors and years of individual references may be cited in the text in several ways, all of which employ parentheses. Here are some examples:

(1) The object N 157B in the Large Magellanic Cloud shows a filled center and nonthermal spectrum at both radio and x-ray wavelengths (Clark *et al*., 1982).

(2) The interested reader will find good discussions of much of this work in Potter (1983), Hockney and Eastwood (1991), and Birdsall and Langdon (1995).

(3) The field of nonlinear transport, which had been initiated long before by a few pioneer papers (Landau and Kompanejez, 1934; Davydov, 1936, 1937), then entered a period of rapid development.

(4) The constant C can be obtained from Cohen and Keffer (1955; see also Osheroff *et al*., 1980 and Roger, 1980).

In example (1), *et al.* has been used, signifying that there are three or more co-authors. Of course, the names of all co-authors will be given in the list of full references at the end of the paper. However, there are cases in which it would be preferable to name the co-authors in the text as well, for example, if two papers by Clark and co-workers were listed in the references for 1982, one by Clark, Jones, and Smith, and the other by Clark, Lewis, and Jones. These could not be labeled 1982a and 1982b because they are not by the same group.

In example (2), only the year of the reference appears in parentheses. It is unnecessary to repeat the author's name in parentheses when it occurs naturally as part of a sentence.

In example (3), a list of references is given within parentheses. Note that they are arranged chronologically, with the earliest first, and that a semicolon separates one reference from the next. When the list contains more than one work that appeared in the same year, these should be arranged alphabetically by authors' names. Commas separate authors' names from years. When more than one work by the same author is cited, the years are separated by commas. No ''and'' is used before the last citation.

B. Citations in footnotes

We encourage authors to put long lists of references in footnotes if it would be cumbersome and detrimental to the flow of the article to keep them in the text. Of course, single citations are always made in the text. As footnotes should be notes and not just lists, incorporate your list of citations into a sentence, e.g.,

[1]For historical background on this problem, see Adams and Withey (1952, 1970), . . .

[2]A number of theorists have proposed alternatives to this model which we shall not discuss here. They include . . .

See also Sec. IX.B on textual footnotes.

C. Format of full reference entries

Because *Reviews of Modern Physics* is an archival journal and we know that our bibliographies get heavy use, we attach considerable importance to providing references that are as helpful as possible. To this end we ask our authors to be generous with the information they supply, including names of all co-authors and editors, subtitles of books and conference proceedings, titles of preprints when an article is not yet published, etc. Authors may choose between a standard, short format and a longer format that gives titles of articles and inclusive page numbers. Whichever style is used, all journal entries in the reference section must follow the same format. Examples of both styles are given below.

1. Journal articles

a. Long format

Alicki, Robert, John R. Klauder, and Jerzy Lewandowski, 1993, ''Landau-level ground-state degeneracy and its relevance for a general quantization procedure,'' Phys. Rev. A **48**, 2538–2548.

b. Short format

Abe, F., *et al.* (CDF Collaboration), 2000, Phys. Rev. Lett. **84**, 5716.

Barrett, R. F., B. A. Robson, and W. Tobocman, 1983, Rev. Mod. Phys. **55**, 155; **56**, 567(E).

Bethe, H. A., 1932, Z. Phys. **76**, 293.

Carraro, C., and M. W. Cole, 1992, J. Low Temp. Phys. **89**, 597.

Einstein, A., B. Podolsky, and N. Rosen, 1935, Phys. Rev. **47**, 777.

The first example shows the longer style, giving both the title of the article, in quotes, and inclusive page numbers. While it is not required, we encourage our authors to provide this information. The remaining examples are in the shorter style.

Note that only the first author's name is inverted. Each author's name is followed by a comma, and the name of the last author is preceded by ''and.'' All co-authors are named for papers with ten or fewer co-authors. When there are eleven or more, they may be represented by *et al*. in italics.

The journal volume number is in boldface. When a journal has more than one section (e.g., Nucl. Phys. A or B), separate the section letter A, B, etc. from the volume number by a space.

The Barrett *et al.* entry shows an original article followed by an erratum that appeared in a later issue. For references requiring more than one line, indent the sec-

ond and subsequent lines one space. See Appendix B for a list of standard journal abbreviations.

2. Russian journal articles with English journal translations

Maximov, A. V., and V. P. Silin, 1993, Zh. Éksp. Teor. Fiz. **103**, 73 [JETP **76**, 39 (1993)].

List the translation journal after the original Russian journal; it is not necessary to say that the second reference is a translation. Enclose the translation reference in square brackets. Since translations sometimes appear in a later year than the original, give the year of the translation in parentheses at the end. When translation and original appear in different years, the citation in the text should be to the earlier of the two, i.e., the original Russian journal.

3. Books

Barcons, X., and A. C. Fabian, 1992, Eds., *The X-ray Background* (Cambridge University, Cambridge, England).

Feynman, R. P., and A. R. Hibbs, 1965, *Quantum Mechanics and Path Integrals* (McGraw-Hill, New York).

Geiss, J., 1993, in *Origin and Evolution of the Elements*, edited by N. Prantzos, E. Vangioni-Flam, and M. Cassé (Cambridge University, Cambridge, England), p. 89.

Mathieu, H. J., 1984, in *Thin Film and Depth Profile Analysis*, edited by H. Oeschsner, Topics in Current Physics No. 37 (Springer, Berlin), p. 39.

When a book is listed under the name(s) of its editor(s), use the abbreviation Ed. (Eds.) after the year. When the reference is to an article in a collection, use the words ''edited by'' after the title of the collection, and give the page number of the article at the end. Enclose the names of publishers and cities of publication in parentheses. If the book is published in more than one city, the cities of publication should be separated by slashes. The words ''Press,'' ''Verlag,'' etc. should be omitted from the publisher's name.

4. Proceedings

Lehar, F., 1991, in *Proceedings of the 9th International Symposium on High Energy Spin Physics*, Bonn, edited by K.-H. Althoff and W. Meyer (Springer, Berlin), Vol. 1, p. 113.

Lingenfelter, R., and R. Ramaty, 1982, in *The Galactic Center,* AIP Conference Proceedings No. 83, edited by G. R. Riegler and R. D. Blandford (AIP, New York), p. 148.

Matsuoka, N., K. Hatanaka, T. Saito, T. Itahashi, K. Hosono, A. Shimizu, M. Kondo, F. Ohtani, and O. Cynshi, 1983, in *Proceedings of the 1983 RCNP International Symposium on Light Ion Reaction Mechanism*, edited by H. Ogata, T. Kammuri, and I. Katayama (Research Center for Nuclear Physics, Osaka, Japan), p. 527.

The general treatment of proceedings follows that of books. Proceedings, however, can be much more difficult to locate, making it doubly important that you provide the reader with every possible clue. Spell out *the whole title, including subtitle*, if any, as it appears on the title page. When the proceedings are part of a series, give the series name and number after the title. Be sure to include the name and city of the publisher. If the proceedings are to be published in a special issue of a journal, say so. Do not abbreviate the words ''proceedings'' and ''international.''

5. Theses, preprints, and other references

Below are examples of the correct form for listing theses, preprints, reports, and unpublished work.

Allard, F., 1991, Ph.D. thesis (University of Heidelberg).

There is no need to add ''unpublished'' to a thesis or report reference.

Polchinsky, J., and E. Witten, 1996, ''Evidence for Heterotic Type-I String Duality,'' preprint hep-th/9510169.

Binette, L., 1984, ''Photoionisation models for liners: gas distribution and abundances,'' European Southern Observatory Scientific Preprint No. 350.

Cowley, C. E., 1998, Phys. Rev. A (in press).

Wagner, Z., 1994, unpublished.

If a preprint exists, but the paper has not yet been accepted for publication, give either the preprint number or the preprint title and institution, to aid the interested reader in obtaining a copy. The preprint title is placed in quotation marks. Do not say, ''submitted to…,'' ''in preparation,'' or ''to appear.''

When a paper has been accepted by a journal but not yet published, give the journal name followed by ''(in press).'' Frequently such entries can be updated in proof to include volume and page numbers.

If a preprint of the work is not available, the work should be cited as ''unpublished'' or ''private communication,'' with the year.

D. Order of reference list

The reference section is arranged alphabetically by author. When several works by the same author are in-

cluded, these are arranged chronologically. When more than one work by the same author is listed in the same year, they are distinguished by labeling the first, say, 1996a, the second 1996b, etc.

If all papers were by single authors, the above guidelines would be sufficient. However, multiple authorship introduces the need for a few further distinctions. Consider the following list:

Smith, G. F., 1987

Smith, G. F., 1990

Smith, G. F., 1996

Smith, G. F., H. T. Dietrich, and W. K. Lee, 1998a

Smith, G. F., H. T. Dietrich, and W. K. Lee, 1998b

Smith, G. F., W. K. Lee, and H. Sorenson, 1998

Smith, G. F., W. K. Lee, and A. T. Washington, 1989

Smith, G. F., and L. M. Young, 1988

All works by Smith as a single author are listed first, in chronological order. The remaining references are arranged alphabetically by surname of the second author (Dietrich, Lee, Young). When the first two authors are the same, alphabetize according to the surnames of the third authors (e.g., Sorenson, Washington).

Two works by the same group in the same year are distinguished by labeling the first 1984a and the second 1984b. The work by Smith, Lee, and Sorenson should not be labeled 1998c, because the makeup of the group is different from that of 1998a and 1998b.

Occasionally the use of a and b is extended to groups of 4 or more co-authors that are similar but not identical in makeup. This is done to simplify the task of discriminating among several choices or when the alternative would be a cumbersome citation listing all co-authors in the text. Feel free to consult the editorial office about cases for which you think such a bending of the rules might be warranted.

IX. FOOTNOTES

Footnotes may be used in the introductory information (titles, authors, affiliations), in the body of the text (to make short comments about the textual material), and in tables or figures. Note that footnotes are *not* used in *Reviews of Modern Physics* for purely bibliographic purposes, except for long lists (see Sec. VIII.B)

A. Introductory footnotes \thanks{ }

The following symbols, as superscripts, are used (in the order listed) for footnotes to title page material: *, †, ‡, §, ††, ‡‡, §§. The online edition of the journal may substitute *, **, ***, etc. for these symbols, which are not readily available in electronic fonts. Here are some examples of footnotes to preliminary matter:

*This paper is based in part on a talk delivered at the J. Robert Oppenheimer Memorial Prize ceremonies on January 9th, 1974, at the Center for Theoretical Studies, University of Miami, Coral Gables, Florida.

†Present address: Department of Physics, University of Illinois at Urbana-Champaign, Urbana, IL 61801.

‡On leave from Brookhaven National Laboratory, Upton, NY 11973.

§Electronic address: bucky@phys.washington.edu

An author's primary affiliation (address) should be given after his or her byline and not put into a footnote.

Acknowledgments of financial support should not appear as footnotes to the title or to an author's name, but rather belong in the acknowledgment section at the end of the paper.

B. Textual footnotes \footnote{ }

Indicate footnotes in the text by the insertion of superscript numbers, in this manner:

The appearance of these data caused a furor[3] among the theorists.

Acceleration, vibration,[4] temperature gradients, and temperature changes all produce stresses in the active region of the device.

When punctuation is present at the point where a footnote is cited, place the superscript number *after* commas, periods, and quotation marks, but *before* colons and semicolons.

Be cautious about placing a superscript footnote number immediately after quantitative material, where it might be mistaken for an exponent. In such cases, the footnote usually can be cited elsewhere in the sentence; if no other position can be used, spell out the word ''footnote'' in parentheses (footnote 4), on the line, instead of using a superscript number.

Each note is in the form of a paragraph (i.e., first line indented), beginning with a superscript number one space in from the left-hand margin.

Although simple citations of sources are not treated as footnotes (see instructions for references), bibliographic material may be incorporated in footnotes, as in the following examples:

[1]Their result was also presented at Les Houches by Corbière (1984).

[2]Mason (1950) gives an alternate method for calculating c_i.

[3]A description of these early experiments can be found in Adams, 1978. The present status of such experiments is discussed in reviews by Stein (1998) and Callaghan (1999).

[4]See Rubbia's comment after G. Myatt's talk at the 1973 Bonn Conference (Myatt, 1974): "The important question in my opinion is whether neutral currents exist or not, not so much the value of the branching ratio" (discussion after Myatt's talk, p. 405).

C. Notes in tables and figure captions

Most notes in figure captions and tables are simple references to sources and can be treated in the same way as bibliographic references in the text, i.e., by naming author and year in parentheses.

Examples:

FIG. 1. The ^{3}He data compared to the prediction of Maize and Kim (1983): dashed curve, impulse approximation; solid curve, impulse approximation plus MEC.

FIG. 2. Einstein Observatory (HEAO 2) data on the x-ray spectrum of Tycho Brahe's supernova remnant. From Becker *et al*., 1979.

FIG. 3. Typical recorded spectra when argon ions are incident on thick silicon and carbon targets (adapted from Jones *et al*., 1972).

In tables, use lower-case roman letters to identify the footnotes, placing them as superscripts to table entries or headings and placing them on-line when they replace a missing entry. Order the footnote letters consecutively row by row, and not by column.

Example:

TABLE X. Experimental results (Benhar, 1994).

$\delta(E2/M1)$	
Theor.[a]	Expt.
−41.0	− 18 ± 0.3[b]
−57.5	− 10 ± 0.6
37.3	
13.7	c

[a]Jones *et al*. (1993).
[b]Barclay and Stewart (1990).
[c]Not available.

Remember to include in the reference list at the end of the paper full entries for any sources you cite in a table or figure.

X. TABLES

Tabular material of more than four lines should not remain as part of the text. It should be treated as a separate, numbered table, complete with a descriptive caption. All such tables must be cited in text and are numbered with roman numerals consecutively in order of their appearance in the text. Assemble tables at the end of the manuscript, before the figures. Like the figures, tables will be inserted as close as possible to where they are cited in the text. Some guidelines for preparation of tables are given below. For further examples, see any recent issue of *Reviews of Modern Physics*.

A. Table sizes

Tables will print out the same width as the caption. There are four standard one-page table widths:

(1) narrow (one column, 8.6 cm or 3.4 in.), \narrowtext
(2) wide (two columns, 17.8 cm or 7.0 in), \widetext
(3) medium (1.5 column width, 14 cm or 5.5 in.), \mediumtext
(4) turned table (one-page length turned sideways, 25.4 cm or 10.0 in.).

A turned table cannot be formatted in ReVTeχ and requires special handling by the production staff. Please identify it as such in a cover letter.

In addition, to accommodate extremely wide tabular material, tables can read across facing pages (35.6 cm or 14.0 in.). This type of table also requires special handling by the production staff and should be identified in a cover letter.

B. Table captions

Each table that is not part of the text must have a descriptive caption. It should be as concise as possible. If it is made up of more than one sentence, treat it as a single paragraph.

The caption is positioned above the table. It begins with the word table, in capital letters, followed by the appropriate roman numeral and period, and then a small amount of explanatory text.

Examples:

TABLE I. Spin-orbit parameters.

TABLE II. Calculated $M1$ matrix elements for ^{156}Gd, $M_{rs}(M1) = \langle S1|M(M1)|r\rangle$ in $10^{-2}\mu_N$.

C. Lines and space in tables

A simple table needs lines in only three locations: two lines together at the beginning and end of the table and a single line separating the headings and columns of entries. A more complicated table, one made up of several

parts and having more than one set of headings, will need additional space and lines. Extra space running horizontally can be used to distinguish broad groups among the entries.

D. Headings within tables

Always capitalize the first word or abbreviation in all headings and subheadings.

Column headings are separated from the body of the table by a horizontal line. They are usually dropped to the bottom of the heading area. However, units of measure that pertain to each entry in a whole column should be included in parentheses and placed as the last entry in the heading on their own line (sample 1) or spaced off from the heading on the same line (sample 2).

Sample 1

Branching ratio (%)
1
2
3

Sample 2

E_x (MeV)	J^π
2720	2^-
411	2^-

XI. FIGURES

When submitting PostScript figures electronically, each figure should be in a separate file, with the number as part of the filename, e.g., Smith_fig01.eps. Do not embed the figures in the text or place tags in the text to show where they go. Our page makeup software will place them as close as possible to where they are cited, within the constraints of the two-column format. The following technical suggestions and basic style requirements should be kept in mind.

A. Types of figures

(1) Line drawings, generated by draftsman. Submit original on drafting vellum.
(2) Line drawings, computer generated. Submit hard-copy printout *and* PostScript file. Name the file with one author's name and the figure number.
(3) Continuous-tone photograph (photographs that contain variations in tone). *Do not screen.* Submit sharp glossy photographs.
(4) Combination (composite figure, both line drawing and continuous-tone photograph). Prepare as separate figures. Submit two components, indicating that they are to be treated as one figure. *Do not screen.*

B. Designing and labeling figures

(1) Prepare hard-copy figures on standard size paper (21× 28 cm or 8.5× 11 in.). Larger figures are easily damaged by handling and smaller ones are sometimes overlooked or misplaced.
(2) Keep in mind the column width of *RMP*, ~ 8.6 cm (~3.4 in.). The production staff reduces all line drawings and photographs, if they are in proper scale, to three basic sizes to fit within the following limits:
   (a) narrow, to fill the width of one column;
   (b) wide, to fill two columns; or
   (c) $1\frac{1}{2}$ column width, flush left, with space on the right-hand side.
(3) Make symbols and lettering in proper scale in relation to the overall figure size so that reduction will not reduce clarity. Two sizes for lettering (one for on-line lettering, the other for subscripts, superscripts, and data points) is recommended. Draw symbols and lettering so that after reduction the smallest of these will not be less than 1.5 mm ($\frac{1}{16}$ in.) tall. Consider also that intricate symbols tend to fill in when reduced. Solid or open symbols are easier to read.
(4) Hand lettering is not acceptable.
(5) Make line thickness consistent (solid and dark). Lines tend to become less distinct when reduced.
(6) When shading is necessary, use diagonal or cross-hatched lines. Follow the same stylistic conventions in the figures as in the rest of the paper. Hyphenation, abbreviations, symbols, and upper- and lower-case letters should be consistent throughout.
(7) Label parts of figures (a), (b), (c), etc.; curves A, B, C, etc.; geometric points, angles, and lines A, B, C, etc.; or a, b, c, etc., as appropriate.
(8) Treat graphs so that they are completely self-explanatory. Label each axis (horizontal and vertical) with the quantity being plotted, including the appropriate units, which should be spaced off and enclosed in parentheses, i.e., θ (deg). Avoid powers of 10 if possible; instead use the appropriate prefixes of the *Système International* (see Table II, Sec. XIV). If powers of 10 cannot be avoided the following form is preferred: $R(10^{-4}\ \Omega)$.
(9) Decimal quantities less than 1 should include a zero to the left of the decimal point, e.g., 0.5.

C. Identifying figures

Number each figure consecutively with an arabic numeral according to the order in which it is discussed in the paper. On hard copies write the figure number and first author's name preferably on the lower right-hand corner of each figure. If this is not possible, write them on the back of the figure with a very soft pencil. This will

ensure proper matching of figure and text. It is helpful to identify the top of the figure when this is not obvious from the axes or lettering.

All figures must be cited in consecutive order in the text. For example, you could refer to your first figure in one of these ways:

Figure 1 shows experimental results.

Experimental results are shown in Fig. 1.

The results, however, are conflicting (see Fig. 1).

Note that the word figure is written out when it begins a sentence, but it is abbreviated at other times. The production department at AIP has page makeup software that will place each figure as close as possible to its original citation when designing the final layout of the paper.

D. Figure captions

The list of figure captions is the last item of text in the manuscript or compuscript. Captions will be placed with their respective figures during page makeup. Every figure should have a caption, even though it may consist only of an abbreviated title.

Example:

FIG. 1. Schematic drawing of the R110 apparatus. From Camilleri *et al*., 1981.

Give the symbol or describe the curve *before* you give its definition.

Examples:

FIG. 2. Measured and theoretical rotation-rate uncertainty as a function of integration time τ: ○, first harmonic measurement, with the solid line being the corresponding shot noise; ●, second harmonic measurement, with the dashed line indicating the corresponding shot-noise limit. From Davis and Ezekiel (1981).

FIG. 3. Suppression factor S for magnetic suppression: long-dashed curve, $E=0.1\,E_B$; short-dashed curve, $E=10\,E_B$; solid curve, $E=1\,E_B$.

When two or more figures are grouped together as parts of one figure number, there should be one caption for the group, beginning with a title that applies to all parts, and then proceeding to individual descriptions, as necessary, for parts (a), (b), (c), etc.

Example:

FIG. 4. Regge diagrams for scattering in hadron-hadron collisions: (a) total scattering; (b) elastic scattering; (c) single diffractive scattering.

If you cannot come up with an initial label that applies to all the parts, you should probably give each part its own figure number and its own caption.

Finally, if the figure is from a previously published source, the source should be credited.

XII. PUNCTUATION

A. Hyphenation

The purpose of hyphenation is to resolve ambiguity as to which words are being modified in multiword terms containing more than one noun. The basic rule is that words modifying modifiers get hyphenated, but not words modifying nouns that are used as such. For example: consider a heavy-fermion system, composed of heavy fermions. A heavy fermion system (no hyphen) would be quite different: the system is both heavy and composed of fermions. Certain classes of two-word modifiers are easily recognized. They include the following:

• Quantitative modifiers: three-photon, double-well, many-body, 12-channel, single-particle, zero-mass, three-dimensional.

• Compound modifiers using high, low, large, small, wide, narrow, strong, weak, hard, soft, long, or short: high-energy, low-density, large-angle, weak-coupling, hard-pion, long-range.

• Two-word modifiers in which the second word is a past participle: collision-induced, angle-resolved, Coulomb-corrected, diffusion-limited, mode-locked, pair-correlated, phase-matched, phonon-assisted, space-fixed, vacuum-deposited, valence-excited.

There are some exceptions to the above rule:

(1) Terms that are hyphenated when used as adjectives remain unhyphenated as predicate adjectives, i.e., when they follow a form of the verb ''to be.'' For example,

A block-diagonal matrix is obtained.

The matrix is block diagonal.

(2) The adverb ending ''ly'' implies that the adjective immediately following is being modified, so no hyphen is needed. Examples: slowly varying, strongly coupled.

(3) Latin prefixes can usually be joined to a word without using a hyphen: nonzero, intermolecular, superconducting, infrared. However, do not close up the two parts if a double letter other than e is produced (semi-infinite, preexisting), if a proper noun is involved (non-Fermi), or if closing up could change the meaning of the word (un-ionized). Chemical prefixes (in italics) should be hyphenated (*cis*-dimethylethylene).

(4) Do not hyphenate written-out names of chemical compounds when they are used as adjectives: sodium iodide crystal, alkali halide crystal.

(5) ''Self'' words and ''free'' words should be hyphenated (self-consistent, worry-free), but ''like'' words and ''wise'' words are closed up (spacelike, stepwise) unless they become extremely long or cumbersome. ''Fold'' words are closed up through ten (twofold, tenfold), but hyphenated above ten (11-fold, 100-fold).

To sort a string of modifiers, you can use a combination of hyphens and longer dashes (two-particle–two-hole configuration) or hyphens and a slash (two-particle/two-hole).

B. Use of the comma

RMP style calls for a comma before ''and'' at the end of a list. This is known as the ''serial comma'':

Grant, Komsky, Oswald, and Peters

oscillating, rotating, or stationary

When introducing a variable, do not set it off with commas when it immediately follows the noun that defines it:

The melting temperature T_m is ...,

but do use commas when another phrase intervenes:

The melting temperature reported by Green, T_m, is ...

Use commas on either side of the following: e.g., i.e., for example, in particular, namely, respectively, say, that is.

Do not use commas after thus or therefore.

C. Use of parentheses

Equation numbers cited in the text should be enclosed within parentheses. To avoid having parentheses within parentheses, use square brackets for the outer pair: [see Eqs. (2) and (3)]. Figure numbers should not be enclosed in parentheses, but parts of the figures should: Figs. 4(a)–4(c).

When citing individual references, the most common form is to name the author, then put the year in parentheses: ''Mahan (1996) confirmed that ...'' Lists of references can be enclosed without separate parentheses for each year: (see Jones, 1987, 1992; Armitage, 1993b; Wurtz *et al.*, 1996).

Avoid adjacent parentheses, for example, a definition or acronym followed by a reference:

(hereafter EPR) (Einstein, Podolsky, and Rosen, 1935).

Related items can share the same set of parentheses, separated by a semicolon:

(hereafter EPR; Einstein, Podolsky, and Rosen, 1935).

Parenthetical remarks usually do not have closing punctuation inside the parentheses (as you might expect). However, a separate and complete sentence within parentheses, beginning with a capital letter, should have its end punctuation inside: (Armitage took exception to Brown's approach, as we shall see below.)

D. Use of the colon

The most frequent misuse of the colon by *RMP* authors is in introducing equations. A colon should not follow a form of the verb ''to be'' and it should not come between a verb and its object or between a preposition and its object. Often a displayed equation is the object. Thus the following lead-ins to equations should not have colons, or indeed any end punctuation:

We obtain

The result is

This reduces to

Then the coordinates are given by

Colons may, however, be used to introduce equations when the object has already been stated or the clause completed:

We obtain the following distribution:

The result is a multidimensional gamma function:

Open sets can be characterized as follows:

This produces a power-law series:

A second question concerning the use of colons is whether to capitalize what follows them. The answer may be stated in three parts:

(1) Phrases introduced by a colon do not begin with a capital letter:

Furthermore, the lake has a natural noise center source: a dam.

(2) A complete sentence introduced by a colon may be, but need not be, capitalized:

Finally, the energies of bound surface states are calculated by means of the ''effective-Hamiltonian'' technique: Let H_{eff} be defined by $E - H_{\text{eff}} = G_0(E^{-1} - V)$.

(3) When more than one sentence is introduced by a colon, capitalize the first word:

In order to tackle Eq. (A5) we introduce the following simplifications and approximations: (1) Each eigenmode in the band is excited by white noise. (2) No eigenmode beyond the band is excited. (3) Because the . . .

E. Use of the apostrophe

(1) Contractions. Contractions such as don't, haven't, they'll are well established in spoken English, but they have not yet won a place in the pages of *Reviews of Modern Physics*. Please do not use them in your *RMP* article.

(2) Plurals. To form the plural of a number, add s: 1980s, tens of eV. To form the plural of a symbol, add 's (apostrophe s): A's, x's. To form the plural of an abbreviation or an acronym, you may add either s or 's: LCAO's or LCAOs.

(3) Possessives. To form the possessive of a name, add 's (apostrophe s), regardless of the number of syllables or final letter: Green's, Jones's, de Gennes's.

Be careful not to create imaginary possessives by adding unneeded apostrophes to terms like Kramers doublet or Higgs field. Although contemporary usage may be moving in the direction of ''Green function,'' the editors at *RMP* still prefer ''Green's function.''

F. Use of exclamation points and italics

It is not the style of *RMP* to clamor for its readers' attention. The use of exclamation points and italics for emphasis should be as restrained as possible. Indeed, the Editor suggests a limit of one exclamation point per article.

Italics should also be used sparingly. It is conventional to italicize terms when they are introduced and defined. Beyond this, if your personal writing style employs many italics, you will find that our copymarkers remove most of them.

XIII. ABBREVIATIONS AND ACRONYMS

Abbreviations and acronyms should be kept to a minimum in articles written for *Reviews of Modern Physics*. Use only a handful of the best-known or most widely used, keeping in mind that a broad audience including physicists from other subfields will be reading the article and should not be forced to learn a code at the same time. Here are a few guidelines to keep in mind.

(1) Define all abbreviations and acronyms the first time you use them.

(2) Do not use an acronym as the subject of a sentence, even though it has been previously defined or is well known. For example, replace ''CDWs provide . . .'' with ''Charge-density waves provide . . .''

(3) Generally it is unnecessary and distracting to assign a special acronym to a paper, using the initials of its co-authors, and it may be seen as a bid for attention if one is citing one's own work. Only classic papers that are already widely known by such acronyms justify this treatment. A simple citation of the form Smith *et al.* (1997) is less obtrusive than four or five capital letters and takes very little additional effort to type.

(4) When using an abbreviation of a proper name as a superscript or subscript, retain the initial capital letter: E_{Coul} or E_{C} for Coulomb.

(5) Do not use multiletter abbreviations as mathematical variables. Use the conventional symbol instead, e.g., E_k, not KE for kinetic energy. An exception is the Reynolds number, conventionally written Re.

(6) Avoid ''abbreviations'' that have more syllables than the original term, e.g., FW (four syllables) for framework.

XIV. UNITS

RMP uses the metric system of units. Check *Books in Print* under International System of Units for the most up-to-date listing of these units. At the time this Style Guide went to press, the IEEE Standards Office offered a version revised in 1997, and a still useful summary was that of Barry N. Taylor, *Guide for the Use of the International System of Units* (SI) *The Metric System* (DIANE Publishing Co., 1995). The following units and abbreviations are standard.

TABLE I. Standard metric units.

Units	Abbreviations
ampere	A
barn	b
becquerel	Bq
coulomb	C
electron volt	eV
farad	f
gram	g
henry	H
herz	Hz
kelvin	K
meter	m
ohm	Ω
pascal	Pa
second	s
steradian	sr
tesla	T
volt	V
watt	W
weber	Wb

Other units used in the article should be defined in terms of the standard units.

RMP discourages the use of historic units that have been superseded in the modern physics literature. These include wave numbers for energy, oersteds and gauss for magnetic fields, atmospheres for pressure, and curies for radioactivity.

(1) The number (numeral) is separated from the unit following by a full space, e.g.,

1.8 MeV.

(2) Most units have a single form for both singular and plural, i.e., 1.0 cm and 2.7 cm.
(3) Most symbols for units are printed in lowercase roman type without periods. Units derived from proper names, however, are written with initial capital letters, i.e., coulomb (C), weber (Wb).
(4) The abbreviated form of a unit must be used after a number given in numerals: 1 cm (not 1 centimeter) but the unit is written out in cases like ''a few centimeters.''
(5) Decimal multiples or submultiples of units are indicated by the use of prefixes. See Table II below. The combination of prefix and unit symbol is treated as a single symbol. For instance, such a combination can be raised to a power, i.e., cm^2. Compound units are written 1 $\mathrm{g\,cm^2}$ or $\mathrm{g\,cm^2\,s^{-2}}$, with a thin space between unit parts. The form $6\ \mathrm{J/cm^3/s}$ is ambiguous. Write instead $6\ \mathrm{J\,cm^{-3}\ \ s^{-1}}$, if that is what is meant.

TABLE II. Multiplier prefixes of the *Système International*.

Prefix	Symbol	Factor	Prefix	Symbol	Factor
centi	c	10^{-2}			
milli	m	10^{-3}	kilo	k	10^{3}
micro	μ	10^{-6}	mega	M	10^{6}
nano	n	10^{-9}	giga	G	10^{9}
pico	p	10^{-12}	tera	T	10^{12}
femto	f	10^{-15}	peta	P	10^{15}
atto	a	10^{-18}	exa	E	10^{18}

XV. MATHEMATICAL MATERIAL

Mathematical symbols must be defined immediately where they are introduced. Exceptions are the fundamental constants: the velocity of light c, Planck's constant $\hbar$, the electronic charge e, Boltzmann's constant k or k_B, and the electron's mass m_e.

Avoid using the same symbol for two different things. If you think that a list of symbols would be helpful to your readers, you can provide one preceding the references (see Sec. II.G).

A. Characters

1. Character fonts

The italic font is used for mathematical symbols and it is taken care of by the math mode. In addition to variables and constants, the italic font is used for particle symbols, symbols of quantum states, and group-theoretic designations.

In general please use the following hierarchy of fonts for symbols:

TABLE III. Fonts for symbols.

Lower case:	variables, constants, and ordinary functions
Upper case:	matrices and functions
Script upper case:	operators
Boldface lower case:	three-vectors
Boldface upper case:	matrices

2. Diacritical signs

For a list of easily available diacritics see Table IV below. It is possible to make multilevel accents, but placing one sign above a symbol or letter and one below is often clearer. Restrict the number of oversymbols to two. The underline can appear under any configuration.

TABLE IV. Diacritical signs in math.

Symbol	Teχ
$\vec{x}$	$\vec{x}$
$\overleftrightarrow{\mathrm{x}}$	$\tensor{\rm x}$
$\dot{x}$	$\dot x$
$\ddot{x}$	$\ddot x$
$\hat{x}$	$\hat x$
$\tilde{\mathrm{x}}$	$\tilde x$
$\overline{x}$	$\bar x$
$\underline{x}$	$\underline x$

3. Subscripts and superscripts

All available characters can be used as subscripts or superscripts. Position of subscript or superscript is dictated by standard notation. In almost all cases you should set right and left subscripts and superscripts flush against the symbol they accompany (as in the following):

$$R_0^x, \quad {}^{110}\mathrm{Ag}^m, \quad \rho_0^{(N)}, \quad {}^{14}\mathrm{N},$$

$$\int_0^1, \quad \sum', \quad {}^{14}\mathrm{N}_2,$$

$\lim_{l\to\infty}$ (in text).

There are, however, some exceptions to this general rule. Examples appear below:

tensor notation: $g_{\mu\nu}(\phi^z)^{;\alpha}{}_{;\alpha}$

```
g_{\mu\nu}(\phi^z)^{;\alpha}{}_{;\alpha}\\
```

molecular ions: H_2^+, O_2^-

```
{\rm H}_2{}^+,{\rm O}_2{}^-\\
```

footnotes in tables: $E_n{}^{\rm a}$.

```
E_n{}^{\rm a}.
```

Presuperscripts or presubscripts are set flush against the symbols they accompany. In addition, it is advisable to insert an extra thin space between a presuperscript or presubscript and a preceding symbol in cases where clarity is questionable, i.e.,

$8p\sigma\ {}^1\Sigma_u^+ \quad \text{or} \quad d^9s^zp\ {}^3P_2.$

```
$8p\sigma\,^1\Sigma_u^+
+\sim\sim {\rm or} \sim\sim d^9s^zp ^3P_2.$
```

The number of levels of subscripts and superscripts attached to a symbol will also affect clarity. Two double levels is generally considered the most complicated combination acceptable, i.e.,

$$M_{b_k^\dagger}^{\alpha_i^2}$$

```
$M_{b_k^\dagger}^{\alpha_i^2}$
```

When additional indices are needed, insert a comma or thin space and keep the added indices on the same line, i.e.,

$M_{b_k,d_p}, \quad \sigma_{r,s+1}, \quad \text{or} \quad \sigma_{r\,s+1}.$

```
$M_{b_k,d_p}, \sigma_{r,s+1}, or \sigma_{r\,s+1}.$
```

B. Abbreviations in math

Some abbreviations, such as those for mathematical functions and those used in superscripts or subscripts, require special handling and are discussed below.

1. Abbreviations designating mathematical functions

The multiletter abbreviations of mathematical functions are always written in the roman font (i.e., sin). The standard trigonometric functions are cos, cot, sec, sin, and tan. Hyperbolic trigonometric functions add "h" to the end; the preferred notation for inverse functions is $\tan^{-1}$ rather than arctan. The preferred notation for the logarithm to the base e is ln; log without a subscript also denotes the same function.

(a) Roman multiletter abbreviations must be closed up to the argument following and separated from any preceding symbol by a thin space, (\,), that is,

$K\cos[Q(z-z_0)],$

```
$K\,\cos[Q(z-z+0)],$
```

$K\ \exp[x^2(b_2+b_1)^{-1/2}].$

```
$K\,\exp[x^2(b_2+b_1)^{-1/2}].$
```

(b) In addition, by convention it is assumed that an argument ends as soon as another function appears, i.e., sin$x$cos$b$, or at a plus or minus sign, i.e., sin$x$ + y, but if other mathematics is involved or there is any ambiguity you should insert bracketing, as in the following examples:

$\sin[-(x+a)], \quad (\sin x)/a, \quad \text{and}$
$\exp[x^2(b_z+b_1)^{-1/2}].$

(c) To treat a function of a function enclose it in bold round parentheses, i.e.,

$g(x^2a^{3/2}(\alpha_1+\alpha_2)^{-1/2}).$

(d) e and exp (for exponent) notation follow both of the preceding conventions. The choice of which form to use, e or exp, is determined by the number of characters and the complexity of form of the superscript. The e^x form is appropriate when short, simple superscripts would be involved, i.e., e^z, whereas exp(xx) should be used if the superscript form is complex. In the on-line form the argument should be enclosed in bracketing.

2. Abbreviations in subscripts and superscripts

Abbreviations in subscripts and superscripts fall into two categories: (1) single-letter and (2) multiletter abbreviations. Most single-letter abbreviations are conventionally printed in the italic font, i.e., E_C where C stands for Coulomb. Multiletter abbreviations are conventionally printed in the roman font whether they represent one or more words, i.e., $E_{\rm lab}$, where lab stands for laboratory and $E_{\rm HF}$, where HF stands for Hartree and Fock, two proper names. Please note that you should always capitalize abbreviations that represent proper names.

When you are creating your own abbreviations in text do not put periods in acronyms (whether on line or in subscripts), but do insert them if you are abbreviating words that are headings in a table.

C. Mathematical expressions

1. When to display

Display (1) equations of importance, (2) all equations that are numbered, (3) those that are too long to fit easily in text (over ~ 25 characters), or (4) those that are complicated (contain built-up fractions, matrices, or matrixlike expressions). Consider, also, displaying math that contains multilevel indices, integral, summation, and product signs, with multilevel or complex limits, or any other situation in a formula that creates the need for extra vertical spacing in a text line.

2. Punctuation

Even though displayed math is separated by space from the running text it still is a part of that text and needs to be punctuated accordingly. The following is an example. The final result is

$$H_{ij}=\left(\frac{\Omega}{\Delta}\right)^2\frac{|J|^2}{E_g+\frac{1}{2}(W_c+W_v)}e^{\lambda\mathbf{K}\cdot\mathbf{R}_{ij}}, \tag{1}$$

where

$$\mathbf{K}=\frac{1}{a}(\hat{\mathbf{i}}+\hat{\mathbf{j}}+\hat{\mathbf{k}}) \tag{2}$$

and

$$\lambda=\ln[W_l W_v/(12E_g)^2]. \tag{3}$$

3. Equation "breaking" (multilinear equations)

Mathematical expressions often need to be displayed on two or more lines ("broken") because of the line-length limitations of the *Reviews of Modern Physics* standard two-column layout. The best place for a "break" is right before an operator or sign of relation. These signs should begin the next line of the equation. When it is necessary to break a product, begin the continued line with a multiplication sign. Note that the material that comes after a break can and should be aligned so that its relationship to the material on the first line is mathematically correct. Here is an example:

$$N_x(\mathbf{r})+iN_2(\mathbf{r})=e^{i\theta(\mathbf{r})}=\exp[-ij_x u(\mathbf{r})]. \tag{4}$$

The LaTeχ version of this is

```
\begin{eqnarray}
N_x({\bf r})+iN_2({\bf r})&=&e^{i\theta ({\bf r})}
\nonumber\\ &=& \exp[-ij_xu({\bf r})],
\end {eqnarray}
```

Equations that are not displayed, but appear in text may also need to be broken. Basically the same rules apply as when breaking displayed math. Breaking at an operator or sign of relation is best. The operator or sign of relation usually begins the next line of text:

... and their respective displacement vectors are $a\hat{\mathbf{i}}/2 + \sqrt{2}a\hat{\mathbf{j}}/2$ and ...

Products are broken with a multiplication sign:

... keep $\delta m \simeq 4$ MeV and choose γ $(=-5.46\times10^{-3})$ at ...

In addition, you may break in text at a solidus, leaving the numerator and fraction bar on the top line. The denominator will begin the continued line. See an example below:

... the above current is proportional to $T_0(\Delta_1,\Delta_3)^{1/2}/N_2(0)$ if the injection level $G_{\rm ng}\Omega_2^{-1}$ remains ...

4. Equation numbering, special situations

Equation numbers are placed flush with the right margin:

$$H_{2m\,2l}(\theta^{(i)},\theta^{(j)})=\sqrt{w_i w_j}(\sin\theta^{(i)}\sin\theta^{(j)})^{1/2}[K_{2m\,2l}(\theta^{(i)},\theta^{(j)}) + K_{2m\,-2l}(\theta^{(i)},\theta^{(j)})]. \tag{5}$$

Some situations require unique numbering. Please use the forms shown in the following examples when you encounter similar circumstances.

(1) A set of equations of equal importance may be numbered to demonstrate that relationship, e.g., (1a), (1b), and (1c).

(2) A principal equation and subordinate equations (those that define quantities or variables in that equation) may be numbered (1), (1a), and (1b), etc.

(3) If an equation is a variant of a previous equation (it may be separated from the original equation by other equations and/or by text), it may be numbered with the same number as the original and a prime, double prime, etc., as appropriate.

D. Bracketing

1. Grouping sequence

For the purpose of grouping, the sequence of bracketing preferred for *Reviews of Modern Physics* articles is {[()]}, working outwards in sets ( ), [ ], and { }. If you have used these three sets and need additional bracketing, begin the sequence again in the same order but in bold print:

{ [({ [( )] })] }

```
\bbox\{\bbox[\bbox(\{ [ ( ) ]\} \bbox)
\bbox] \bbox\}
```

For grouping situations that contain built-up material and need larger sized bracketing, it is preferable to start again at the beginning of the sequence around the built-up material, i.e.,

$$\left[\left(\frac{(a-2)^{1/2}}{\alpha^2}\right)\left(\frac{(x+2)^{1/2}}{\beta}\right)\right]=0.$$

2. Specific bracket notation

Bracketing (ordered and special) is also used to create specific notation that defines what it encloses. A list of approved specialized notation is included below. When used in an equation along with ordered bracketing, this special kind of bracketing should not alter the regular sequence of bracketing. The special notation $\langle\ \rangle$ in the following equation does not interfere with the sequence of the equation bracketing:

$$\hbar[\langle E-(a+1)\rangle]^{-1}=0.$$

3. Specialized notation

Plane or set of parallel planes	(111)
Direction	[111]
Class (group) of symmetry equivalent directions	$\langle 111\rangle$
Class (group) of symmetry equivalent planes	{111}
Point designated by coordinates	(x,y,z)
Lattice position in a unit cell (*not* bracketed; included for your information)	$\frac{1}{2}\frac{1}{2}\frac{1}{2}$
Vector written in components	(H_z,H_y,H_z)
Commutator	$[f,g]$
Iterated commutations	$[H_0,[H_0,H_1]]$
Functionals	$F[x]$
Anticommutators	$\{f,g\}$
Sets	$\{x\}$
Absolute values	$\lvert a\rvert$
Determinants	$\lvert x\rvert$
Notation used to indicate at what value of the argument some quantity is to be taken	$\vert_{s\to\infty}$
Matrices or norms	$\lVert f\rVert$
Average or expectation value	$\langle\ \rangle, \langle\ \rangle_{\mathrm{av}}$
Dirac bra-ket notation	$\langle\vert\vert\rangle$

E. Additional style guidelines

1. Placement of limits

In displayed math, limits are treated in the following manner:

$$\sum_{\substack{i,j,k\\ i<j<k}} \quad \backslash\mathrm{sum\_\{\backslash begin\{array\}\{c\}}i,j,k\backslash\backslash i<j<k\backslash\mathrm{end\{array\}\}}$$

$$\sum_{n=1}^{\infty} \quad \backslash\mathrm{sum\_\{}n\ =\ 1\backslash\}\hat{}\backslash\{\backslash\mathrm{infty}\backslash\}$$

$$\sum_{l}' \quad \backslash\mathrm{sum\_\{}l\backslash\}\{\backslash\}\hat{}\backslash\{\backslash\mathrm{prime}\backslash\}$$

$$\prod_{n>1} \quad \backslash\mathrm{prod\_\{}n\ >\ 1\backslash\}\ \backslash\mathrm{quad}$$

$$\int_{-\infty}^{+\infty} \quad \backslash\mathrm{int\_\{}-\backslash\mathrm{infty}\backslash\}\hat{}\backslash\{+\backslash\mathrm{infty}\backslash\}$$

$$\lim_{\alpha\to 0} \quad \backslash\mathrm{lim\_}\backslash\{\backslash\mathrm{alpha}\backslash\mathrm{rightarrow}\ 0\backslash\}$$

Stacking of limits, seen in the first example, is possible, as is centering. In text, however, space limitations require that limits be treated as subscripts and superscripts. The second example above should be set $\Sigma_{n=1}^{\infty}$ in text. The stacking in the first example would mean that any math containing that summation should be displayed or be rewritten.

2. Fractions

Fractions can be ''built up'' with a fraction bar,

$$\frac{a+b}{c},$$

''slashed'' with a solidus, $(a\ +\ b)/c$, or written with a negative exponent, $(a\ +\ b)c^{-1}$.

In text all fractions must be either slashed or written with a negative exponent. In displayed math all three forms are allowed.

Apply the following guidelines to the mathematics in your compuscript:

(a) Use built-up fractions in matrix notation (instead of the slashed configuration):

$$M_1=-\begin{pmatrix} \dfrac{\partial^2}{\partial x^2} & 2\theta_0'\dfrac{\partial}{\partial x} \\ \theta_0\dfrac{\partial}{\partial x} & \theta_0^2\dfrac{\partial^2}{\partial x^2} \end{pmatrix}.$$

(b) Use built-up fractions (instead of the slashed configuration) in display formulas:

$$H_A(w)=\left[\frac{1}{2}\left(\frac{Q}{\pi\omega^2}\right)^2+\frac{c_e^2}{4d}\right]\pi\omega^2 d.$$

(c) Using slashed fractions in subscripts, superscripts, and limits is preferred:

$$\mathscr{N}^{-1/2}.$$

(d) Use slashed or sized fractions in the numerators and denominators of built-up fractions except where excessive bracketing would obscure your meaning or slashing would interfere with continuance of notation:

$$\varphi+\frac{(\beta/6)\varphi}{\gamma+[\beta(\beta-1)/12]\varphi^2}=0.$$

(e) When slashing fractions, respect the following conventions. In mathematical formulas this is the accepted order of operations:

(1) raising to a power,

(2) multiplication,

(3) division,

(4) addition and subtraction.

According to the same conventions, parentheses indicate that the operations within them are to be performed before what they contain is operated upon. Insert parentheses in ambiguous situations. For example, do not write $a/b/c$; write in an unambiguous form, such as

$$(a/b)/c$$

or

$$a/(b/c),$$

as appropriate.

3. Multiplication signs

The primary use of the multiplication sign is to indicate a vector product of three-vectors ($\boldsymbol{\kappa}\times\mathbf{A}$). Do not use it to express a simple product except

(1) when breaking a product from one line to another (described in equation breaking, Sec. XV.C.3) or

(2) for other cases such as indicating dimensions ($3\times3\times3$ cm^3), magnification ($3\times$), symbols in figures ($\times$'s), or numbers expressed in scientific notation (5.3×10^2 MeV).

The center dot also should not be used to mean a simple product. Use the dot to represent inner products of vectors ($\boldsymbol{\kappa}\cdot\mathbf{A}$).

4. Mathematical terms

The use of the following standard symbols is recommended.

$\sim$	approximately or varies as
$\simeq$	approximately equal
$\rightarrow$	tends to
$\propto$	is proportional to
$O(\ )$	of the order
A^*	complex conjugate of A
$A^\dagger$	Hermitian conjugate of matrix A
A^T	transpose of matrix A
$\hat{\mathbf{k}}$	unit vector $\mathbf{k}/k$

5. Radical signs and overbars

You may use radical signs (roofed only, $\sqrt{xx}$) and overbars ($\overline{xx}$) when they go over material of six or fewer characters that are without superscripts. If the material is longer or has superscripts, alternative notation should be used. For $\sqrt{xx}$ use $(xx)^{1/2}$ and for $\overline{xx}$ use $\langle xx\rangle$ or $\langle xx\rangle_{av}$. If the overbar means complex conjugate, then $(xx)^*$ should be used. A radical sign (roofed) cannot be used on built-up material, although an overbar can be used.

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Thank you to Ugo Fano for proposing the writing of Appendix A and to the following authors for permission to quote examples of their (good) writing in this Appendix: F. C. Adams, Paul Forman, G. Laughlin, N. David Mermin, P. J. Morrison, Virginia Trimble. Thanks, as well, to the sources of the bad examples, who though anonymous have performed a service to the readers of this guide that is warmly appreciated.

APPENDIX A: WRITING A BETTER SCIENTIFIC ARTICLE

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Using examples drawn from the pages of *RMP*, the author presents specific writing techniques that can enhance the sense of immediacy between writer and reader and improve the clarity, economy, and polish of scientific writing. The first half of the article is devoted to elements of good style applicable by anyone, while the second half treats problems often encountered by non-native writers of English.

What sets a first-rate scientific article apart from the thousands of forgettable publications that appear in the literature every year? For a very few, content alone ensures that the paper will be widely cited. But for most, it is the way the article is written. A good article puts us in touch with a good mind (or team of good minds) at work, whose quality is revealed by clarity, economy, order, and perhaps wit. These rather abstract qualities are warmed by the author's effort to share his or her interest in the subject as if speaking with a colleague, presenting the work not as a series of cut and dried results, but as an ongoing process by which understanding is sought. The reader whose interest is thus engaged can then share the author's satisfaction as a solution begins to emerge.

A number of specific writing techniques can enhance the sense of immediacy between you and your reader. In addition, avoidance of some common pitfalls will reduce dullness, wordiness, and pomposity, which—contrary to popular belief—are not desirable attributes in a scientific article, but represent negative values of the clarity, economy, and wit mentioned above. In this guide, I describe practical measures that you, the author, can take to give your writing greater impact, with examples drawn from the work of RMP's contributors. The guide is divided into two sections, one of more general application, for anyone interested in writing better, and the other aimed specifically at the author whose first language is not English.

A. Elements of good style for everyone

1. Active and passive voices

You have heard this before, but it bears repeating: active sentences are more vigorous than passive ones. When you want to put more muscle into your prose style, replace ''Science is done by people'' with ''People do science.''

Writers of scientific papers often favor the passive because it relieves them of naming themselves as the ones who conducted an experiment or proposed a theory. Saying that ''it was thought that the magnetoresistance could provide an answer'' shields the person who thought so from the critical gaze of his audience and is vague enough to spread credit or blame, implying that the writer was not alone in having this idea. The passive voice also provides a way out for those who feel reticent about naming names and pointing fingers when discussing others' work. Keeping names to a minimum, such a writer introduces, say, the work of Erikson *et al*., and then follows with a three-page description in which ''the bubble formation was simulated,'' ''a constant of a = 1.5 was assumed,'' and ''agreement with the model of McCray was found to within 3%.'' There are three problems with this approach. First, it sounds stuffy. Second, it may lead to confusion, especially if other people's models and parameters were adopted by Erikson *et al*. and need to be discussed as well. After a while the reader will no longer be sure whose work is being described. And third, any effort to dissociate science from its practitioners by describing it passively is doomed to failure, since readers not only know that scientists do science, they are very interested in which scientists—it could well be one of their friends or competitors. Changing to the active voice and stating who did what—''we simulated the bubble formation,'' ''McCray assumed a constant of a = 1.5,'' ''they found''—will tell readers what they want to know and set the work in the context of human endeavor.

The active voice also encourages economy. Compare the following pairs of sentences:

> A review of the main problems in this field was given by Luo *et al.*
>
> Luo *et al*. reviewed the main problems in this field.
>
> A discussion of intrinsic pinning is offered in Sec. VIII.
>
> In Sec. VIII we discuss intrinsic pinning.

In each pair above, the active version uses fewer words. Most readers will perceive this brevity as the mark of a direct and vigorous mind.

There are, of course, occasions when the passive voice is useful. Sometimes you will want to put emphasis on the thing being acted upon, by naming it at the beginning of a sentence.

> This problem has been the subject of intensive study ever since 1934.

And, for simple variety, a modest number of passive constructions can lend grace to a piece of writing, especially when no particular agent is being obscured by them:

All perturbations can be naturally divided into two classes.

Abstracts are another place where the passive voice is appropriate. Abstracts appear separately from the articles they describe, in on-line listings and reference works like *Physics Abstracts*. Use of the first person in such an impersonal setting sounds a bit odd. (However, consider the active alternative, "The author surveys . . . ," "The authors find that . . . ")

2. Economy

A clean, direct style shows respect for your reader's time. While it is possible to be so direct as to be blunt and graceless, most scientific writing suffers from the opposite tendancy, wordiness. One exercise that helps to curb wordiness in your writing is to see how many verb-noun phrases you can replace by simple verbs. For example,

make a decision	decide
experience failure	fail
place under consideration	consider
perform an experiment	experiment
give indications of	indicate
present a discussion of	discuss
conduct an investigation	investigate
make an attempt	try
introduce a replacement	replace

The expressions in the left-hand column need not be banished from your writing. They can be useful for creating parallels, introducing variety, or smoothing a transition. If you find, however, that you are using a great many, be aware that you may be regarded as windy and your papers as needlessly long.

A few other wordy expressions deserve mention here. One is "the fact that." It can always be replaced by a more economical construction:

the fact that Clark succeeded	Clark's success
owing to the fact that	because
despite the fact that	although
he was unaware of the fact that	he was unaware

Another is "the reason . . . is that" and variants of this pattern. Generally, rearranging a sentence so as to start with a subject and verb produces a more vital sounding statement:

The reason for solving the Cauchy problem first is that . . .

We solve the Cauchy problem first because . . .

The main theme of this section is to tell why we have chosen to generalize . . .

This section presents our rationale for generalizing . . .

My purpose has been to provide a description of thermodynamic phase transitions.

I have tried to describe thermodynamic phase transitions.

Then there is "the case." Personally, I am rather fond of "In the first case" and "in the second case," but have to grant that "cases" can be totally useless appendages, better amputated:

for the case of	for
in many cases	often
it has rarely been the case that we	we rarely
in the case when	when

If the writer is tempted to use "in the case where," he or she should see the section on grammar below.

3. Forward momentum

Here is an actual sentence from a contributor to *Reviews of Modern Physics*:

> That the wavelength of any oscillator employed must necessarily be very small follows from the circumstance that the length of an accelerator of given energy—i.e., the lengths of the individual drift tubes in an accelerator with a given number of drift tubes (and hence acceleration gaps)—to which a given voltage is applied, and through which a given species of ion is accelerated—is proportional to the period, hence the wavelength, of the oscillation.

Before publication, this sentence was edited to about two-thirds of its present length. Its problem, however, is not length *per se*. It suffers from the author's attempt to cover everything. The cumulative effect of multiple asides, parenthetical remarks, i.e.'s, and "hences" is to leave the reader feeling like a passenger in a car whose driver starts up, then stops, then starts again, then stops, etc. Moreover, by the time the reader gets to the verb "is proportional," he or she is likely to have forgotten the subject, the length of an accelerator.

Asides and parenthetical remarks can enhance a text. They reflect the way people talk and thus give a conversational tone to any piece of writing. When overused as above, however, they will kill the momentum of the article. To keep the reader moving forward, one should use them judiciously and not place more than one between a subject and its verb, where they become merely distractions.

Here are some examples of sentences that use parenthetical remarks to good effect. The asides serve a variety of functions: (a) helping to organize the material, offering a tidy place in which to stow ramifications of the

main statement; (b) drawing the reader's attention forward to a subject that will be discussed further on; (c) enhancing author-reader immediacy by offering opinions—"crude," "pathological," etc.—and simply giving a more personal style to the presentation. Note that only two of the asides below are interposed between a subject and its verb, thus ensuring minimum loss of momentum.

> Finally, we note that the derivation, crude as it is, reveals one very important point: the precise details of the collision rules (aside from certain pathological choices to be discussed later) do not affect the form of the constitutive hydrodynamic equations.
>
> It is easy to solve this equation (since we have dropped the inconvenient, higher-order terms).
>
> Hydrodynamic flows can be obtained (albeit at considerable computational expense) from large molecular systems.
>
> The exciting lattice-gas simulations of hydrodynamics have exploited one of the strengths of the method: fluctuations (to excite bifurcations), complex geometries (to exploit the ease of coding boundary conditions), or phase transitions.
>
> Either an inhibitory substance h is produced by the activator (which slows down the activator production) or a substate s is consumed during autocatalysis (whose depletion slows down the self-enhancing reaction).

Some of these are long sentences, but they are perfectly clear and easy to follow.

Generally, short sentences quicken the pace and long ones slow it down. The same can be said of paragraph lengths. A paragraph break allows the reader to take a breath and refocus. Provide enough of them to keep the members of your audience fresh, as this too will help keep them moving through the article.

4. Inviting the reader in

Bringing the rhythms of everyday speech into an article by the use of a few asides is one way to invite the reader into your world—or, at least, into the world of the topic you are writing about. Addressing the reader directly is another. That mind-to-mind contact that characterizes the best scientific articles comes about only when the writer is friendly towards the reader. This does not mean that you need to pretend a familiarity that you do not feel. It does mean that you should take pains to speak to your reader as if he or she were in the same room with you—and not the recipient of an anonymous pre-recorded message. To see how well you are accomplishing this, scan your manuscript first for questions and then for other remarks addressed to the reader.

If you have not up until now included questions in your writing, consider what they offer. A rhetorical question can be a wonderful device. It states the problem without your needing to say "In this section I shall be considering the problem of . . . " It creates the illusion that you are thinking the problem through at the very moment you are speaking. And it engages the reader's participation in finding an answer. If you are very daring, you can even put the question in your reader's mouth by saying, "The reader may well ask . . . " This allows you to disarm potential critics and capture attention for your answer.

One should not underestimate, either, the power of a gracious remark to one's reader. The following well-worn phrases may seem so obvious as to be unnecessary, but they perform vital work in welcoming the reader to your intellectual world, where you will engage him or her in friendly discourse or serve as a guide over unfamiliar terrain.

> Let us suppose
>
> Consider
>
> Contrast this with
>
> Before we turn to
>
> Up to this point we have not
>
> Let us take a closer look at
>
> Let us now attempt
>
> Indeed, we shall see
>
> Clearly, what is happening here is that
>
> Seeing this, we should not be surprised to find
>
> Remember that
>
> It is sometimes helpful to think of t as
>
> Going beyond this approximation brings us up against
>
> We now return to
>
> The reader is warned
>
> A cautionary remark:

Many of these phrases make particularly graceful openings for paragraphs and for subsections. Your subject matter will suggest other ways of combining cordiality with critical exposition.

5. Hedging

There seem to be many writers who take it as an operating principle never to commit themselves firmly to any point of view. They will hedge even simple statements of historical fact, and their "conclusions" sections are full of "may"s and "might"s and "it would seem"s. In a review paper, this will not do. Part of the job of the reviewer is to describe the field as he or she sees it. We want the reviewer to be fair, but not irresolute.

A classic sign of commitment avoidance is misuse of the auxiliary verbs ''may'' and ''could'':

> Schroedinger may be counted as one of the first to propose the concept of what are now called ''coherent states.''
>
> This term could be regarded as combining nonlinear and spatial dispersion.

Actually, it would be perfectly accurate to say

> Schroedinger first proposed the concept of what are now called ''coherent states.''
>
> This term combines nonlinear and spatial dispersion.

When you are confident of your facts, speak with authority. Save ''could,'' ''would,'' ''may,'' ''might,'' and other expressions of uncertainty for situations that truly warrant them.

Another frequently used hedging expression is ''associated with,'' as in

> Under suitable circumstances, pairs of fermions are associated with bosonlike behavior.
>
> The differences between Chakravarty's and Schwinger's calculations are associated with differences in the value of the constant prefactor C.

Under scrutiny, statements like these appear not only imprecise, but weaselly. How much better to say, with precision and conviction,

> Under suitable conditions, pairs of fermions *exhibit* bosonlike behavior
>
> The differences between Chakravarty's and Schwinger's calculations are *due to* different values of the constant prefactor C.

6. Littering the landscape: abbreviations and acronyms

There is no rule at *Reviews of Modern Physics* that says you must replace all frequently used terms with groups of letters. On the contrary, our copy editors have been instructed to disallow excessive abbreviations, so that no article looks like alphabet soup. Readers who do not share your familiarity with the subject, but would like to learn, should not be forced to translate a private language. Limit yourself to a handful of the most widely used abbreviations and define these where they are introduced.

Even justifiable and widely known abbreviations should not be used as the subject of a sentence. Thus, while you might refer to ''the BCS approach,'' change ''BCS found that . . . '' to ''Bardeen, Cooper, and Schrieffer found that . . . ''

7. Time travel: the mixed-tenses syndrome

Consider the following discussion.

> Andrews noted that the absence of Bragg peak splitting at $x = 0.016$ is due to the small magnitude of the spontaneous deformation, which at $x = 0.016$ should be 25 times smaller than at $x = 0.05$. At the same time, experiments on diffuse scattering of x rays (Varma *et al*., 1991) indicate that homogeneous deformation regions with an average size of at least 1000 $\AA$ exist in the crystal even at $x = 0.016$. This conclusion was supported by subsequent experiments.

If you find yourself a bit at sea after reading this passage, you are probably experiencing disorientation from time shifts. Either the past or the present tense may correctly be used in such a discussion, but not both. Stick to one tense per topic. For example, when discussing a paper by Smith, you can say ''Smith *finds* a heavy concentration of H, which *indicates* . . . '' or ''Smith *found* a heavy concentration of H, which *indicated*,'' but you should stay with the same tense until the end of the paragraph.

8. Contrast and variety

The English language is a rich medium, offering the writer a choice of short Anglo-Saxon words and longer latinate words, as well as borrowings from French, German, and other sources. Not surprisingly, to an American ear, a judicious mix sounds most pleasing. This is how people talk and it is also easiest to read.

One of the dangers of writing about physical principles and other abstractions is that one finds latinate words so useful one favors them over all others. Consider this pair of examples:

> I first outline the most feasible candidate states and how one might go about distinguishing them experimentally. Next I discuss . . .
>
> An initial outline of the most feasible candidate states and of their experimental identification will be followed by discussion of . . .

The first example does use latinate words, but they are mixed with shorter, Anglo-Saxon ones. Its effect is direct and accessible, qualities strengthened by the active voice. In contrast, the heavily latinate (and passive) second sentence seems dense and pedantic. (I was interested to learn from our former Associate Editor Ugo Fano that, to an Italian ear, it is germanic words that have this association.) If you suspect that others might find your writing a bit dry, check it for its Latin density. Do you say

first	or	initial?
place	or	location?
is	or	consists of?

find	or	detect, determine, establish?
use	or	utilize?
takes place	or	occurs?
takes the form	or	is represented by?
looks like	or	appears similar to?
is needed	or	is required, is necessary?

The point is not that shorter words are better, only that a balance of long and short will be more pleasing.

In the same way, a variety of sentence lengths is also pleasing. An article made up entirely of short, choppy sentences is no more to be preferred than one of long, rambling ones. When you find that you have been favoring either short or long for awhile, slip in a bit of contrast.

Here is an example of a sentence that I believe combines long and short in a tonic fashion (note the rhetorical question):

> Since it is almost certain (and will henceforth be assumed) that corrections to the theory are of the order of 25% even for Z as large as 64, the pragmatic reader might well ask: ''What can the theory do for me?''

9. Grammar

This guide is not intended to be a treatise on English grammar, but here is a very brief list of errors to be avoided in polished scientific writing.

(1) ''We will'' and ''we shall.'' The correct form is ''shall'' for the first person and ''will'' for the second and third. Reversing them is supposed to provide unusual emphasis—e.g., ''We cannot review the vast literature here, but we *will* give a brief overview of recent work in the field.'' The exchange of ''we will'' for ''we shall'' is widely accepted in spoken English, but this is one instance in which you should not write as you speak. (Another is the exclusion of contractions—can't, don't, they'll, etc.—from professional writing.)

(2) Dangling participles. When an ''-ing'' word is used in a phrase like ''leaping to the obvious conclusion'' or ''inserting the higher number,'' the phrase should be immediately followed by the agent who is doing the leaping or the inserting. The following examples fail to provide an agent and are thus incorrect:

> Leaping to the obvious conclusion, the equation ...
>
> Inserting the higher number, the answer can be found.
>
> Comparing the energy density and the lifetime, only a chemical storage mode makes sense.

They can be repaired (a) by providing an agent:

> Leaping to the obvious conclusion, *we* decide that the equation ...

or (b) by rearranging the order:

> The answer can be found by inserting the higher number.

or (c) by expanding the ''-ing'' phrase to an independent clause:

> When the energy density and the lifetime are compared, only a chemical storage mode makes sense.

(3) Possessives before ''-ing'' words. A possessive pronoun (e.g., our, its, their) or a possessive form of a noun (Brown's, the equation's) should precede ''-ing'' words, as in the following examples:

Right:	There is no danger of the rule's being broken.
Wrong:	There is no danger of the rule being broken.
Right:	This led to his locating all unstable periodic orbits up to ninth order.
Wrong:	This led to him locating all unstable periodic orbits up to ninth order.

Right:	We denote this by N′ to prevent its being confused with N.
Wrong:	We denote this by N′ to prevent it being confused with N.

Right:	A direct consequence of momentum's being conserved ...
Wrong:	A direct consequence of momentum being conserved ...

(4) Introducing conditions. The subjunctive mood provides a neat, simple way of stating conditions:

> This model requires that the system remain near equilibrium.
>
> We impose the constraint that the eigenmodes satisfy the boson commutation relation.
>
> It is important that theory be compared with experimental results.

Those unfamiliar with this construction may try to strengthen it by inserting ''should'' or ''must'' before the verb. Such insertions are superfluous.

Wrong:	Heinz required that L must be less than 8 mm.
Right:	Heinz required that L be less than 8 mm.
Wrong:	Observations of deuterium abundance demand that the density of baryons in the universe should be rather low.
Right:	Observations of deuterium abundance

demand that the density of baryons in the universe be rather low.

(5) ''That'' and ''which''. These two relative pronouns are not interchangeable. ''That'' is the right choice for restrictive clauses: ''An approach that is based on perturbation theory offers several advantages'' (only an approach based on perturbation theory is under consideration – ''that is based'' limits or restricts the kind of approach we are talking about).

''Which'' is the right choice for nonrestrictive clauses: ''This approach, which is based on perturbation theory, has generated a good deal of controversy'' (the nonrestrictive ''which'' clause simply gives additional information – the sentence would still make sense without it).

Authors who choose incorrectly tend to overuse ''which.'' For a discussion of when each is appropriate, and why, I refer the reader to Wilson Follett's *Modern American Usage*, in the lexicon under ''That, which, relative.'' Two easy-to-remember models, however, are

The house that Jack built.

The umbra is surrounded by a penumbra, which is not as dark.

Note that ''which'' is usually preceded by a comma. And keep in mind a third option, no ''which'' or ''that'' at all:

''An approach based on perturbation theory . . . ,''
''This approach, based on perturbation theory, has generated . . . ''

(6) ''Where.'' This word is correctly used to refer to a place or a region. Common usage in the scientific literature allows it also to be used to refer to an equation. However, it should *not* be used for nonlocalized abstractions. Change

a case where	to	a case in which
a situation where	to	a situation in which
a form where	to	a form in which

Change ''in the case in which'' simply to ''When.''

(7) Starting a sentence with ''also.'' It is generally bad form to begin a sentence with ''also,'' not because there is a rule against this, specifically, but because the adverb is then likely to be separated from the verb it modifies. Sentences like these:

Also we can adjust the parameters.

Also it is desirable to apply the highest feasible voltage.

Also the concept of the classical limit will be discussed.

can be improved by moving ''also'' in to follow the verb or auxiliary verb:

We can also adjust the parameters.

It is also desirable to apply . . .

The concept of the classical limit will also be discussed.

(8) Starting a sentence with ''This.'' Pronouns like ''this'' or ''these'' spare us from having to repeat cumbersome phrases and provide a smooth link with what has gone before. They can, however, contribute to vagueness and lack of focus if the thing to which they refer – the antecedent – is not clear. To banish any doubt, provide a reminder: ''this approach,'' ''this procedure,'' ''this substitution,'' ''these terms.''

10. Frequently misused words and expressions

(1) Data. This is a plural noun and requires a plural verb – e.g., ''The neutron scattering data *are* not helpful.''

(2) Cite and quote. To refer to an article is to cite it: ''Details can be found in the two papers cited above.'' To reprint a sentence or passage from it is to quote it.

(3) Three Latin abbreviations.

1. Cf. Authors wishing to refer their readers to a figure, equation, or article sometimes write ''cf. Fig. 32,'' ''cf. Eq. (2.3),'' or ''cf. Orsini, 1995.'' They should be certain, in doing this, that they mean ''compare,'' because that is what the Latin *confer* means. When no comparison is being made, they should write ''see.'' The two are not interchangeable.

2. E.g. (Latin *exempli gratia*). Everyone knows that e.g. means ''for example.'' In English, however, it is used only between two nouns. The first noun describes a class of things, the second describes a specific instance:

. . . discussed by many authors, e.g., Brownell, 1988.

. . . in several review articles (e.g., Brownell, 1988).

. . . the larger mammals, e.g., elephants.

The following construction, with the first item a verb rather than a noun, is unidiomatic:

''See, e.g., Brownell, 1988''

and should be replaced by

See, for example, Brownell, 1988.

3. *Et al.* (Latin *et alii* or *aliae* or *alia*, depending on gender). ''And others.'' Use this abbreviation to refer to two or more unnamed co-authors (''others''), but not to a single co-author. Note that *et* is a whole word, not an abbreviation, and therefore should not be followed by a

period. Neither should it be separated from what comes before—place no comma after the first author's name in "Karliner *et al.*"

11. Being concrete

Your readers would rather hear about a bear than a mammal, a sandwich than nutrition, and a car wreck than an accident. Translating this principle into an article about lattice-gas models or gauge invariance, however, is a challenge. To meet it you need to be ready to link the everyday world with the scientific. One of the easiest places in which to do this is your introduction. This is your stepping-off point into the world of the abstract. Rather than plunging right in, you are allowed to take two or three sentences to lead your reader to the diving board. A certain irreverence helps. Consider, for example, these openings from two of *RMP's* more lively authors:

> "Even scientists who have spent the last few years under large rocks cannot help having heard of Supernova 1987A in the Large Magellanic Cloud (the associated neutrino burst having readily penetrated the very largest rocks)."
>
> *Virginia Trimble*
>
> Rev. Mod. Phys. **60**, 859 (1988)

> "It is a fundamental quantum doctrine that a measurement does not, in general, reveal a preexisting value of the measured property. . . . Setting aside the metaphysics that emerged from urgent debates and long walks in Copenhagen parks, can one point to anything in the modern quantum theory that forces on us such an act of intellectual renunciation? Or is it merely reverence for the Patriarchs that leads us to deny that a measurement reveals a value that was already there, prior to the measurement?"
>
> *David Mermin*
>
> Rev. Mod. Phys. **65**, 803 (1993)

Supposing that your style is more conservative than that of the two writers above, you can still refer to the concrete, everyday world with great benefit to your text. And you will be in good company. Schroedinger's cat, the small dark cloud on the blue sky of physics referred to by Planck, Feynman's story of the woman with the turtle-based cosmology—all have captured the imaginations of countless readers.

Clever gimmicks are not necessary. You might, for example, say something about the external appearance or the setting of an experiment, especially if it is a historic one. This is quite different from showing in a diagram the placement of gates, counters, relays, amplifiers, etc. I once attended a public lecture on the birth of high-temperature superconductivity, delivered by a leading theorist. Unfortunately, it was pitched over the heads of most people in the audience, myself included. At the end of the lecture, as we were filing out of the hall, a neighbor voiced my own complaint. "Yes," she said, "but what did these experiments *look* like? What would I have seen if I just walked into the laboratory?"

Of course, many of your readers will already know this, but it does no harm to describe the experiment in a way that the initiated will enjoy and the uninitiated learn from. I loved it when my elementary astronomy textbook described the neutrino telescope in Homestake Gold Mine as "a 400,000-liter tank of cleaning fluid."

The charm of contrast between the abstruse and the mundane need not be limited to the opening of a paper. Here are a few more examples:

> "The difference between the two types of variables can be elucidated by describing two ways of watching fish. In the Eulerian picture one stays at a point and watches whatever fish happen by; in the Lagrangian picture one picks out a particular fish and keeps track of where it goes" [P. J. Morrison, Rev. Mod. Phys. **70**, 467 (1998)].

> "One can imagine an ensemble of 10^9 - $10^{10} M_\odot$ black holes that have descended from dead galaxies and are now roaming freely and hoovering up an occasional remaining star in the volume R^3" [F.C. Adams and G. Laughlin, Rev. Mod. Phys. **69**, 347 (1997)].

> "It should be clear to anyone who has ever wrapped a rubber band around a cylinder that any mapping with winding number n can be deformed into any other mapping with winding number n, but that two mappings with distinct winding numbers cannot be deformed into one another" [David Mermin, Rev. Mod. Phys. **51**, 597 (1979)].

> "As late as the spring of 1946, neither the fact of Sloan's (1941) patent application nor the concept it embodied of electrons 'surfing' in a disc-loaded waveguide was known even by those most intimately involved" [(Paul Forman, Rev. Mod. Phys. **67**, 417 (1995)].

> "Radiative fluxes from 1987A are still changing on time scales short compared to journal publication time scales." [Virginia Trimble, Rev. Mod Phys. **60**, 859 (1988)].

> "I have observed that the Hamiltonian philosophy is like avocado: you either like it or you don't" [P.J. Morrison, Rev. Mod. Phys. **70**, 467 (1998)].

The important thing to remember is that science is indeed done by people — people who live in a world of cats, blue skies, rubber bands, and journal publication as well as in the intellectual world of concepts and relation-

ships. These people are like your audience and in many cases they *are* your audience. Speak to them.

12. Choosing a title

In the years I have worked at *Reviews of Modern Physics*, I have noticed an inverse correlation between length of an article's title and age of its author. Younger physicists, eager to make a splash in the literature, like titles that could serve as abstracts, spelling out the particulars of the work and sometimes running on so long that they require a reduced font to fit onto the page. Perhaps these authors imagine their readers as a very large dissertation committee or think that, to be taken seriously, they must present their work with as much aplomb as they can muster.

Their elders already know a large portion of their readership personally and are not intimidated by them. From the security of tenured positions, they are more likely to try a catchy or witty title, use language calculated to attract a wider audience, and save the details for the paper itself.

There are, of course, exceptions to complicate this generalization, but whether it is a mark of my age or of my youth, I favor the simpler and shorter titles, as do *RMP*'s Editor and Associate Editors. We often ask our authors to replace particularly cumbersome titles. Here is a selection of article titles in their ''Before'' and ''After'' versions. The Afters have all been published in *Reviews of Modern Physics*, whereas some of the Befores are fictitious, having been created for the sole purpose of offering a bad example. I apologize to authors who submitted perfectly good titles yet are represented in this list as providers of bad ones. And I promise never to reveal which Befores are genuine.

EXAMPLES OF SIMPLIFIED TITLES

Before	After
The diabolical nature of conical intersections of potential-energy surfaces of the same symmetry	Diabolical conical intersections
Nuclear magnetic resonance techniques as a probe of C_{60} and C_{60} superconductors: structural, electronic structural, and superconducting-state properties	Nuclear magnetic resonance of C_{60} fulleride superconductors
Technology for improving the resolution of large ground-based astronomical telescopes	Improving the resolution of ground-based telescopes
Reparametrization invariance and physical processes in stochastic growth equations	Stochastic growth equations and reparametrization invariance
Chaos in the class generated by perturbing periodic orbits	Strange attractors and the origin of chaos
The search for and discovery of the top quark	The discovery of the top quark

B. Elements of style for non-native writers of English

To write about physics in a language other than your native tongue must be a daunting undertaking, and I am continually impressed by how well *RMP*'s contributors manage it. Nonetheless, certain problems seem to be more daunting than others, judging from the frequency with which they come up. Here are a few areas in which the non-native writer of English needs to be especially careful.

1. Past tense and present perfect

Non-native speakers of English often select a two-word past tense, thinking this to be analogous to the French *passé composé*, for action that is completed and thoroughly in the past. Unfortunately, English is just the reverse of French in this regard. The two-word past, or present perfect (e.g., has surveyed, have shown) describes action that is recent and perhaps ongoing, whereas the simple, one-word past tense (surveyed, showed) is more appropriate for history. The sentences below show typical misuse of the present perfect, with corrections written in by hand:

At the same time it ~~has been~~ was shown by these authors in 1985 that ...

These studies ~~have~~ acquired new impetus after York discovered that ...

The way out of this difficulty ~~has been~~ was indicated a long time ago by Adams (1957), ...

Conversely, actions in the very recent past are better described by the two-word present perfect:

In this section we have tried to draw attention ...

Recent research has focused on ...

2. Placing the verb early in the sentence

English-speaking readers grow impatient when forced to wait too long for a verb. The following sentences are marked to position the verb closer to the beginning of the sentence:

If we neglect the processes of entropy generation such as plasma heating owing to decay or the annihilation of massive particles when they depart from thermal equilibrium ~~are neglected,~~ then N_γ coincides with the photon concentration,...

At low temperatures the interaction not only between particles in clusters, but also between different clusters is substantial.

In Table IV the expected numbers above 10^{20} eV, if the true rate is taken from the integration of Eq. (43) given in Sec. V are listed.

3. Placement of adverbs

In English, adverbs are more often placed before the verb than after it. While placement after the verb is not incorrect, it has an awkward and foreign sound to a native English-speaker (usually). Two cases deserve special care. First, an adverb should not be placed between a verb and its object:

Wrong: Impurities affect also the elastic properties.
Right: Impurities also affect the elastic properties.

Wrong: If we extend further the analogy...
Right: If we further extend the analogy...

Second, when an auxiliary verb is used, place the adverb between the auxiliary and the verb, as in the following examples:

will rapidly converge
has long been known
could severely limit
may also be incomplete
would then follow
might incorrectly assume
can no longer be seen
had not yet received

An exception is the adverb "differently," which always goes after the verb:

are handled differently
must evolve differently
could behave differently

Adverbs placed at the beginning of a sentence are understood to apply to the whole statement rather than to a single verb. Common examples:

Unfortunately
Consequently
Hence
Analogously
Moreover

4. Nouns as modifiers

Like German, English sometimes uses nouns as modifiers:

the *CP* conjugation operator

the interaction potential

the order parameter

More often, however, it prefers to introduce them after the thing modified, using "of" or another preposition:

the expansion of the universe (not the universe expansion)

the reorientational dynamics of Li (not the Li reorientational dynamics)

the wavelength of light (not the light wavelength)

the concept of the coherent state (not the coherent-state concept)

a rise in temperature (not a temperature rise)

an upper bound for the density of matter (not a matter density upper bound)

the decay of the X meson (not the X-meson decay)

I can offer no hard and fast rule, as idiom is not consistent, but when in doubt you are more likely to be right placing noun modifiers after the thing modified. Long strings of modifiers are almost always better positioned later in the sentence. For example, the following phrases are grammatically correct, but awkward:

kinetic-ballooning-mode-induced losses

few- and infinite-degree-of-freedom fluid-mechanical systems

Rearranging these makes for a smoother sentence and eliminates the need for multiple hyphens:

losses induced by the kinetic ballooning mode

fluid-mechanical systems with few or infinite degrees of freedom.

5. Articles

People whose first language has no articles (e.g., Chinese, Japanese) tend to omit articles from their writing. The following sentences are marked to insert necessary articles:

The
Study of x-ray absorption spectra has a long history,
beginning with the discovery of the x-ray by Roentgen.

The
Coherent states defined by Eq. (3.10) are nonorthogonal.

S^2 is usually called a Bloch sphere.

As early as the 1980s, ...

People whose native language uses more articles than English (e.g., Germans) often allow extra articles to creep over into the English version. The following sentences are marked to delete unnecessary articles.

It follows from ~~the expression~~ Eq. (5.3) ...

They include ~~the~~ corrections due to ~~the~~ general relativity.

The use of ~~the~~ "effective Hamiltonians" is not limited to ~~the~~ solid-state physics.

The number of unit cells of ~~the~~ volume v_0 ...

Even a small change in the delta values would suffice for ~~the~~ ferroelectric ordering to occur.

The importance of ~~the~~ many-body effects in x-ray spectra ...

Finally, definite articles (the) and indefinite articles (a, an) are sometimes confused. "A" and "an" should be used for general statements, "the" for particular and specific things. The following incorrect sentences have been marked to show the proper article:

This case demonstrates ~~an~~ the opposite behavior.

~~The~~ A degeneracy of this type usually leads to ...

For ~~the~~ a conduction band with uniform level spacing, one may calculate ...

6. Describing figures

When describing the curves in a diagram, choose the idiomatic English terms,

solid line	rather than	full line
dashed line	rather than	broken line
heavy line	rather than	thick line

For economy, use data-point symbols (●, ○, □, △) whenever possible, rather than words. This also eliminates the problem of how to describe the symbols in English. Finally, for greatest clarity, name the curve or give the data point first and then give the description:

□, Smith *et al.*, 2000. Solid curve, absorption as a function of energy.

FIG. 10. Temporal evolution of the minimum film thickness H_{min} for $C^{-1} = 0.01$: solid curves, nonlinear evolution as described by Eq. (4.9); dashed curves, linear evolution in accordance with Eq. (4.21) for the fastest-growing mode. From Edwards and Oron (1995), reprinted with permission of Cambridge University Press.

7. Participles and infinitives

Where other languages combine a noun with an infinitive, English often favors a noun-participle combination:

Wrong: The probability to find a given type ...
Right: The probability of finding a given type ...

Wrong: A convenient method to generate sum rules ...
Right: A convenient method for generating sum rules ...

Wrong: The idea to look for a power series ...
Right: The idea of looking for a power series ...

There are, however, important exceptions. "Ability," unlike "probability," should be followed by an infinitive:

''A Penning trap has the ability to hold a single particle indefinitely.''

Other exceptions: ''Right,'' as in ''the right to remain silent,'' ''need,'' as in ''the need to be careful'' − see ''necessity'' below, under Frequently Misused Words and Expressions.

8. Covering two possibilities

The following very efficient construction is a Europeanism rarely encountered in articles by native English speakers:

With an increase (decrease) in interaction strength, the limit on the number of massless particles grows more (less) restrictive.

Many editors would let this stand, figuring that the reader is probably intelligent enough to sort it out, but this construction certainly violates the rule of thumb that good prose can be understood when read aloud. A native English-speaker would treat the two possibilities separately:

With an increase in interaction strength, the limit on the number of massless particles grows more restrictive, whereas with a decrease it becomes less so.

9. Omitting ''it''

In the following examples, non-native speakers are tempted to insert ''it'' where idiomatic usage leaves it out:

When these terms are independent of each other, as ~~it~~ is the case for N = 3, the criterion of Iacobson and Amit is satisfied.

The existence of a stable fixed point is less conclusive than ~~it~~ was originally supposed.

10. Frequently misused words and expressions

(1) Evidently, apparently. In English these words do not carry the weight that you might think. They are not simply another way of saying ''It is evident that . . . '' or ''It is apparent that . . . '' but introduce an overtone of doubt. A native English speaker would interpret them as ''The evidence to date supports it (but I am reserving judgment)'' or ''It appears to be so (but the final word is not yet in).'' For a more forceful statement, choose ''clearly'' or ''obviously,'' or ''plainly,'' or spell out ''It is evident that . . . ''

(2) As seen, as is seen, it is seen. Native English writers would not be so bold as to tell their readers what they see. Instead, they suggest ''As can be seen'' or try to involve the reader in a shared vision, ''As we have seen, . . . ''

(3) Contrary, conversely, in contrast, unlike. The expression ''on the contrary'' is used to contradict a positive statement. It has an argumentative tone. When you wish only to compare different things, use ''in contrast'' or, for opposites, ''conversely.''

Be careful with ''unlike,'' which requires two comparable nouns−two people, two atoms, two Hamiltonians. A common error is to try to compare, say, scientists with models or a theory with a variable:

Wrong: Unlike the work of Adams, Cohen uses . . .
Right: The work of Adams, unlike that of Cohen, uses . . . or
Right: Unlike Adams, Cohen uses . . .

Wrong: Unlike the case of covalent crystals, here the neighboring atoms . . .
Right: Here the neighboring atoms, unlike those in covalent crystals, . . .

When the comparison does not involve two specific nouns, replace ''unlike'' with ''in contrast.''

Wrong: Unlike in neurophysiology . . .
Right: In contrast to neurophysiology, . . .

(4) Firstly. This word has fallen into disrepute and is not permitted in AIP publications. Its sisters, ''secondly'' and ''thirdly,'' are quite acceptable. One can say ''first, secondly, thirdly.'' For parallelism, I propose ''first, second, third.''

(5) Estimation. A false friend. This word is used subjectively in English for esteem, regard, or a high or low opinion of something, e.g., ''In my estimation, the contract is worthless.'' For objective or scientific attempts to predict a result, use ''an estimate'' or the participle ''estimating'':

Wrong: Estimations based on Eq. (3.37)
Right: Estimates based on Eq. (3.37)

Wrong: This result will prove useful for the estimation of L.
Right: This result will prove useful for estimating L.

(6) Evidence. When experiments produce data supporting a theory, the data (plural) are referred to collectively as evidence (singular). There is no plural ''evidences.'' Moreover, there is no such verb as ''to evidence.'' Other verbs should be used, according to the circumstances: to reveal, to indicate, to suggest, to bear out, to confirm, to argue for, to support, to bear witness to, to signal.

(7) Of . . . of. Sentences that employ two or more ''of''s in close succession are ungainly. An English-speaking writer would instinctively try to rearrange them:

Poor: The probability of formation of strongly coupled clusters . . .
Better: The probability that strongly coupled clusters will form

Poor: Studies of the features of turbulence in accretion disks . . .
Better: Studies of turbulence in accretion disks . . .

Poor: Calibration of the estimates of the energy of the primary particles.
Better: Calibration of the energy estimates for the primary particle.

(8) Compared to. The two most common ways of stating a comparison in a scientific paper are demonstrated by the following models:

Model A: The size of the halo is small compared with the separation between galaxies.

Model B: This cross section is significantly smaller than those predicted by Eq. (23).

In Model A, a noncomparative form of the adjective—small, high, broad, weak, etc.—is used with ''compared to.'' In Model B, a comparative form—smaller, higher, broader, weaker, etc.—is used with ''than.''

The error to be avoided here is to mix elements from the two models and to produce a sentence that has both a comparative adjective and ''compared to'':

Wrong: Power corrections are greater for the delta as compared to the nucleon.
Model A: Power corrections for the delta are great compared to those for the nucleon.
Model B: Power corrections are greater for the delta than for the nucleon.

(9) Favor. An event can be energetically favored or not energetically favored. It is never energetically unfavorable.

(10) Monotony. Be careful not to confuse ''monotonic'' (a mathematical sequence) with ''monotonous'' (boring).

Wrong: The energy per atom decreases monotonously.
Right: The energy per atom decreases monotonically.

(11) Singular. The word ''singular'' has two meanings in English. The first is the opposite of ''plural.'' The second is ''rare'' or ''deviating from the norm.'' To avoid ambiguity, use ''single'' when referring to number.

Ambiguous: singular crystal surface (unusual crystal surface?)
Clearer: single-crystal surface (surface of one crystal)

(12) Enable, allow, permit. Verbs of empowerment take an object—generally the person or persons being empowered:

Wrong: The experiment does not allow to distinguish between $T/1nt$ and $T^{3/2}$.
Right: The experiment does not allow one to distinguish between $T/1nt$ and $T^{3/2}$.

Wrong: This device enabled probes of new areas.
Right: This device enabled Kelly to probe new areas. Or
Right: This device made possible probes of new areas.

''Enable'' *must* have a person or pronoun as object, followed by an infinitive. ''Allow'' and ''permit'' may be used like ''Enable'' (followed by person-plus-infinitive) or they may take simple objects.

. . . so as to allow deeper penetration.

. . . which permits a lively exchange of ideas.

Note that an infinitive, standing alone, is not a suitable object for any of these verbs.

Right: which permits use of the Hamiltonian.
Right: which permits us to use the Hamiltonian.
Wrong: which permits to use the Hamiltonian.

(13) Necessity. English favors the noun ''need'' over ''necessity,'' probably because it lends itself to a simpler sentence construction. ''Need'' can be followed by an infinitive:

The need to use low temperatures . . .

The need to take into account . . .

whereas ''necessity,'' in a similar position, must be followed by ''of'' and an ''-ing'' form:

The necessity of using low temperatures . . .

The necessity of taking into account . . .

Plainly the second construction is more cumbersome. It is thus seldom used, though not incorrect.

(14) Absence. A person or an element can be absent, but an event cannot. When something does not happen, scientifically speaking, English prefers a simple negation to ''is absent.''

Wrong: The frequency dispersion of B is absent.
Right: There is no frequency dispersion of B.

Wrong: The depolarization is absent.
Right: There is no depolarization. Or
Depolarization does not occur. Or
No depolarization takes place.

However, ''absence'' as a noun is okay: ''From the above analysis we infer the absence of long-range order.''

(15) The question. When English refers to ''the question,'' it leaps right in to state it, using only a comma, a colon, or the preposition ''of.'' This probably sounds abrupt to a European ear. Nonetheless, inserting other words and phrases is unnecessary and usually wrong:

Wrong: . . . will answer the question concerning its origin.
Right: . . . will answer the question of its origin.

Wrong: . . . will answer the question as to whether . . .
Right: . . . will answer the question of whether . . .

Wrong: . . . will answer the question about which model . . .
Right: . . . will answer the question, Which model . . .

Wrong: The question can be raised as to what happens when . . . .
Right: The question can be raised: What happens when . . .

(16) Replace, substitute. The verb ''to substitute'' is always accompanied by ''for.'' The verb ''to replace'' can stand alone:

Active: Y replaces X.
We substitute Y for X.

Passive: X is replaced by Y.
Y is substituted for X.

(6) Aspects. This noun rarely appears alone in English, but is followed by ''of'' and an object. If you cannot provide the object, replace ''aspects'' with a different word.

Wrong: Two aspects deserve special mention.
Right: Two aspects of this problem deserve special mention.

Wrong: Section V treats off-equilibrium aspects.
Better: Section V treats off-equilibrium processes /calculations/whatever.

Wrong: Adiabatic processes are likely to be relevant in various aspects.
Better: Adiabatic processes are likely to be relevant in several ways.

C. Conclusion

I hope that the examples above have encouraged you to pay closer attention, in writing your next scientific article, to writing techniques that can make it more vital and engaging. A greater reliance on the active voice, reduction in wordiness, judicious use of asides and questions directed to the reader, concrete examples drawn from everyday life, and a little extra grammatical polish should go a long way towards giving your writing greater impact. The first step, however, is to abandon the idea that, to be respected, you must speak in a stuffy manner for a stuffy judgmental audience. If you think of your reader as a colleague or potential colleague, someone with whom you might one day hold animated discussions or go to lunch, you will be better able to communicate the excitement that your work holds for you. Mind-to-mind contact between author and reader is the goal towards which you are working when you write a paper. The closer you come to achieving it, the more memorable your writing will be and the greater the rewards for you and for your readers.

APPENDIX B: JOURNAL TITLE ABBREVIATIONS

The following list contains standard abbreviations for the names of many journals commonly cited in the physics research literature. A more complete list is given in *INSPEC List of Journals and other Serial Sources* (Institution of Electrical Engineers, London) which comes out annually and is available in most libraries. Additional standard abbreviation listings may be found in *Chemical Abstracts Service Source Index* (CASSI) (American Chemical Society, Washington, D.C.) and *Abbreviations of the Names of Scientific Periodicals Reviewed in Mathematical Reviews* (American Mathematical Society, Providence, RI). *Please note*: Many Russian journals changed their names after the breakup of the Soviet Union. References to these journals should use the form of their name that was current at the time of publication.

Accounts of Chemical Research	Acc. Chem. Res.
Acta Chemica Scandinavica	Acta Chem. Scand.
Acta Crystallographica	Acta Crystallogr.
Acta Crystallographica, Section A: Crystal Physics, Diffraction, Theoretical and General Crystallography	Acta Crystallogr. Sec. A
Acta Crystallographica, Section B: Structural Crystallography and Crystal Chemistry	Acta Crystallogr. Sec. B
Acta Mathematica Academiae Scientiarum Hungaricae	Acta Math. Acad. Sci. Hung.
Acta Metallurgica	Acta Metall.
Acta Physica	Acta Phys.
Acta Physica Austriaca	Acta Phys. Austriaca
Acta Physica Polonica	Acta Phys. Pol.
Acustica	Acustica
Advances in Applied Mechanics	Adv. Appl. Mech.
Advances in Atomic and Molecular Physics	Adv. At. Mol. Phys.
Advances in Chemical Physics	Adv. Chem. Phys.
Advances in Magnetic Resonance	Adv. Magn. Reson.
Advances in Physics	Adv. Phys.
Advances in Quantum Chemistry	Adv. Quantum Chem.
AIAA Journal	AIAA J.
AIChE Journal	AIChE J.
AIP Conference Proceedings	AIP Conf. Proc.
Akusticheskii Zhurnal [Soviet Physics—Acoustics]	Akust. Zh. [Sov. Phys. Acoust.]
American Journal of Physics	Am. J. Phys.
Analytical Chemistry	Anal. Chem.
Annalen der Physik (Leipzig)	Ann. Phys. (Leipzig)
Annales de Chimie et de Physique	Ann. Chim. Phys.
Annales de Geophysique	Ann. Geophys.
Annales de l'Institut Henri Poincaré	Ann. Inst. Henri Poincaré
Annales de l'Institut Henri Poincaré, Section A: Physique Theorique	Ann. Inst. Henri Poincaré, A
Annales de l'Institut Henri Poincaré, Section B: Calcul des Probabilités et Statistique	Ann. Inst. Henri Poincaré, B
Annales de Physique (Paris)	Ann. Phys. (Paris)
Annals of Fluid Dynamics	Ann. Fluid Dyn.
Annals of Mathematics	Ann. Math.
Annals of Physics (New York)	Ann. Phys. (N.Y.)
Annual Review of Astronomy and Astrophisics	Annu. Rev. Astron. Astrophys.
Annual Review of Atomic and Molecular Physics	Annu. Rev. At. Mol. Phys.
Annual Review of Fluid Mechanics	Annu. Rev. Fluid Mech.
Annual Review of Nuclear Science	Annu. Rev. Nucl. Sci.
Applied Optics	Appl. Opt.
Applied Physics Letters	Appl. Phys. Lett.
Applied Spectroscopy	Appl. Spectrosc.
Arkiv foer Fysik	Ark. Fys.

Astronomical Journal	Astron. J.
Astronomicheskii Zhurnal [Soviet Astronomy]	Astron. Zh. [Sov. Astron.]
Astronomische Nachrichten	Astron. Nachr.
Astronomy and Astrophysics	Astron. Astrophys.
Astrophysical Journal	Astrophys. J.
Astrophysical Journal, Letters to the Editor	Astrophys. J. Lett.
Astrophysical Journal, Supplement Series	Astrophys. J. Suppl. Ser.
Astrophysical Letters	Astrophys. Lett.
Atomic Data and Nuclear Data Tables	At. Data. Nucl. Data Tables
Atomnaya Energiya [Soviet Journal of Atomic Energy]	At. Energ. [Sov. J. At. Energy]
Australian Journal of Physics	Aust. J. Phys.
Bell System Technical Journal	Bell Syst. Tech. J.
Berichte der Bunsengesellschaft für Physikalische Chemie	Ber. Bunsenges. Phys. Chem.
British Journal of Applied Physics	Br. J. Appl. Phys.
Bulletin of the Academy of Sciences of the USSR, Physical Series (translation of Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya)	Bull. Acad. Sci. USSR, Phys. Ser.
Bulletin of the American Astronomical Society	Bull. Am. Astron. Soc.
Bulletin of The American Physical Society	Bull. Am. Phys. Soc.
Bulletin of the Astronomical Institutes of the Netherlands	Bull. Astron. Inst. Neth.
Bulletin of the Chemical Society of Japan	Bull. Chem. Soc. Jpn.
Bulletin of the Seismological Society of America	Bull. Seismol. Soc. Am.
Canadian Journal of Chemistry	Can. J. Chem.
Canadian Journal of Physics	Can. J. Phys.
Canadian Journal of Research	Can. J. Res.
Chaos	Chaos
Chemical Physics	Chem. Phys.
Chemical Physics Letters	Chem. Phys. Lett.
Chemical Reviews	Chem. Rev.
Chinese Journal of Physics [translation of Wuli Xuebao (Acta Physica Sinica)]	Chin. J. Phys.
Comments on Astrophysics and Space Physics	Comments Astrophys. Space Phys.
Comments on Atomic and Molecular Physics	Comments At. Mol. Phys.
Comments on Nuclear and Particle Physics	Comments Nucl. Part. Phys.
Comments on Plasma Physics and Controlled Fusion	Comments Plasma Phys. Controlled Fusion
Comments on Solid State Physics	Comments Solid State Phys.
Communications in Mathematical Physics	Commun. Math. Phys.
Communications on Pure and Applied Mathematics	Commun. Pure Appl. Math.
Complex Systems	Complex Syst.
Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences	C. R. Acad. Sci.
Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Serie A: Sciences Mathématiques	C. R. Acad. Sci. Ser. A
Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Serie B: Sciences Physiques	C. R. Acad. Sci. Ser. B
Cryogenics	Cryogenics
Czechoslovak Journal of Physics	Czech. J. Phys.
Discussions of the Faraday Society	Discuss. Faraday Soc.
Doklady Akademii Nauk SSSR [Soviet Physics—Doklady]	Dokl. Akad. Nauk SSSR [Sov. Phys. Dokl.]
Earth and Planetary Science Letters	Earth Planet. Sci. Lett.
Earth Planets Space [formerly Journal of Geomagnetism and Geoelectricity]	Earth Planets Space
Electronics Letters	Electron. Lett.
European Journal of Physics	Eur. J. Phys.

Europhyics Letters	Europhys. Lett.
Few-Body Systems	Few-Body Syst.
Fields and Quanta	Fields Quanta
Fizika Elementarnykh Chastits i Atomnogo Yadra [Soviet Journal of Particles and Nuclei]	Fiz. Elem. Chastits At. Yadra [Sov. J. Part. Nucl.]
Fizika i Tekhnika Poluprovodnikov [Soviet Physics—Semiconductors]	Fiz. Tekh. Poluprovodn. [Sov. Phys. Semicond.]
Fizika Metallov i Metallovedenie [Physics of Metals and Metallography (USSR)]	Fiz. Met. Metalloved. [Phys. Met. Metallogr. (USSR)]
Fizika Nizkikh Temperatur [Soviet Journal of Low Temperature Physics]	Fiz. Nizk. Temp. [Sov. J. Low Temp. Phys.]
Fizika Plazmy [Soviet Journal of Plasma Physics]	Fiz. Plazmy [Sov. J. Plasma Phys.]
Fizika Tverdogo Tela (Leningrad) [Soviet Physics—Solid State] (Leningrad) [Sov. Phys. Solid State]	Fiz. Tverd. Tela (Leningrad) [Sov. Phys. Solid State]
Fortschritte der Physik	Fortschr. Phys.
Foundations of Physics	Found. Phys.
General Relativity and Gravitation	Gen. Relativ. Gravit.
Geochimica et Cosmochimica Acta	Geochim. Cosmochim. Acta
Helvetica Chimica Acta	Helv. Chim. Acta
Helvetica Physica Acta	Helv. Phys. Acta
High Temperature (USSR) (translation of Teplofizika Vysokikh Temperatur)	High Temp. (USSR)
Hyperfine Interactions	Hyperfine Interact.
IBM Journal of Research and Development	IBM J. Res. Dev.
Icarus	Icarus
IEEE Journal of Quantum Electronics	IEEE J. Quantum Electron.
IEEE Transactions on Electron Devices	IEEE Trans. Electron Devices
IEEE Transactions on Information Theory	IEEE Trans. Inf. Theory
IEEE Transactions on Instrumentation and Measurement	IEEE Trans. Instrum. Meas.
IEEE Transactions on Magnetics	IEEE Trans. Magn.
IEEE Transactions on Microwave Theory and Techniques	IEEE Trans. Microwave Theory Tech.
IEEE Transactions on Nuclear Science	IEEE Trans. Nucl. Sci.
IEEE Transactions on Sonics and Ultrasonics	IEEE Trans. Sonics Ultrason.
Industrial and Engineering Chemistry	Ind. Eng. Chem.
Infrared Physics	Infrared Phys.
Inorganic Chemistry	Inorg. Chem.
Inorganic Materials (USSR) (translation of Izvestiya Akademii Nauk SSSR, Neorganicheskie Materialy)	Inorg. Mater. (USSR)
Instruments and Experimental Techniques (USSR) (translation of Pribory i Tekhnika Eksperimenta)	Instrum. Exp. Tech. (USSR)
International Journal of Energy Research	Int. J. Energy Res.
International Journal of Magnetism	Int. J. Magn.
International Journal of Quantum Chemistry	Int. J. Quantum Chem.
International Journal of Quantum Chemistry, Part 1	Int. J. Quantum Chem. 1
International Journal of Quantum Chemistry, Part 2	Int. J. Quantum Chem. 2
International Journal of Theoretical Physics	Int. J. Theor. Phys.
Izvestiya, Academy of Sciences, USSR, Atmospheric and Oceanic Physics (translation of Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana)	Izv. Acad. Sci. USSR, Atmos. Oceanic Phys.
Izvestiya, Academy of Sciences, USSR, Physics of the Solid Earth (translation of Izvestiya Akademii Nauk SSSR, Fizika Zemli)	Izv. Acad. Sci. USSR, Phys. Solid Earth

Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana [Izvestiya, Academy of Sciences, USSR, Atmospheric and Oceanic Physics]	Izv. Acad. Nauk SSSR, Fiz. Atmos. Okeana [Izv. Acad. Sci. USSR, Atmos. Oceanic Phys.]
Izvestiya Akademii Nauk SSSR, Fizika Zemli [Izvestiya, Academy of Sciences, USSR, Physics of the Solid Earth]	Izv. Acad. Nauk SSSR, Fiz. Zemli. [Izv. Acad. Sci. USSR, Phys. Solid Earth]
Izvestiya Akademii Nauk SSSR, Neorganicheskie Materialy [Inorganic Materials (USSR)]	Izv. Akad. Nauk SSSR, Neorg. Mater. [Inorg. Mater. (USSR)]
Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya [Bulletin of the Academy of Sciences of the USSR, Physical Series]	Izv. Acad. Nauk SSSR, Ser. Fiz. [Bull. Acad. Sci. USSR, Phys. Ser.]
Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika [Soviet Physics Journal]	Izv. Vyssh. Uchebn. Zavad. Fiz. [Sov. Phys. J.]
Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika [Soviet Radiophysics]	Izv. Vyssh. Uchebn. Zaved. Radiofiz. [Sov. Radiophys.]
Japanese Journal of Applied Physics	Jpn. J. Appl. Phys.
Japanese Journal of Physics	Jpn. J. Phys.
JETP Letters (translation of Pis'ma v Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki)	JETP Lett.
Journal de Chimie Physique	J. Chim. Phys.
Journal de Physique (Paris)	J. Phys. (Paris)
Journal de Physique et le Radium	J. Phys. Radium
Journal of Applied Crystallography	J. Appl. Crystallogr.
Journal of Applied Physics	J. Appl. Phys.
Journal of Applied Spectroscopy (USSR) (translation of Zhurnal Prikladnoi Spektroskopii)	J. Appl. Spectrosc. (USSR)
Journal of Atmospheric and Terrestrial Physics	J. Atmos. Terr. Phys.
Journal of Atmospheric Sciences	J. Atmos. Sci.
Journal of Chemical Physics	J. Chem. Phys.
Journal of Colloid and Interface Science	J. Colloid Interface Sci.
Journal of Computational Physics	J. Comput. Phys.
Journal of Crystal Growth	J. Cryst. Growth
Journal of Electron Spectroscopy and Related Phenomenon	J. Electron. Spectrosc. Relat. Phenom.
Journal of Fluid Mechanics	J. Fluid Mech.
Journal of Geophysical Research	J. Geophys. Res.
Journal of Inorganic and Nuclear Chemistry	J. Inorg. Nucl. Chem.
Journal of Low Temperature Physics	J. Low Temp. Phys.
Journal of Luminescence	J. Lumin.
Journal of Macromolecular Science, [Part B] Physics	J. Macromol. Sci. Phys.
Journal of Magnetism and Magnetic Materials	J. Magn. Magn. Mater.
Journal of Mathematical Physics (New York)	J. Math. Phys. (N.Y.)
Journal of Molecular Spectroscopy	J. Mol. Spectrosc.
Journal of Non-Crystalline Solids	J. Non-Cryst. Solids
Journal of Nonlinear Science	J. Nonlinear Sci.
Journal of Nuclear Energy	J. Nucl. Energy
Journal of Nuclear Energy, Part C: Plasma Physics, Accelerators, Thermonuclear Research	J. Nucl. Energy, Part C
Journal of Nuclear Materials	J. Nucl. Mater.
Journal of Physical and Chemical Reference Data	J. Phys. Chem. Ref. Data
Journal of Physical Chemistry	J. Phys. Chem.
Journal of Physics A: Mathematical and General	J. Phys. A
Journal of Physics and Chemistry of Solids	J. Phys. Chem. Solids
Journal of Physics B: Atomic, Molecular and Optical	J. Phys. B

Journal of Physics C: Solid State Physics	J. Phys. C
Journal of Physics D: Applied Physics	J. Phys. D
Journal of Physics E: Scientific Instruments	J. Phys. E
Journal of Physics F: Metal Physics	J. Phys. F
Journal of Physics (Moscow)	J. Phys. (Moscow)
Journal of Plasma Physics	J. Plasma Phys.
Journal of Polymer Science	J. Polym. Sci.
Journal of Polymer Science, Polymer Letters Edition	J. Polym. Sci. Polym. Lett. Ed.
Journal of Polymer Science, Polymer Physics Edition	J. Polym. Sci. Polym. Phys. Ed.
Journal of Quantitative Spectroscopy & Radiative Transfer	J. Quant. Spectrosc. Radiat. Transfer
Journal of Research of the National Bureau of Standards	J. Res. Natl. Bur. Stand.
Journal of Research of the National Bureau of Standards, Section A: Physics and Chemistry	J. Res. Natl. Bur. Stand. Sec. A
Journal of Research of the National Bureau of Standards, Section B: Mathematical Sciences	J. Res. Natl. Bur. Stand. Sec. B
Journal of Research of the National Bureau of Standards, Section C: Engineering and Instrumentation	J. Res. Natl. Bur. Stand. Sec. C
Journal of Research of the National Institute of Standards and Technology	J. Res. Natl. Inst. Stand. Technol.
Journal of Scientific Instruments	J. Sci. Instrum.
Journal of Sound and Vibration	J. Sound Vib.
Journal of Statistical Physics	J. Stat. Phys.
Journal of the Acoustical Society of America	J. Acoust. Soc. Am.
Journal of the American Ceramic Society	J. Am. Ceram. Soc.
Journal of the American Chemical Society	J. Am. Chem. Soc.
Journal of the American Institute of Electrical Engineers	J. Am. Inst. Electr. Eng.
Journal of the Audio Engineering Society	J. Audio Eng. Soc.
Journal of the Chemical Society	J. Chem. Soc.
Journal of the Electrochemical Society	J. Electrochem. Soc.
Journal of the Mechanics and Physics of Solids	J. Mech. Phys. Solids
Journal of the Optical Society of America	J. Opt. Soc. Am.
Journal of Theoretical Biology	J. Theor. Biol.
Journal of the Physical Society of Japan	J. Phys. Soc. Jpn.
Journal of Vacuum Science and Technology	J. Vac. Sci. Technol.
Kolloid Zeitschrift & Zeitschrift für Polymere	Kolloid Z. Z. Polym.
Kongelige Danske Videnskabernes Selskab, Matematisk-Fysiske Meddelelser	K. Dan. Vidensk. Selsk. Mat. Fys. Medd.
Kristallografiya [Soviet Physics—Crystallography]	Kristallografiya [Sov. Phys. Crystallogr.]
Kvantovaya Elektronika (Moscow) [Soviet Journal of Quantum Electronics]	Kvant. Elektron. (Moscow). [Sov. J. Quantum Electron.]
Lettere al Nuovo Cimento	Lett. Nuovo Cimento
Lick Observatory Bulletin	Lick Obs. Bull.
Materials Research Bulletin	Mater. Res. Bull.
Mathematical Biosciences	Math. Biosci.
Mathematical Physics and Applied Mathematics	Math. Phys. Appl. Math.
Medical Physics	Med. Phys.
Memoirs of the Royal Astronomical Society	Mem. R. Astron. Soc.
Molecular Crystals and Liquid Crystals	Mol. Cryst. Liq. Cryst.
Molecular Physics	Mol. Phys.
Monthly Notices of the Royal Astronomical Society	Mon. Not. R. Astron Soc.

National Bureau of Standards (U.S.), Circular	Natl. Bur. Stand. Circ. (U.S.)
National Bureau of Standards (U.S.), Miscellaneous Publication	Natl. Bur. Stand. Misc. Publ. (U.S.)
National Bureau of Standards (U.S.), Special Publication	Natl. Bur. Stand. Spec. Publ. (U.S.)
Nature (London)	Nature (London)
Naturwissenschaften	Naturwissenschaften
Nuclear Data, Section A	Nucl. Data, Sec. A
Nuclear Data, Section B	Nucl. Data, Sec. B
Nuclear Fusion	Nucl. Fusion
Nuclear Instruments	Nucl. Instrum.
Nuclear Instruments & Methods	Nucl. Instrum. Methods
Nuclear Physics	Nucl. Phys.
Nuclear Physics A	Nucl. Phys. A
Nuclear Physics B	Nucl. Phys. B
Nuclear Science and Engineering	Nucl. Sci. Eng.
Nukleonika	Nukleonika
Nuovo Cimento	Nuovo Cimento
Nuovo Cimento A	Nuovo Cimento A
Nuovo Cimento B	Nuovo Cimento B
Optica Acta	Opt. Acta
Optics and Spectroscopy (USSR) (translation of Optika i Spektroskopiya)	Opt. Spectrosc.
Optics Communications	Opt. Commun.
Optics Letters	Opt. Lett.
Optics News	Opt. News
Optik (Stuttgart)	Optik (Stuttgart)
Optika i Spektroskopiya [Optics and Spectroscopy (USSR)]	Opt. Spektrosk. [Opt. Spectrosc. (USSR)]
Optiko-Mekhanicheskaya Promyshlennost [Soviet Journal of Optical Technology]	Opt.-Mekh. Prom. [Sov. J. Opt. Technol.]
Philips Research Reports	Philips Res. Rep.
Philosophical Magazine	Philos. Mag.
Philosophical Transactions of the Royal Society of London	Philos. Trans. R. Soc. London
Philosophical Transactions of the Royal Society of London, Series A: Mathematical and Physical Sciences	Philos. Trans. R. Soc. London, Ser. A
Physica B	Physica B
Physica Scripta	Phys. Scr.
Physica Status Solidi	Phys. Status Solidi
Physica Status Solidi A: Applied Research	Phys. Status Solidi A
Physica Status Solidi B: Basic Research	Phys. Status Solidi B
Physica (Utrecht)	Physica (Utrecht)
Physical Review	Phys. Rev.
Physical Review A: Atomic, Molecular, and Optical Physics	Phys. Rev. A
Physical Review B: Condensed Matter	Phys. Rev. B
Physical Review C: Nuclear Physics	Phys. Rev. C
Physical Review D: Particles and Fields	Phys. Rev. D
Physical Review E: Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics	Phys. Rev. E
Physical Review Letters	Phys. Rev. Lett.
Physics and Chemistry of Solids	Phys. Chem. Solids
Physics Letters	Phys. Lett.
Physics Letters A	Phys. Lett. A

Physics Letters B	Phys. Lett. B
Physics (New York)	Physics (N.Y.)
Physics of Fluids	Phys. Fluids
Physics of Metals and Metallography (USSR) (translation of Fizika Metallovi Metallovedenie)	Phys. Met. Metallogr. (USSR)
Physics of Plasmas	Phys. Plasmas
Physics Reports	Phys. Rep.
Physics Teacher	Phys. Teach.
Physics Today	Phys. Today
Physikalische Zeitschrift	Phys. Z.
Physikalische Zeitschrift der Sowjetunion	Phys. Z. Sowjetunion
Physik der Kondensierten Materie	Phys. Kondens. Mater.
Pis'ma v Astronomicheskii Zhurnal [Soviet Astronomy Letters]	Pisma Astron. Zh. [Sov. Astron. Lett.]
Pis'ma v Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki [JETP Letters]	Pis'ma Zh. Eksp. Teor. Fiz. [JETP Lett.]
Pis'ma v Zhurnal Tekhnicheskoi Fiziki [Soviet Technical Physics Letters]	Pis'ma Zh. Tekh. Fiz. [Sov. Tech. Phys. Lett.]
Planetary and Space Science	Planet. Space Sci.
Plasma Physics	Plasma Phys.
Plasma Physics and Controlled Fusion	Plasma Phys. Control. Fusion
Pribory i Tekhnika Eksperimenta [Instruments and Experimental Techniques (USSR)]	Prib. Tekh. Éksp. [Instrum. Exp. Tech. (USSR)]
Proceedings of the Cambridge Philosophical Society	Proc. Cambridge Philos. Soc.
Proceedings of the IEEE	Proc. IEEE
Proceedings of the IRE	Proc. IRE
Proceedings of the National Academy of Sciences of the United States of America	Proc. Natl. Acad. Sci. USA
Proceedings of the Physical Society, London	Proc. Phys. Soc. London
Proceedings of the Physical Society, London, Section A	Proc. Phys. Soc. London, Sec. A
Sec. A	
Proceedings of the Physical Society, London, Section B	Proc. Phys. Soc. London, Sec. B
Sec. B	
Proceedings of the Royal Society of London	Proc. R. Soc. London
Proceedings of the Royal Society of London, Series A: Mathematical and Physical Sciences	Proc. R. Soc. London, Ser. A
Progress of Theoretical Physics	Prog. Theor. Phys.
Publications of the Astronomical Society of the Pacific	Publ. Astron. Soc. Pac.
Quantum Electronics	Quantum Electron. (UK) or Quantum Electron. (USA)
Quantum Optics	Quantum Opt.
Radiation Effects	Radiat. Eff.
Radio Engineering and Electronic Physics (USSR) (translation of Radiotekhnika i Elektronika)	Radio Eng. Electron. Phys. (USSR)
Radio Engineering and Electronics (USSR) (translation of Radiotekhnika i Elektronika)	Radio Eng. Electron. (USSR)
Radiotekhnika i Elektronika [Radio Engineering and Electronic Physics (USSR)]	Radiotekh. Elektron. [Radio Eng. Electron. Phys. (USSR)]
Radiotekhnika i Elektronika [Radio Engineering and Electronics (USSR)]	Radiotekh. Elektron. [Radio Eng. Electron. (USSR)]
RCA Review	RCA Rev.
Reports on Progress in Physics	Rep. Prog. Phys.
Review of Scientific Instruments	Rev. Sci. Instrum.

Reviews of Modern Physics	Rev. Mod. Phys.
Revue d'Optique, Théorique et Instrumentale	Rev. Opt. Theor. Instrum.
Russian Journal of Physical Chemistry (translation of Zhurnal Fizicheskoi Khimii)	Russ. J. Phys. Chem.
Science	Science
Scientific American	Sci. Am.
Solar Physics	Sol. Phys.
Solid State Communications	Solid State Commun.
Solid-State Electronics	Solid-State Electron.
Soviet Astronomy (translation of Astronomicheskii Zhurnal)	Sov. Astron.
Soviet Astronomy Letters (translation of Pis'ma v Astronomicheskii Zhurnal)	Soc. Astron. Lett.
Soviet Journal of Atomic Energy (translation of Atomnaya Energiya)	Sov. J. At. Energy
Soviet Journal of Low Temperature Physics (translation of Fizika Nizkikh Temperatur)	Sov. J. Low Temp. Phys.
Soviet Journal of Nuclear Physics (translation of Yadernaya Fizika)	Sov. J. Nucl. Phys.
Soviet Journal of Optical Technology (translation of Optiko-Mekhanicheskaya Promyshlennost)	Sov. J. Opt. Technol.
Soviet Journal of Particles and Nuclei (translation of Fizika Elementarnykh Chastitsi Atomnogo Yadra)	Sov. J. Part. Nucl.
Soviet Journal of Plasma Physics (translation of Fizika Plazmy)	Sov. J. Plasma Phys.
Soviet Journal of Quantum Electronics [translation of Kvantovaya Elektronika (Moscow)]	Sov. J. Quantum Electron.
Soviet Physics—Acoustics (translation of Akusticheskii Zhurnal)	Sov. Phys. Acoust.
Soviet Physics—Crystallography (translation of Kristallografiya)	Sov. Phys. Crystallogr.
Soviet Physics—Doklady (translation of Doklady Akademii Nauk SSSR)	Sov. Phys. Dokl.
Soviet Physics—JETP (translation of Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki)	Sov. Phys. JETP
Soviet Physics Journal (translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika)	Sov. Phys. J.
Soviet Physics—Semiconductors (translation of Fizika i Tekhnika Poluprovodnikov)	Sov. Phys. Semicond.
Soviet Physics—Solid State [translation of Fizika Tverdogo Tela (Leningrad)]	Sov. Phys. Solid State
Soviet Physics—Technical Physics (translation of Zhurnal Tekhnicheskoi Fiziki)	Sov. Phys. Tech. Phys.
Soviet Physics—Uspekhi (translation of Uspekhi Fizicheskikh Nauk)	Sov. Phys. Usp.
Soviet Radiophysics (translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika)	Sov. Radiophys.
Soviet Technical Physics Letters (translation of Pis'ma v Zhurnal Tekhnicheskoi Fiziki)	Sov. Tech. Phys. Lett.
Spectrochimica Acta	Spectrochim. Acta
Spectrochimica Acta, Part A: Molecular Spectroscopy Acta, Part A	Spectrochim. Acta, Part A
Spectrochimica Acta, Part B: Atomic Spectroscopy Acta, Part B	Spectrochim. Acta, Part B
Surface Science	Surf. Sci.
Teplofizika Vysokikh Temperatur [High Temperature (USSR)]	Teplofiz. Vys. Temp. [High Temp. (USSR)]
Theoretica Chimica Acta	Theor. Chim. Acta
Thin Solid Films	Thin Solid Films
Transactions of the American Crystallographic Association Assoc.	Trans. Am. Crystallogr. Assoc.
Transactions of the American Geophysical Union	Trans. Am. Geophys. Union
Transactions of the American Institute of Mining, Metallurgical and Petroleum Engineers	Trans. Am. Inst. Min. Metall. Pet. Eng.
Transactions of the American Nuclear Society	Trans. Am. Nucl. Soc.
Transactions of the American Society for Metals	Trans. Am. Soc. Met.
Transactions of the American Society of Mechanical Engineers Eng.	Trans. Am. Soc. Mech. Eng.
Transactions of the British Ceramic Society	Trans. Br. Ceram. Soc.

Transactions of the Faraday Society	Trans. Faraday Soc.
Transactions of the Metallurgical Society of AIME	Trans. Metall. Soc. AIME
Transactions of the Society of Rheology	Trans. Soc. Rheol.
Ukrainian Physics Journal [translation of Ukrainskii Fizicheskii Zhurnal (Russian Edition)]	Ukr. Phys. J.
Ultrasonics	Ultrasonics
Uspekhi Fizicheskikh Nauk [Soviet Physics—Uspekhi]	Usp. Fiz. Nauk [Sov. Phys. Usp.]
Vistas in Astronomy	Vistas Astron.
Wuli Xuebao (Acta Physica Sinica) [Chinese Journal of Physics]	Wuli Xuebao (Acta Phys. Sin.) [Chin. J. Phys.]
Yadernaya Fizika [Soviet Journal of Nuclear Physics]	Yad. Fiz. [Sov. J. Nucl. Phys.]
Zeitschrift für Analytische Chemie	Z. Anal. Chem.
Zeitschrift für Angewandte Physik	Z. Angew. Phys.
Zeitschrift für Anorganische und Allgemeine Chemie	Z. Anorg. Allg. Chem.
Zeitschrift für Astrophysik	Z. Astrophys.
Zeitschrift für Elektrochemie	Z. Elektrochem.
Zeitschrift für Kristallographie, Kristallgeometrie, Kristallphysik, Kristallchemie	Z. Kristallogr. Kristallgeom. Kristallphys. Kristallchem.
Zeitschrift für Metallkunde	Z. Metallkd.
Zeitschrift für Naturforschung	Z. Naturforsch.
Zeitschrift für Naturforschung, Teil A: Physik, Physikalische Chemie, Kosmophysik	Z. Naturforsch. Teil A
Zeitschrift für Physik	Z. Phys.
Zeitschrift für Physik A: Atoms and Nuclei	Z. Phys. A
Zeitschrift für Physik B: Condensed Matter and Quanta	Z. Phys. B
Zeitschrift für Physik C: Particles and Fields	Z. Phys. C
Zeitschrift für Physikalisch-Chemische Materialforschung	Z. Phys. Chem. Materialforsch.
Zeitschrift für Physikalische Chemie, Abteilung A: Chemische Thermodynamik, Kinetik, Elektrochemie, Eigenschaftslehre	Z. Phys. Chem. Abt. A
Zeitschrift für Physikalische Chemie, Abteilung B: Chemie der Elementarprozesse, Aufbau der Materie	Z. Phys. Chem. Abt. B
Zeitschrift für Physikalische Chemie (Frankfurt am Main)	Z. Phys. Chem. (Frankurt am Main)
Zeitschrift für Physikalische Chemie (Leipzig)	Z. Phys. Chem. (Leipzig)
Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki [Soviet Physics—JETP]	Zh. Eksp. Teor. Fiz. [Sov. Phys. JETP]
Zhurnal Fizicheskoi Khimii [Russian Journal of Physical Chemistry]	Zh. Fiz. Khim. [Russ. J. Phys. Chem.]
Zhurnal Prikladnoi Spektroskopii [Journal of Applied Spectroscopy (USSR)]	Zh. Prikl. Spektrosk. [J. Appl. Spectrosc. (USSR)]
Zhurnal Tekhnicheskoi Fiziki [Soviet Physics—Technical Physics]	Zh. Tekh. Fiz. [Sov. Phys. Tech. Phys.]