```
integer odd = 1
for (int i = odd, i =< 10, i + 2)
    std::cout << i << std::endl
```

```
odd := 1
for i in range[0, 10]:
    if i % 2 = odd:
    print i
```

While being incremented from 0 to ten, I print out the even (odd) number only if the flag “odd” is 0 (1), respectively.

```
int odd = 1;
for (int i = odd; i <= 10; i += 2)
    std::cout << i << std::endl;
```

```
odd = 1
for i in range(0, 11):
    if i % 2 == odd:
        print i
```

If the flag “odd” is zero, I print the even numbers from zero to ten; if it is one, I print the odd numbers in the same range.

English Writing for Physicists

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Why care about writing?

- Grammar rules exist & are not arbitrary.
- Bad grammar is not a (wise) style choice.
- Bad writing is hard to read and undermines your purpose.

Where do most physicists learn English grammar from?

- Advisors & colleagues.
- Articles they read.
- (secondary education)

Are these reliable sources?

- Where did your colleagues learn from?
- Where do most article authors learn from?

This vicious circle leads to the sorry state of literature in physics!

Reference Material

Don't trust an article that quotes unreferenced outside results.

Likewise: Don't trust colleagues's writing tips without references.

Don't trust someone just because they are a native speaker:

Donald Trump is a native speaker.

Joseph Conrad learned English at age 21.

This course is not based on my personal preferences.

It is based on respected and widely used references books.

Many definitions are word for word from these books.

I recommend owning a usage guide (Garner's is my favorite).

And I highly recommend A.E. Greene's writing guide,

Writing Science in Plain English.

References: Style Guides

MLA Handbook
Modern Language Association of America (2016)
https://books.google.de/books?id=fAH-jgEACAAJ

MLA Handbook for Writers of Research Papers
Modern Language Association of America (2009)
https://books.google.de/books?id=icYRAQAAMAAJ

The Chicago Manual of Style
University of Chicago Press (2010)
https://books.google.de/books?id=4xJIAQAAIAAJ

A Manual for Writers of Research Papers, Theses, and Dissertations, 8th Ed.: Chicago Style for Students and Researchers
K.L. Turabian et al. (2013)
https://books.google.de/books?id=fqkgAgAAQBAJ

Physical Review Style and Notation Guide
https://journals.aps.org/author-information

Reviews of Modern Physics Style Guide
https://journals.aps.org/author-information

References: Usage Guides

The Careful Writer
T.M. Bernstein (1995)
https://books.google.de/books?id=qYd35MUlSm4C

Fowler's Dictionary of Modern English Usage
H.W. Fowler and J. Butterfield (2015)
https://books.google.de/books?id=AvmzBgAAQBAJ

Garner's Modern American Usage
B. Garner (2009)
https://books.google.de/books?id=Sd3byNeBdR4C

References: Writing Guides

Writing: Grammar, Usage, and Style
Jean Eggenschiler, Emily Dotson Biggs, and Claudia L.W. Reinhardt (2011)
https://books.google.de/books/about?id=E4qbUL_gtZMC

How to Write and Publish a Scientific Paper, 8th Edition
B. Gastel and R.A. Day (2016)
https://books.google.de/books?id=eyyyCwAAQBAJ

Writing Science in Plain English
A.E. Greene (2013)
https://books.google.de/books?id=l6pBR29W7isC

From Research to Manuscript: A Guide to Scientific Writing
M.J. Katz (2009)
https://books.google.de/books?id=8f7yxf6qBgoC

Elements of Style
W. Strunk and E. B. White (2012)
https://books.google.de/books?id=dAeZDAAAQBAJ

Course Outline

Ordinarily this is a semester-long course covering

- the parts of speech,
- punctuation,
- integration of mathematics into text, and
- proper sentence, paragraph, and article structure.

Today I will cover

- proper sentence, paragraph, and article structure,
- integration of mathematics into text, and
- common mistakes

and if there's time, some important aspects of

- the parts of speech and
- punctuation.

Structure

Stay focused on the point of your writing:

- Make your point clear to the reader.
- Don't obscure it with superfluous information.
- Give information in a logical order.

This guides structure for

- sentences,
- paragraphs,
- sections, and
- whole articles.

It takes time to train yourself to write well, so focus on **editing**.

Sentence Structure

Have clear and concrete actors in your sentences
and have them take clear actions:

BAD *A measurement was made of the cross section by Mustermann et al.*

Don't turn verbs into abstract nouns.

Find the concrete nouns:

cross section, Musterman et al.

PASSIVE *The cross section was measured by Mustermann et al.*

ACTIVE *Musterman et al. measured the cross section.*

Replace *Be* with Strong Verbs

When verbs become abstract nouns, they are replaced with weak verbs:

be, have.

They don't describe action. They link to words that describe action.

The integrated luminosity is determined to be $(107.91 \pm 0.05)\,\mathrm{pb}^{-1}$*, which is in good agreement with the previous result.*

Weak verb: *is*
Strong verb: *determine*, *agree*

We determined the integrated luminosity is $(107.91 \pm 0.05)\,\mathrm{pb}^{-1}$*, which agrees well with the previous result.*

Favor the Active Voice

The active voice

- always directly states an actor, making a stronger statement;
- uses fewer words; and
- fulfils our expectation of [Subject] [Verb] [Object]

PASSIVE *Theoretically, several narrow Λ^* resonances with hidden charm were predicted several years before the LHCb data.*

ACTIVE *Theorists predicted narrow Λ^* resonances with hidden charm years before LHCb published its observations.*

Place Subjects and Verbs Close Together

We expect: [Subject] [Verb] [Object]

After learning the subject, we look for the verb.

Make it easy to find.

The recent observation of candidates for pentaquark states by the LHCb Collaboration has generated an enormous renewed interest in these multiquark states with almost weekly publications in the arXiv and the scientific literature.

The LHCb collaboration has recently observed candidates for pentaquark states, generating an enormous renewed interest in these multiquark states with almost weekly publications in the arXiv and the scientific literature.

Don't be wordy!

Remove unnecessary words:

- Replace long phrases with equivalent words (or shorter phrases).
- Remove repetition.
- Remove excess detail.
- Remove unnecessary definite articles.
- Remove meta-discourse.
- Remove unnecessary qualifiers.
- Replace negations with negative verbs.

Shorten Long Phrases

Let's revisit the last example:

The LHCb collaboration has recently observed candidates for pentaquark states, generating an enormous renewed interest in these multiquark states, with almost weekly publications in the arXiv and the scientific literature.

What are the unnecessarily long phrases?

- *has recently observed* $\rightarrow$ *recently observed*
- *candidates for pentaquark states* $\rightarrow$ *pentaquark candidates*
- *generating an enormous renewed interest* $\rightarrow$ *[greatly] renewing interest*
- *almost weekly* $\rightarrow$ *weekly*
- *the scientific literature* $\rightarrow$ *journals*
- *in the arXiv and in journals* $\rightarrow$ [nothing]

The LHCb collaboration recently observed two pentaquark candidates, renewing interest in such multiquark states and prompting weekly publication of new theories.

Some phrases we can shorten:

make a measurement	$\rightarrow$	*measure*
conduct an investigation of	$\rightarrow$	*investigate*
is responsible for	$\rightarrow$	*causes*
is a factor in	$\rightarrow$	*contributes to*
come to the conclusion	$\rightarrow$	*conclude*
for the following reasons	$\rightarrow$	*because*
most of the	$\rightarrow$	*most*
fail to pass	$\rightarrow$	*fail*
data sample	$\rightarrow$	*data*

Don't Repeat Yourself

Repition is sometimes obvious:

The integrated luminosity is $108.49 \pm 0.02 \pm 0.75$ *pb*$^{-1}$*, where the first uncertainty is statistical and the second is systematic. The center-of-mass energy is* $2126.55 \pm 0.03 \pm 0.84$ *MeV, where the first uncertainy is statistical and the second is systematic.*

More often it is less obvious:

WRONG *The data are selected using the selection criteria described in [4].*

RIGHT *The data are selected using the criteria described in [4].*

WRONG *The prompt photon candidates are selected from the isolated clusters in the ECL that are not associated with any of the charged tracks reconstructed by the SVD and the CDC.*

RIGHT *The prompt photon candidates are selected from the clusters in the ECL that are not associated with any of the charged tracks reconstructed by the SVD and the CDC.*

Remove Excess Detail

This is very similar to repitition,
but usually involves words of slightly different meaning.

BAD *We predict and expect negligibly small CP asymmetry.*

predict / expect

negligible / small

The distinction of meanings is superfluous:

GOOD *We predict negligible CP asymmetry.*

Remove *The*

You can often remove *the* without any change of meaning:

BAD *The prompt photon candidates are selected from the clusters in the ECL that are not associated with any of the charged tracks reconstructed by the SVD and the CDC.*

GOOD *Prompt photon candidates are selected from clusters in the ECL that are not associated with any charged tracks reconstructed by the SVD and CDC.*

Remove Meta-Discourse

Meta-discourse are direct statements about the logic of your paper:

> *to summarize, in conclusion, more importantly,*
> *note that, to understand, let us consider*

You can usually remove these phrases without affecting meaning and **improve** the flow of the writing.

Particularly bad meta-discourse describes the structure of the paper:

in this letter, in this chapter, in the previous section

Cut out such phrases:

In this letter, we present our updated calculations on . . .

→ *We present our updated calculations on . . .*

→ *We update our calculations on . . .*

Here, we show . . .

→ *We show . . .*

Remove Unnecessary Qualifiers

Qualifying statements hedge (weaken) your statements:

indicate, suggest, may, might, could, seem, sometimes, perhaps.

BAD *The Mount Wilson sample established that the mean activity level seems to scale with the Rossby number.*

Can you *establish* that something *seems* . . . ?

GOOD *The Mount Wilson sample established that the mean activity level scales with the Rossby number.*

Replace Negations with Negative Verbs

English usually has a negative form for a word.
Prefer it to the negated word:

If the jet does not pass the quality requirements, the event is vetoed.

If the jet fails the quality requirements, the event is vetoed.

Make Your Sentences Readable

Some further ways to make your sentences more readable:

- Use simple language.
- Avoid jargon.
- Establish and reuse your terms.

Use Simple Language

Prefer short, old English words over long, pretentious Latin ones:

retain	$\rightarrow$	*keep*
utilize	$\rightarrow$	*use*
terminate	$\rightarrow$	*end*
ascertain	$\rightarrow$	*find*
faciliate	$\rightarrow$	*help*
transmit	$\rightarrow$	*send*
initiate	$\rightarrow$	*start*
alteration	$\rightarrow$	*change*
investigation	$\rightarrow$	*work*
subsequent	$\rightarrow$	*next*
spatial	$\rightarrow$	*in space*
termporal	$\rightarrow$	*in time*

Studies determined the mass of the electron to great precision, . . .

$\rightarrow$ *We know the electron mass precisely, . . .*

Avoid (Unnecessary) Jargon

Jargon can be useful when its replaces longer phrases
you would otherwise need to repeat.

BUT:

- Always define jargon.
- Don't use jargon when a simpler non-jargon phrase suffice.

Establish and Reuse Your Terms

Establish your terms:

- If you use a word or phrase in a sense that is special to your work, **define it**.

  This can be explicit,

  > *We remove the constant pedestal from our data. We refer to the data after this step as the corrected data.*

  or implicit,

  > *We analyze the corrected data—the raw data with the constant pedestal removed.*

And then consistently use them:

- After introducing a new term, use it when it's appropriate!

Be consisent with terms.

This also applies to terms you don't need to establish:

- If you refer to *uncertainty*, don't start discussing *error*.
- If you *constrain* something, don't start *limiting* the next thing.
- If you build a *detector*, don't install it as a *sensor*.
- If your figure shows a mass *spectrum*, don't discuss the shape of the mass *distribution*.
- If your text discusses the *points* in a plot, don't label them *dots* in your caption.

Be consistent.

English values consistency, not variety.

Use prepositions to avoid repitition. Don't use your thesaurus.

Paragraph Structure

Now that we know how to structure our sentences logically, let's move up one level:

Structure your paragraphs logically:

- Make sure each paragraph has a clear point.
- Present that point in a logical order.
- Structure your sentences to ease paragraph reading.

Make Your Point Clear

Have a clear **point**. Not points.

$\Longrightarrow$ Limit the lengths of your paragraphs:

Don't overwhelm your reader with too much information in a single dense block of text.

Split your text into paragraphs wherever you logically can!

A paragraph longer than **200 words** should be broken up.

I found this paragraph in a paper on the arXiv:

> In this context, long-lived radioactive impurities in the materials of the set-up induced by the exposure to cosmic rays at sea level (during fabrication, transport and storage) may be even more important than residual contamination from primordial nuclides and become very problematic, depending on the target. For instance, the poor knowledge of cosmic ray activation in detector materials is highlighted in [6] as one of the three main uncertain nuclear physics aspects of relevance in the direct detection approach pursued to solve the dark matter problem. In principle, cosmogenic activation can be kept under control by minimizing exposure at surface and storing materials underground, avoiding flights and even using shields against the hadronic component of cosmic rays during surface detector building or operation. But since these requirements usually complicate the preparation of experiments (for example, while crystal growth and detectors mounting steps) it would be desirable to have reliable tools to quantify the real danger of exposing the different materials to cosmic rays. Direct measurements, by screening of exposed materials in very low background conditions as those achieved in underground laboratories, and calculations of production rates and yields, following different approaches, have been made for several materials in the context of dark matter, double beta decay and neutrino experiments [7]. Many different studies are available for germanium [8–16] and interesting results have been derived in the last years also for other detector media like NaI [17, 18], tellurium and TeO2 [19–21], xenon [22, 23] or neodymium [24, 25] as well as for materials commonly used in the set-ups like copper [14, 22, 23, 26, 27], lead [28], stainless steel [23, 26], titanium [23] and teflon [23].
>
> **261 Words**

You can read it on your own later.

For now, pay attention to how intimidating it is as a block.

Some of that bloat is from bad writing we've already learned to fix:

- Unnecessary metaphrases.
- Superfluous information.
- Excessive use of the passive voice.
- Inconsistent terms.
- Wordiness.
- Unneccessary qualifiers.

> Long-lived radioactive impurities in construction materials formed by exposure to cosmic rays at sea level during fabrication, transport, and storage may be more problematic than residual contamination from primordial nuclides. For instance, poor knowledge of cosmogenic activation in detector materials is one of the three main uncertainties in the direct detection of dark matter highlighted in [6]. We cam limit cosmogenic activation by reducing the time components spend at sea level, shielding them against hadronic cosmic rays when there, storing them underground when possible, and avoiding transportating them by air. But since doing so complicates experiment preparation, it is useful to reliably quantify the effects cosmic-ray exposure on different materials. Direct measurements, by screening exposed materials in the very low background conditions achieved in underground laboratories, and calculations of production rates and yields, following different approaches, have been made for several materials in the context of dark matter, double beta decay, and neutrino experiments [7]. Many studies were performed for detector media: germanium [8–16], NaI [17, 18], tellurium, and TeO2 [19–21], xenon [22, 23], and neodymium [24, 25]; and for commonly used construction materials: copper [14, 22, 23, 26, 27], lead [28], stainless steel [23, 26], titanium [23], and teflon [23].
>
> **185 words**

But it's still intimidating as a block.

Adding paragraph breaks (at logical break points)
makes it less intimidating:

> Long-lived radioactive impurities in construction materials formed by exposure to cosmic rays at sea level during fabrication, transport, and storage may be more problematic than residual contamination from primordial nuclides. For instance, poor knowledge of cosmogenic activation in detector materials is one of the three main uncertainties in the direct detection of dark matter highlighted in [6].
>
> We cam limit cosmogenic activation by reducing the time components spend at sea level, shielding them against hadronic cosmic rays when there, storing them underground when possible, and avoiding transportating them by air. But since doing so complicates experiment preparation, it is useful to reliably quantify the effects cosmic-ray exposure on different materials.
>
> Direct measurements, by screening exposed materials in the very low background conditions achieved in underground laboratories, and calculations of production rates and yields, following different approaches, have been made for several materials in the context of dark matter, double beta decay, and neutrino experiments [7]. Many studies were performed for detector media: germanium [8–16], NaI [17, 18], tellurium, and TeO2 [19–21], xenon [22, 23], and neodymium [24, 25]; and for commonly used construction materials: copper [14, 22, 23, 26, 27], lead [28], stainless steel [23, 26], titanium [23], and teflon [23].
>
> **58 Words, 54 words, and 173 words**

This greatly aids your reader in understanding your writing.

Present Information Logically

Structure your sentences and paragraphs to proceed

from old information

to new information.

Structure your paragraphs to

- introduce an issue,
- develop it, and
- conclude it.

Introduce An Issue

The first sentence (or sentences) introduce the issue of the paragraph.

It should flow logically from the previous paragraph's subject or object:

. . . poor knowledge of cosmogenic activation of detector materials is one of the main uncertainties in dark-matter detection.

We can limit cosmogenic activation by reducing the time components spend at sea level, shielding them against hadronic cosmic rays, storing them underground when possible, and avoiding air transportation. . . .

What is the issue?
We can limit cosmogenic activation.

What was the previous object?
Uncertainties in the direct detection of dark matter

What is the issue?
We can limit cosmogenic activation

What was the previous object?
Uncertainties in the direct detection of dark matter

We can reduce this uncertainty by limiting cosmogenic activation: reducing the time components spend above ground, shielding them against hadronic cosmic rays, storing them underground whenever possible, and avoiding air transportation. . . .

How to structure a paragraph

- Have a clear topic sentence (or sentences).
- Clearly conclude that topic.
- Connect from the topic sentence(s) to the conclusion
  by going from old information to new.
- Let the topic sentence logically flow from the previous conclusion if possible.

You may conclude a paragraph by prompting the next one's issue.

But do not steal the next paragraph's issue.

Sentence Rhythm

If you vary the length of your sentences,
you hold the interest of your reader better.

- Long sentences contain 30 words or more.

  Text consisting of only long sentences is difficult to understand.

  Physicists have no problem writing long sentences.

- Medium-length sentences contain 15 to 25 words.

  Text consisting of only medium-length sentences is monotonous.

- Short sentences contain 10 words or fewer.

  Text consisting of only short sentences is choppy.

Overall structure

- Introduction
- Meat
- Conclusion

Introduction

Your introduction, should contain no meat and no conclusions:

- State clearly what problems or questions your article addresses.
- Don't give too much detail:
  - Avoid formulas.
  - Avoid numbers.
  - Avoid defining variables.
  - Avoid introducing hardware and software.
- Don't give any results.

Your introduction should not turn away your reader.

Conclusion

- State (or restate) your main result.
- Emphasize its importance to the field.
- If appropriate, give an outlook to the future.

- **Don't** introduce new data.
- **Don't** introduce new concepts.
- **Don't** draw conclusions not fully justified by what you have presented.

Meat

Describe your work in a logical order:

If you reference forward, your structure is wrong.

In each section (and subsection), clearly divide

- **Motivation**

  Let your reader know why they should read the section.

- **Overview**

  Explain general concepts.

- **Details**

  Give the nitty gritty details: long equations, plots, tables, ...

These structures nest.

Abstracts

Finally, **only after you have written your work**, write your abstract:

An abstract should be readable in about 30 seconds.

It should be no more than one paragraph.

It should state

- the main topic,
- what you have done, and
- the main result.

It should **not** contain

- intermediate steps,
- intermediate results,
- other people's results, or
- any discussion.

Avoid

- introducing abbreviations,
- defining mathematical symbols, and
- giving numbers.

It's best to steal sentences from your paper for the abstract.

Remember the abstract is **completely** separate from the paper:

- Anything you define in the abstract must be redefined in the paper: abbreviations, mathematical symbols, etc.
- You cannot reference the paper in the abstract.
- You cannot reference the abstract in the paper.

Keep your title simple

Keep in mind how people browse for papers:

1. **They read the title.**
2. They read the abstract.
3. They start reading the paper.

Make the title inviting: short and simple
with just enough detail to say what the paper is about.

Figures & Tables

Support your text with figures and tables.

Don't just string together figures and tables.

Your figures and tables should have a clear point.

Only give the information you need to make your point.

And organize that information to make your point.

Examples:

- Don't display a 2D histogram,
  if you don't care about the correlation of the two variables.
- Don't stack histograms,
  if you want to comment on the shapes of the individual histograms.
- If you want the reader to compare columns in a table,
  put them next to each other.

  If the values themselves are unimportant,
  only show the comparison: a ratio, a difference, etc.

Figures & Tables Are Never Self Explanatory

You must discuss all figures and tables.

Even if a table just lists the complete data (or results), state this.

Figures must not be forgotten parentheticals:

WRONG *Twenty percent of the events come from background processes (fig. 3).*

RIGHT *Fig. 3 shows the mass distributions of events divided according to their sources: background (in green) and signal (in red). Twenty percent of the events come from background processes and are flatly distributed.*

If a figure is not worth discussing, it's not worth including.

Captions

A caption may consist of

- a word or two,
- an incomplete sentence,
- a complete sentence, or
- several sentences.

You may follow an incomplete sentence with complete ones,
but only the opening sentence may be incomplete.

- No punctuation is needed after a single incomplete sentence.
- But if your caption is more than one sentence, all sentences must be punctuated, including the incomplete opening one.

Captions follow all the normal rules of capitalization in sentences.

Your captions must all be consistent with each other:

- **All** captions start with an incomplete sentence.

  Or **No** captions start with an incomplete sentence.

- If you use incomplete sentences,

  all incomplete sentences end in punctuation

  or **no** incomplete sentences end in punctuation.

- **All** opening sentences use the definite article:

  The cross section as a function of energy.

  Or **No** opening sentences use the definite article:

  Cross section as a function of energy.

- All captions should follow the same rules for locators & identifiers.

Locators

Locators are phrases such as

top, bottom, left, right, left to right, clockwise from top left

that identify elements within a single figure.

The Chicago Manual of Style recommends they be set in italic font, but check the convention of the journal you submit to.

Identifiers are a subclass of locators that describe **identifying symbols**:

> Reconstructed mass of the D meson in data (*red points*) and simulation (*blue points*).

Identify ALL symbols.

Fully describe all symbols, lines, shaded regions, etc.

Do this in

- the caption,
- a legend,
- the figure (with labels), or
- the text,

but do not repeat yourself.

Put the identifier in only one of the first three.

You may repeat identifiers in the text—but this should be limited.

Captions must be simple and purely descriptive.

Do not discuss your figures or tables in your captions.

Do not confuse description—

listing what is shown, locators, and identifiers

—with discussion—

statements about shapes, meanings, conclusions, etc.

Captions should be as short and simple as possible, but must

- indicate the specific nature of the data and
- differentiate the table or graphic from all others.

Do not repeat captions.

Caption Grammar

Use noun phrases and prefer **participles** over relative clauses:

WRONG *Number of events that pass the level-one selection criteria.*

RIGHT *Number of events passing the level-one selection criteria.*

Don't give background information or implications of the data:

WRONG *Mass distribution of reconstructed J/ψ in data collected with the phase-I detector before the upgrade to the phase-II detector.*

RIGHT *Mass distribution of reconstructed J/ψ in data collected with the phase-I detector.*

Mathematics in Text

Mathematical expressions are grammatical objects too!

You must incorporate them into your text with proper grammar.

It is especially important to use symbols consistently and logically.

How to read mathematical expressions

A mathematical expression is treated as either

- a noun phrase or
- a symbolic translation of a sentence:

  $a \geq b$ is "a is greater than or equal to b."

Expressions must be incorporated into text properly.

WRONG *The energy must be $E < 50$ MeV.*

- *energy = equation*
- *energy must be E is less than 50 MeV.*

You don't need an expression at all:

RIGHT *The energy must be less than 50 MeV.*

But if you insist on one:

RIGHT *The energy must fulfill $E < 50\,\mathrm{MeV}$.*

Defining variables

You should not simultaneously define a variable and use it:

WRONG *The energy must be $E < 50\,\text{MeV}$.*

BAD *The energy must fulfill $E < 50\,\text{MeV}$.*

GOOD *The energy, E, must be less than $50\,\text{MeV}$.*

WRONG *The current world average is $\phi_2 = (87.7 \pm 3.5)^\circ$.*

RIGHT *The current world average is $(87.7 \pm 3.5)^\circ$.*

Use Math Expressions Appropriately!

Mathematical symbols are not magical!

Don't use symbols as a shorthand for text
when the result is awkward or grammatically incorrect:

WRONG *the vectors* $\vec{v}_1, \ldots, \vec{v}_n \neq 0$

RIGHT *the nonzero vectors* $\vec{v}_1, \ldots, \vec{v}_n$

You may make mathematical statements *without math expressions*!

In fact, you should prefer this for simple statements!

Use Variables Appropriately!

Don't define a variable that is only used once.

WRONG *The photon energy, E_γ, must be less than* 50 MeV*.*

RIGHT *The photon energy must be less than* 50 MeV*.*

Don't define axes if they are never used.

Likewise don't define an axis *direction* if it is never used:

WRONG *The distance of closest approach must be less than* 2 cm *in the z direction; the z axis is antiparallel to the positron beam direction.*

BETTER *The distance of closest approach must be less than* 2 cm *in the z direction; the z axis is parallel to the positron beam direction.*

RIGHT *The distance of closest approach must be less than* 2 cm *in the direction of the positron beam.*

Use Sensible Variables!

Define your variables!

This may seem obvious, but you will find variables frequently undefined.

For example, the variable σ doesn't signify anything,
if you haven't stated an underlying distribution
or otherwise defined it.

WRONG *We take a window around the nominal mass of ± 2 MeV, corresponding to $\pm 3\sigma$.*

What is σ?

BETTER *We take a 4-MeV window centered around the nominal mass, corresponding to $\pm 3\sigma$, where σ is our mass resolution.*

Do we need sigma?

We take a 4-MeV window centered around the nominal mass, which corresponds to three times the mass resolution in each direction.

Don't use one variable for multiple quantities:

> *We take a 4-MeV window centered around the nominal J/ψ mass, corresponding to $\pm 3\sigma$, where σ is our resolution in the J/ψ invariant mass. . . . We take a 25-MeV window centered around the nominal π^0 mass, corresponding to $\pm 4\sigma$.*

What is σ?

You could define it to always stand for the relevant resolution.

Though it would be better to use text each time, instead of a symbol.

Don't use multiple variables for one quantity:

A common mistake is to introduce E_{beam} in the CM frame and $\sqrt{s}$, though $E_{\text{beam}} = \sqrt{s}/2$.

Do not repeat variable definitions!

Once you introduce the definition of a variable—

the energy, E, ...

—do not repeat it.

In future occurrances, refer to either the energy or E,
but not to both (the energy, E).

Be consistent with your notation!

If you write the mass of particle A as m_{A},

don't write the mass of particle B as $M(\mathrm{B})$.

Don't use overly complicated variable names!

Don't abuse super- and subscripts.

Prefer a unique letter to a super- or subscript.

Don't use unreadable scripts!

This is my personal style choice—but I think a wise one.

You irritate your reader if you use variables that are difficult to identify, pronounce, or write:

$$\mathfrak{ISOATGLVYP} \quad \rightarrow \quad \mathit{ISOATGLVYP}$$

Roman Font in Expressions

Labels are super- and subscripts that are not indices or variables:

E_{CM}, $Y^{(\mathrm{BG})}$, L_{dep}, ν_{sig}, m_{PDG}

They are set in Roman font.

Standard functions are also set in Roman font:

$\sin$, $\cos$, $\exp$, $\log$, $\arg$, err, var, ...

LaTeX will often have built in commands to save you the trouble.

Use them.

Place Expressions Appropriately!

Set an expression on a display line when

- you want to highlight its importance.

  If you spend two years measuring a number, **set it on its own line!**

- you want to number it for future reference.

- it does not easily fit in the text.

  Reviews of Modern Physics's style guide requires expressions over 25 characters be set on their own lines.

  Never let an expression break over a line!

- it is illegible when set inline.

- it creates the need for extra vertical spacing.

Compare:

This gives the corresponding result for $\mathcal{B}(\Upsilon(1S) \to J/\psi + \text{anything})$ ($\mathcal{B}(\Upsilon(1S) \to \psi(2S) + \text{anything})$) of $(5.25 \pm 0.13(\text{stat.}) \pm 0.25(\text{syst.})) \times 10^{-4}$ ($(1.23 \pm 0.17(\text{stat.}) \pm 0.11(\text{syst.})) \times 10^{-4}$) in which the precision is substantially improved from the previous result, $(6.5 \pm 0.7) \times 10^{-4}$ ($(2.7 \pm 0.9) \times 10^{-4}$).

And

This gives the corresponding results

$$\begin{aligned} \mathcal{B}(\Upsilon(1S) \to J/\psi + \text{anything}) &= (5.25 \pm 0.13\,(\text{stat.}) \pm 0.25\,(\text{syst.})) \times 10^{-4}, \\ \mathcal{B}(\Upsilon(1S) \to \psi(2S) + \text{anything}) &= (1.23 \pm 0.17\,(\text{stat.}) \pm 0.11\,(\text{syst.})) \times 10^{-4}, \end{aligned}$$

in which the precision is substantially improved from the previous results, $(6.5 \pm 0.7) \times 10^{-4}$ and $(2.7 \pm 0.9) \times 10^{-4}$, respectively.

The following are mistakes I frequently encounter in papers.

Respectively

Use *respectively* only when there is the possibility of confusion.

$$\mathcal{B} \propto m_{\mathrm{B}} m_\ell^2 \left(1 - \frac{m_\ell^2}{m_{\mathrm{B}}^2}\right)^2,$$

where m_{B} and m_ℓ are the masses of the B meson and charged lepton, respectively.

I know m_{B} is the mass of the B;
I know m_ℓ is the mass of the charged lepton;
so *respectively* is unnecessary.

Likewise:

$$m_X^2 = E_X^2 - p_X^2,$$

where m_X, E_X, and p_X are X's mass, energy, and momentum, respectively.

Respectively is unnecessary because the variables are well chosen.

Do not optimize English

> *The probability to misidentify a pion as an electron (muon) is* 0.25% *(*1.4%*).*

What is the point of this formatting?

It doesn't save the reader time:
the reader must read the sentence twice!

It may save space, but at the price of clarity.

> *The probability to misidentify a pion as an electron is* 0.25%*; as a muon,* 1.4%*.*

Space saving may benefit the writer.
But clarity benefits the reader!

Don't be a selfish writer.

Statistics

In phase II of the experiment, we will collect more statistics.

→ *In phase II of the experiment, we will collect more data.*

To definitively measure it, we need a higher-statistics run.

→ *To definitively measure it, we need more data.*

We could observe it with a high-statistics data set.

→ *We could observe it with more data.*

Seeing a trend here?

"Statistics" = the plural of "statistic,"
a single value obtained from the study of a larger quantity of *data*

When you mean more data, write "more data" /

Don't abuse abbreviations

Just because you have introduced an abbreviation,
doesn't mean you can no longer use what it stands for:

> *This new particle could be the long-sought dark matter (DM). We have a constraint on the mass of such a particle from ref. [3]: $m_{DM} < \ldots$. Experiments searching for DM have yet to find such a particle.*

"DM" is useful for the subscript, so we introduce it.

But it is not useful in the last sentence:

BETTER *Experiments searching for dark matter have yet to find such a particle.*

Quantities as Adjectives

A number and unit used as an adjective should hyphenated:

a 10-T magnet

a 5-cm-diameter beam pipe

Within $\pm X$

M is within 10 MeV of m_ϕ means

$$\left|M - m_\phi\right| < 10\,\text{MeV}.$$

What does M is within ± 10 MeV of m_ϕ mean?

$$\left|M - m_\phi\right| < \pm 10\,\text{MeV}.$$

The second sign choice is meaningless:

$$\left|M - m_\phi\right| < -10\,\text{MeV}.$$

“Denote”

Variables do not “denote” or “stand for” quantities.

They **are** quantities.

WRONG *. . . where m denotes the particle’s mass.*

RIGHT *. . . where m is the particle’s mass.*

Think carefully about your logic

In July 2014, they reported the world's first observation of the Higgs boson by the ATLAS and CMS collaborations.

Is this the same as "the world's first observation"?

In July 2014, the ATLAS and CMS collaborations reported the world's first observation of the Higgs boson.

Find the correct noun

AKA: cut out the jargon:

WRONG *We fit a Gaussian to the data.*

RIGHT *We git a Gaussian function to the data.*

Similar $\neq$ Identical

If you mean *identical*,
write identical (or same).

If you write *similar*,
you should also point out how the objects (or situations) differ:

WRONG *This analysis is similar to the previous one.*

RIGHT *This analysis is identical to the previous one.*

RIGHT *This analysis is similar to the previous one, but we have replaced the background description with . . .*

That / Which

That always introduces a restrictive clause and is **not** preceeded by a comma:

The star that is nearest, . . .

Which usually introduces a nonrestrictive clause and, as such, is preceeded by a comma:

The star, which is nearest, . . .

It may also introduce a restrictive clause:

The star which is nearest . . .

But you should prefer to reserve *that* for restrictive clauses except where a preposition is necessary:

WRONG *The planet on that we live . . .*

RIGHT *The planet on which we live . . .*

Choose your verbs correctly

WRONG *The resolution is dominantly determined by the beam-energy resolution.*

You determine the resolution.

BETTER *The resolution is dominantly dependent on the beam-energy resolution.*

dependent on, influenced by

Do not promote common nouns to proper nouns

particle, experiment, theory, universe, electron, hydrogen

These are all common nouns.

Do not capitalize them.

Hyphenation!

Hyphenate phrasal adjectives

WRONG *high energy physics*

RIGHT *high-energy physics*

Do not hyphenate nouns when unnecessary:

WRONG *The b-quark is heavier than the c-quark.*

RIGHT *The b quark is heavier than the c quark.*

And do not hyphenate phrasal verbs:

WRONG *We read-out the data.*

RIGHT *We read out the data.*

remove unnecessary words

in order to	→	*to*
for the following reasons	→	*because*
during the course of	→	*during*
during the process of	→	*during*
in the absence of	→	*without*
located in	→	*in*
located at	→	*at*
in the vicinity of	→	*near*
in close proximity to	→	*near*
in no case	→	*never*
on no occasion	→	*never*
at the present time	→	*now*
at this point in time	→	*now*

Be Consistent!

Be consistent concerning

- style choices;
- mathematical notation;
- caption styles;
- vocabulary;
- tenses;
- EVERYTHING!

Even consistently breaking a good rule is better than occasionally breaking it!

And most importantly . . .

read your work (at least once) before asking others to read it!

The Parts of Speech

There are eight parts of speech:

- nouns,
- pronouns,
- adjectives,
- verbs,
- adverbs,
- prepositions,
- conjunctions, and
- interjections.

Interjections are exclamations expressing feeling.
They have no place in scientific writing, so we will not discuss them.

Nouns

Nouns are divided into two classes by how they are enumerated:

- **Count nouns** have singular and plural forms and express enumerable things:

  particles, data points, articles.

  They take *fewer* for comparison,

  fewer stars,

  and *number* for a statement of quantity,

  a number of detectors.

- **Mass nouns** denote uncountable things, either because they are abstract,

  precision,

  or because they refer to indeterminate aggregations,

  mass, charge, momentum.

  They take *less* for comparison,

  less mass,

  and *amount* for a statement of quantity,

  an amount of charge.

Some nouns are either mass nouns or count nouns, depending on usage:

- the *mass*, *charge*, and *momentum* of a particle are all mass nouns;
- the *masses*, *charges*, and *momenta* of particles are all count nouns.

Choose comparison (and quantity) words accordingly:

Particle A has less momentum than particle B.

In an event with fewer particles, we sum over fewer momenta.

Genitive Case

The **genitive case** expresses ownership, possession, or relationship (among numerous other related uses).

It is inflected with *'s* or expressed with *of*.

The choice between the two is mostly style;
but "of" is preferable in a double genitive:

BAD *the resonance's width's mass dependence.*

BETTER *the mass dependence of the resonance's width;*

Attributive nouns

An **attributive noun** is a noun used as an adjective:

resonance parameters.

An attributive noun is often preferable to a genitive:

BAD *The mass dependence of the resonance's width.*

GOOD *The mass dependence of the resonance width.*

Avoid strings of attributive nouns,

BAD *The resonance width mass dependence*

Concrete & Abstract Nouns

We also classify nouns by what they refer to

- **Concrete nouns** refer to "tangible" objects:

  detector, particle, galaxy, substrate,
  term (in an equation), distribution

- **Abstract nouns** refer to intangible ideas or qualities:

  understanding, interpretation, prediction,
  running, suppression

Let concrete nouns be subjects.

Avoid making actions the subjects of sentences.

Make the actors the subject.

(We will cover this in detail later.)

Actions become the subject when you over use abstract nouns

Change abstract nouns back into verbs. Some examples:

abstract noun	→	verb
understanding	→	*understand*
observation	→	*observe*
interpretation	→	*interpret*
assumption	→	*assume*
prediction	→	*predict*
development	→	*develop*
running	→	*run*
suppression	→	*suppress*

Find a concrete noun to become the subject.

Pronouns

Pronouns are words that substitute for nouns or other pronouns.

A pronoun typically has an **antecedent**:
an earlier noun, pronoun, phrase, or clause to which it refers.

The antecedent must be unambiguous:

BAD *When a photon hits the detector, it produces a signal.*

Does *it* refer to the photon or to the detector?

BAD *The readout system of the detector, which overheats, . . .*

Does *which* refer to the readout system or the detector?

Pronouns without antecedents are common in spoken English
but should be avoided in scientific writing:

WRONG *It allows to . . .*

STILL BAD *It allows us to . . .*

Pronoun Number

A pronoun's number must agree with its antecedent:

a singular antecedent requires a singular pronoun;

a plural antecedent requires a plural pronoun.

This simple rule is often not obvious to apply.

Some common tricky situations:

- A collective noun takes a singular pronoun if the members are treated as a unit:

  The defense committee presented its decision.

  But it takes a plural pronoun if the members act individually:

  The defense committee took their seats.

- A singular noun modified by two or more adjectives to denote different varieties takes a plural pronoun:

  Hot and cold soldering differ in their strengths.

- Two or more singular nouns joined by *and* take a plural pronoun:

  The electron and proton interact in proportion to their charges.

- However, two antecedents joined by *and*, but refering to only one thing, take a singular pronoun:

  The world's most precise camera and the collaboritive work of 3,000 people, it . . .

- An antecedent modified by *each*, *every*, or *no* takes a singular pronoun:

  Each fiber has its own photosensor.

  The pronoun is singular even if two such antecedents are linked by *and*:

  every detector and magnet requires its own cryogenic system.

- Two or more singular antecedents joined by *or*, *nor*, *either . . . or*, or *neither . . . nor* take a singular pronoun:

  Neither the neutron nor the photon deposited its energy in the detector.

- When two or more antecedents of differing numbers are joined by *or* or *nor*, the pronoun agrees with the nearest antecedent:

  Neither the neutron nor the photons deposited their energy in the detector.

  When possible, word the sentence so that the plural antecedent comes last.

- Be careful with the phrase *one of X*:
  If the pronoun limits the class of *X*, then it has the same number as *X*:

  one of the few physicists who pay attention to their writing.

  If the pronoun refers to *one*, it is singular.

  one of the few physicists who pay attention to their writing, she . . .

Adjectives: Position

An adjective usually precedes the noun it modifies.

An adjective modifying an object possessed by another noun comes between the possessive and the object:

the detector's rapid response = the rapid response of the detector.

If placed before the possessive, it modifies the possessor, not the object:

the rapid detector's response = the response of the rapid detector.

Notice the difference between the possessive noun and attributive noun:

the rapid detector response = the detector's rapid response

the rapid detector response ≠ the rapid detector's response

Adjective Degrees

- The **comparative** degree expresses a relationship between **two** objects.
- The **superlative** degree expresses the quality of an object with respect to **at least two other** objects.

A superlative followed by a noun is usually preceded by *the*:

the fastest particle, the most precise measurement

For a restrictive subclause with a superlative

prefer *to + [infinitive]*

The best experiment to detect . . .

over a relative pronoun:

The best experiment that can detect . . .

The Lower Degree

The comparative and superlative forms express **higher** degrees.

To express a **lower** degree, use *less* or *least* with the positive degree:

The detector is less expensive than the previous one.

Manpower is the least expensive budget item.

But, prefer the higher degree over the lower degree—find the right adjective:

less rapid	→	*slower*	*least rapid*	→	*slowest*
less heavy	→	*lighter*	*least heavy*	→	*lightest*
less difficult	→	*easier*	*least difficult*	→	*easiest*

Equality

Express equality with the positive degree and *as . . . as* or *so . . . as*:

The new detector is as precise as the previous one.

Number & Comparison

Pay attention to the necessary number of objects for a comparison!

- You must have **at least two** objects for a comparison:

  The higher-energy region . . .

  The particle with the highest energy . . .

  are just as meaningless as "$E >$",
  if no second region or group of particles has been stated (or implied).

- If **only two objects** are compared, use the **comparative**:

  The π^0 is detected via its decay to two photons.

  WRONG *The photon with the highest energy . . .*

  RIGHT *The photon with the higher energy . . .*

- If **more than two objects** are compared, use the **superlative**:

  We measure in three energy regions.

  WRONG *In the higher-energy region . . .*

  RIGHT *In the highest-energy region . . .*

Uncomparable Adjectives

An adjective that describes an absolute state (a binary condition) **cannot** form a comparative or superlative:

complete, round, flat, unique, undetectable, visible, invisible, missing, perfect

They also **cannot** be modified by intensifiers like *very, mostly*.

But they **can** be modified by mitigators like *almost, nearly*.

These could be used to form comparisons, but prefer proper comparisons:

more nearly undetectable $\rightarrow$ *harder to detect*

Adjective Series

Adjectives that independently modifying a noun are **coordinated**.

They are separated by commas or *and*:

a bright, talented physicist

An Adjective that modifies the following adjective and noun together, does not take a comma or *and*:

a large background rate

As a general rule,

if *and* can be used, then a comma (or *and*) is necessary;

if *and* is inappropriate, a comma should not be used.

WRONG *a large and background rate*

Phrasal Adjectives

When used before a noun, a phrasal adjective must be hyphenated:

highest-energy electron

low-noise read-out electronics.

Compound nouns in phrasal adjectives are not exceptions to the rule:

cross-section-measurement uncertainty.

When not hyphenated, the adjectives no longer form a phrase,
and each modifies the noun separately.

Contrast:

a small-angle detector detects small angles;

a small angle detector detects angles and is small.

If two (or more) phrasal adjective share a common ending,
the ending may be omitted for the first adjective (or adjectives):

low- and high-mass regions.

But when two (or more) phrasal adjectives share a common beginning,
it must be repeated:

low-mass and low-energy regions.

Amounts and durations are written in the singular as phrasal adjectives:

the experiment ran for two years $\rightarrow$ *the experiment had a two-year run.*

However, fractions take a plural:

The particle has a three-halves spin.

Avoid long or complicated phrasal adjectives:

BAD *The higher-than-expected CP-asymmetry-difference measurement surprised the community.*

OR *The measurement of the CP-asymmetry difference was higher than expected and surprised the community.*

There are exceptions to the hyphenation requirements:

- A two-word phrasal adjective beginning with an *-ly* adverb is not hyphenated:

  a highly volatile compound.

- If a phrasal adjective begins with a proper noun, it need not be hyphenated:

  Monte Carlo data.

  But avoid mixing:

  BAD *Monte Carlo-data-generation campaign*

  BAD *Monte Carlo data-generation campaign*

  BETTER *Monte-Carlo-data-generation campaign*

- Phrasal adjectives are never hyphenated when used in the predicate position:

  a well-trained boosted decision tree is well trained.

Adjectives as Nouns = Jargon

In conversation, we shorten adjective-noun phrases to just the adjective:

background rate $\rightarrow$ *background*

systematic uncertainties $\rightarrow$ *systematics*.

This is a jargon and is inappropriate in scientific writing.

Check if a word is an adjective

WRONG *We inerted the tank by filling it with carbon dioxide.*

Inert is a verb only.

WRONG *$B \to \pi\pi\pi$ proceeds through intermediary resonances.*

Intermediary is a noun. *intermediate* is the adjective.

Articles

Yes—**articles** are adjectives. Tricky ones.

They are limiting adjectives that precede nouns and noun phrases and indicate

definiteness (*the*)

or

indefiniteness (*a, an*).

The Definite Article

The **definite article** points to a definite object:

- something so familiar it does not need a description:

  the universe

- something about to be described

  the detection efficiency, which we calculate from . . . ;

- something important:

  the result of our calculation . . . .

  Compare that with

  a result of our calculation . . . .

It may be used with both singular and plural objects.

In a series, it may be used before each noun but is not necessary:

We calculate the energy and [the] angle.

But if the series involves one plural noun, the article is **not** repeated:

the statistical and systematic uncertainties.

The Indefinite Article

The **indefinite article** points to a nonspecific object
not distinguished from other members of a class.

The object of an indefinite article may be singular,

a polymer,

or uncountable,

an energy.

Occasionally, an indefinite article may be used in a definite sense,

He proposed a new theory of dark matter: . . .

And is usually followed by a description.

The choice of *a* or *an* depends on

the **sound** of the word the article precedes,

not the letter!

Use *a* before consonant **sounds** (regardless of spelling):

a heuristic algorithm, a European funding agency

Use *an* before vowel **sounds** (regardless of spelling):

an honorary professorship, an X shape

Be careful with acronyms:

an MC sample,

an SM particle,

Not

a MC sample,

a SM particle,

Be mindful of the change in meaning when an article is omitted:

The additional parameter has little impact.

$\rightarrow$ the parameter has negligible impact

The additional parameter has a little impact.

$\rightarrow$ the parameter has a small but non-negligible impact

Verbs: Favor the Active Voice

In most cases, the active voice is preferable to the passive voice:

- The passive usually adds unnecessary words.

  PASSIVE *The leading-order contribution was calculated by Smith.* (8 words)

  ACTIVE *Smith calculated the leading-order contribution.* (6 words)

- When those extra words are missing, the sentence usually lacks an actor.

  PASSIVE *The leading-order contribution was calculated.* (6 words)

- The passive voice subverts English's logical word order,
  making it harder for readers to process information.

Put another way, the active voice

- saves words,
- directly states who does what, and
- meets the reader's expectation of the normal sentence order:

  [subject] [verb] [object].

PASSIVE *Improvements in X's precision for measuring Y are required to disprove Z's model.* (13 words)

ACTIVE *X must measure Y more precisely to disprove Z's model.* (10 words)

The active voice also

- prefers concrete nouns over abstract ones and
- brings subject and verb closer together.

Two proper uses of the passive voice

- Keeping the same subject throughout a paragraph:

  Supernovae deposit enormous amounts of energy into their surroundings. They play a key role in the heating of their host galaxies and in the enrichment of the interstellar medium with heavy elements. They have been well studied at radio, X-ray, and optical wavelengths.

- Switching subjects:

  The fundamental constant regulating all microscopic electronic phenomena is the fine-structure constant. Experimentally, it is one of the most precisely determined numbers in physics. Theoretically, the reason nature selects its particular value remains a mystery and has provoked much interesting speculation. These speculations may be divided into three general types.

The Subjunctive Mood

Some relevant uses of the subjunctive:

1. Counterfactual conditions:

   - When the condition is contrary to fact, use the past subjunctive.

     RIGHT *If the electron were massless,*
     it would move at the speed of light.

     WRONG *If the electron is massless,*
     it moves at the speed of light.

   - When the condition concerns an unknown, use the indicative.

     RIGHT *If the newly discovered particle has spin 0,*
     it can decay to two photons.

     WRONG *If the newly discovered particle had spin 0,*
     it could decay to two photons.

2. Statements of necessity use the present subjunctive:

   RIGHT *We require the photon have energy greater than* 1 GeV*.*

   WRONG *We require the photon has energy greater than* 1 GeV*.*

3. Suppositions use the past subjunctive:

   If we were to directly measure dark matter, we could . . .

   where the dependent clause is not an automatic outcome.

   Compare with

   If we directly measure dark matter, we will . . .

Verb Tense: Narrating Action

The present tense can be used to narrate action, for example, in describing a general step-by-step process.

The future tense can also be used.

Once you choose a tense for this purpose, use it consistently throughout the written work.

The past tense can be used if you are narrating action that was actually undertaken.

Number & Person

A verb **must** agree with its subject in number and person.

When a verb has two or more subjects connected by *and*, it is plural:

Polystyrene and DNA are both polymers.

When a verb has two or more singular subjects connected by *or* or *nor*, it is singular:

Neither a kaon nor a pion is detected.

Plural Predicates

With a singular subject, the verb is singular regardless of a plural predicate:

WRONG *The source of the background are radioactive materials.*

RIGHT *The source of the background is radioactive materials.*

And pay attention to what the subject is:

WRONG *The source of the backgrounds are radioactive materials.*

If the singular verb (though grammatically correct) sounds awkward, restructure the sentence:

Radioactive materials are the source of the background.

Connectives

Phrasal connectives do not turn singulars into a plurals:

along with, as well as, in addition to, together with

WRONG *A pion as well as two kaons are detected.*

RIGHT *A pion as well as two kaons is detected.*

If the singular verb (though grammatically correct) sounds awkward, replace the connective with a conjunction:

A pion and two kaons are detected.

The Infinitive

When used in the active voice with other principal verbs, the *to* is generally dropped:

BAD *The agency helped to fund the project*

GOOD *The agency helped fund the project.*

But in the passive voice, the *to* is retained:

RIGHT *The agency could not be convinced to fund the project.*

WRONG *The agency could not be convinced fund the project.*

Dangling infinitives & participles

An infinitive **dangles** when it has no expressed (or well implied) subject:

WRONG *To fit the data, it is binned.*

RIGHT *To fit the data, we bin it.*

A participle **dangles** when it has no subjet or logical relationship to its subject:

WRONG *though frequently used, statisticians are skeptical of p values*

RIGHT *Statisticians are skeptical of p values, though they are used frequently.*

WRONG *After fitting to the data, the is 10.*

WRONG *After data fitting, the yield is 10.* [no subject]

RIGHT *After to the data, we find the yield is 10.*

RIGHT *After being fit to the data, the yield is 10.*

RIGHT *The yield, determined from a fit to the data, is 10.*

Participle Overuse

Avoid using a participle adjective if a regular adjective exists:

BAD *the optimized criteria*

GOOD *the optimal criteria*

Adverbs: Position

Place adverbs as near as possible to the words you intend to modify.

Adverb placement can change the meaning of the sentence:

(1) *The power outage caused all data to be lost.*

(2) *The power outage nearly caused all data to be lost.*

(3) *The power outage caused nearly all data to be lost.*

(4) *The power outage caused all data to be nearly lost.*

(1) is straight forward.

(2) states we came close to a situation wherein we'd lose all data.
(It leaves ambiguous whether any data was lost, but implies none was.)

(3) states we lost data—and nearly all of it.

(4) states we were in a situation where all data become vulnerable to being lost.
(And it implies no data was lost.)

Place adverbs modifying intransitive verbs—those without objects—immediately after the verb:

The amplifier attaches to the detector. + directly

The amplifier attaches directly to the detector.

The detector responds to the highly charged particles. + strongly

The detector responds strongly to the highly charged particles.

Some exceptional adverbs directly precede the verbs they modify

always, never, generally, rarely, seldom, . . .

WRONG *Neutrinos interact with the detector. + rarely*

RIGHT *Neutrinos rarely interact with the detector.*

WRONG *Neutrinos interact rarely with the detector.*

Consult a dictionary or usage guide if you are unsure about the proper position.

Linking verbs

Adverbs rarely modify **linking verbs**—
verbs that link a subject to a predicate.

be-verbs, appear, seem, look, (smell, taste, hear, feel)

Contrast

the particle appears heavily

→ an adverb modifying an action

the particle appears heavy

→ an adjective linked to by the action

Be sure you achieved your intended meaning.

Adverb Degree

All the rules of adjectives degrees apply to adverbs.

This includes the prohibition on comparatives and superlatives for adverbs expressing unqualifiable states:

uniquely, universally, never, always . . .

These can be qualified with other adverbs:

nearly uniquely, almost universally, nearly never, almost always . . .

But prefer an unqualified adverb:

nearly never $\rightarrow$ *rarely*

And never qualify away the meaning:

sometimes always $\rightarrow$ *sometimes*

rarely never $\rightarrow$ *often, usually*

Avoid Preposition Overuse

Replace them with adverbs or genitives:

BAD *We measured with precision.*

GOOD *We measured precisely.*

Replace them with the active voice:

BAD *The data was analyzed by Max Musterman.*

GOOD *Max Musterman analyzed the data.*

Replace the verb:

BAD *our efforts towards optimization were a success*

GOOD *our efforts to optimize succeeded*

Cutting them out (without loss of meaning):

BAD *The most important component in the fit*

BETTER *The most important component*

All solutions result in shorter, simpler sentences.

Shorten Lengthy Prepositional Phrases

in order to	→	*to*
for the following reasons	→	*because*
during the course of	→	*during*
during the process of	→	*during*
in the absence of	→	*without*
located in	→	*in*
located at	→	*at*
in the vicinity of	→	*near*
in close proximity to	→	*near*
in no case	→	*never*
on no occasion	→	*never*
at the present time	→	*now*
at this point in time	→	*now*

Prepositional Phrases

A **prepositional phrase** should be as close as possible its object.

Contrast:

> *the sensor with the highest efficiency is mounted . . .*
>
> *the sensor is mounted with the highest efficiency . . .*

If a prepositional phrase modifies a list of items, it follows the last one:

> *we select the pion, kaon, and photon with the highest energies . . .*

Avoid repeating words that end phrasal verbs and begin prepositional phrases:

BAD *we read in in every case*

GOOD *in every case, we read in*

Like

Like conveys similarity. It is both a preposition and a conjunction.

- As a preposition, *like* is followed by a noun or pronoun:

  We group them with the others that are like them.

- As a conjunction, *like* links *nouns* or *pronouns*:

  RIGHT *The fit to M_A is like the fit to M_B.*

  It does **not** link *verbs*:

  WRONG *We fit to M_A like we fit to M_B.*

  The correct conjunction is *as*:

  RIGHT *We fit to M_A as we fit to M_B.*

Like is often misused in place of *as if*:

WRONG *We simulate it like it was evenly distributed in phase space.*

RIGHT *We simulate it as if it was evenly distributed in phase space.*

Only

Only modifies the word or phrase that **immediately follows it**.

Compare:

We only fit the signal component to this data.

→ The only thing we do is this fit.

We fit only the signal component to this data.

→ The only component we fit to this data is the signal one.

We fit the signal component only to this data.

→ This data is the only one we fit the signal component to.

If nothing follows it, *only* modifies the preceding word or phrase:

We fit the signal component to this datato this data only.

Correlative conjunctions

Correlative conjunctions are pairs of words that join successive clauses:

either . . . or . . . , neither . . . nor . . . , both . . . and . . . ,

They frame structurally identical sentence parts.

WRONG *We want both to measure its mass and charge.*

What are the two conjoined statements here?

We want to measure its mass.

We want charge.

RIGHT *We want to measure both its mass and its charge.*

or forgo the correlative conjunction:

BETTER *We want to measure its mass and charge.*

Starting sentences with conjunctions

The prohibition against starting sentences with conjunctions has no historical or grammatical foundation.

Good writing will contain many sentences starting with conjunctions.

But avoid starting sentences with unnecessary conjunctions.

Avoid overuse of

however, moreover, nonetheless, on the contrary, on the other hand

Avoid poor use of contrasting conjunctions

If you start a sentence with an contrasting conjunction

but,

be sure you really want contrast.

Note that *while*, when not used to express simultaneity,
is a contrasting conjunction—not an additive one.

A good rule of thumb:
If you can substitute *and* for it, *but* is almost certainly wrong.

Only use *but* when the statement truly contrasts with preceding statements.

WRONG *We collected the first half of the data with detector A; while we collected the second half with detector B.*

RIGHT *We collected the first half of the data with detector A; and we collected the second half with detector B.*

Mind your but's

Two (or more) *but*'s in sequence are meaningless:

WRONG *We collected the first third of the data with detector A;*
but we collected the second third with detector B;
but we collected the last third with detector C.

Punctuation

Punctuation should be governed by its function:

to promote easy reading
by clarifying relationships
within and between sentences.

We will cover

- period
- comma
- semicolon
- colon
- hyphen & dashes

and

- parantheses
- virgule
- highlighting
- referencing
- lists

Comma Use

Commas separate items in a list of more than two:

This, that, and the other

The comma between the last two items is the **serial comma**.

Using it is a style choice. But be consistent.

It will always resolve ambiguity and never cause it:

AMBIGUOUS *We installed the sensors, new connectors and controllers for the gas system and the cooling system.*

NOT AMB. *We installed the sensors, new connectors and controllers for the gas system, and the cooling system.*

NOT AMB. *We installed the sensors, new connectors, and controllers for the gas system and the cooling system.*

Remember: *as well as* is not the same as *and*.

WRONG *We detect pions, kaons, muons, electrons, as well as protons.*

RIGHT *We detect pions, kaons, muons, electrons, and protons.*

RIGHT *We detect pions, kaons, muons, and electrons, as well as protons.*

Commas separate coordinated clauses:

> *Charged particles are detected as tracks, and neutral particles are detected in the calorimeter.*

The comma may be omitted if the two clauses are *closely* linked.

> *The particle deposits energy in the detector and the detector then produces a signal.*

The comma **must** be omitted if the two clauses share a subject:

WRONG *Data is read out, and saved to disk.*

RIGHT *Data is read out and saved to disk.*

Commas set apart introductory matter:

Moreover, we . . . ;

In the future, we . . .

Commas set apart appositive or parenthetical words or phrases:

WRONG *Dark matter however is invisible.*

RIGHT *Dark matter , however, is invisible.*

Commas separate participle phrases from main clauses:

Having fit the yield from the mass distribution, we . . .

Restrictive/Nonrestrictive Clauses and Nouns

A restrictive clause is essential to the meaning of the sentence and **cannot** be set off by commas:

The signal that we see is . . .

A nonrestrictive clause is not essential to the meaning of the sentence and **must** be set off by commas:

The signal, which is big, . . .

The same rules apply to appositive nouns:

Restrictive:

There are several people named Steven Weinberg.
The physicist Steven Weinberg won a Nobel prize.

Nonrestrictive:

We saw a presentation given be a physicist.
The physicist, Steven Weinberg, won a Nobel prize.

Because, Since

A dependent clause that explains the cause of the main clause **cannot** be preceded by a comma:

WRONG *We see a signal, because . . .*

RIGHT *We see a signal because . . .*

Introducing a list of examples

For example must precede a **nonrestrictive** list of examples and requires commas:

> *We detect, for example, pions, kaons, and protons.*

nonrestrictive = not exclusive

A **restrictive** (**exhaustive**) list cannot be preceded by *for example*, since the list does not contain examples:

> *We detect pions, kaons, and protons.*

Naming

To introduce a label or variable you **may or may not** set it off by commas:

The deposited energy, E_{dep}, is measured . . .

The deposited energy E_{dep} is measured . . .

This is a style choice. But be consistent.

Note: journals don't give you the choice. Check their style guides.

Semicolon

Semicolons provide larger breaks than commas,
but do not separate as strongly as periods.

Some common uses of the semicolon applicable to academic writing:

- Semicolons unite closely linked sentences without conjunctions:

  Stars form galaxies; galaxies form galaxy clusters.

- Semicolons separate items in a series when the items contain commas.
- Semicolons give a weightier pause than a comma:

  Neutrinos interact only very weakly; therefore, we do not detect them.

Colon

A colon **cannot** separate a verb or preposition from its object(s):

WRONG *It detects: pions, kaons, and protons.*

WRONG *We report the first measurement of: the branching fraction, the asymmetry, . . .*

A colon **cannot** follow *that*:

WRONG *We learn that: the cross section decreases . . .*

A colon **cannot** replace a comma after an introductory phrase:

WRONG *It detects particles, for example: pions, kaons, and protons.*

Hyphens & dashes

Be aware of the three basic hyphens and dashes:

- the hyphen, “-” (in LaTeX: -);
- the en dash, “–” (in LaTeX: --);
- and the em dash “—” (in LateX: ---).

En Dash

En dashes indicate ranges.

An en dash **cannot** be used with text defining a range:

WRONG *from 10–15*

RIGHT *from 10 to 15*

RIGHT *10–15*

WRONG *between 10–15*

RIGHT *between 10 and 15*

Em dashes

Em dashes set off parenthetical phrases with greater emphasis than commas.

> *We fit the signal component—a convolution of a Breit-Wigner distribution and a normal distribution—to the data.*

(The second em dash is necessary if the sentence continues.)

Avoid multiple em-dash clauses in a single sentence:

> *We fit the signal component—a convolution of a Breit-Wigner distribution and a normal distribution—to the data—a mass distribution.*

Never nest them:

> *We fit the signal component—a convolution of a Breit-Wigner distribution—a typical description of a particle's resonance shape—and a normal distribution—to the data—a mass distribution.*

Parentheses

Parentheses set **auxiliary information** off from the main clause.

Parentheses may not be used to add second readings to a sentence!

WRONG *The electron (positron) is negatively (positively) charged.*

RIGHT *The electron is negatively charged; the positron, postively charged.*

WRONG *We require* $\mathcal{P}_{K\pi} > 0.6 (< 0.4)$ *for* $K^{\pm}$ *(*$\pi^{\pm}$*) candidates.*

RIGHT *For* $K^{\pm}$ *candidates, we require* $\mathcal{P}_{K\pi} > 0.6$*; for* $\pi^{\pm}$ *candidates,* $\mathcal{P}_{K\pi} < 0.4$.

WRONG *We obtain 2774 ± 66 (206 ± 25), 770 ± 35 (76 ± 15) and 803 ± 70 (17.5 ± 28.4) signal events for the $B^0 \to \chi_{c1}\pi^- K^+$ ($B^0 \to \chi_{c2}\pi^- K^+$), $B^+ \to \chi_{c1}\pi^- K^0_S$ ($B^+ \to \chi_{c2}\pi^- K^0_S$) and $B^+ \to \chi_{c1}\pi^0 K^+$ ($B^+ \to \chi_{c2}\pi^0 K^+$) decay mode having a significance of 67σ (8.7σ), 34σ (4.6σ) and 16σ (0.4σ), respectively.*

RIGHT *Table I lists the yields and significances of these fits.*

Table I

	yield [events]	significance [σ]
$B^0 \to \chi_{c1}\pi^- K^+$	2774 ± 66	67
$B^0 \to \chi_{c2}\pi^- K^+$	206 ± 25	8.7
$B^+ \to \chi_{c1}\pi^- K^0_S$	770 ± 35	34
$B^+ \to \chi_{c2}\pi^- K^0_S$	76 ± 15	4.6
$B^+ \to \chi_{c1}\pi^0 K^+$	803 ± 70	16
$B^+ \to \chi_{c2}\pi^0 K^+$	17.5 ± 28.4	0.4

Virgule

The **virgule** (/), or "slash," has no place in proper scientific writing.

It may stand for *or*, often in *and/or*.

In nearly all cases only one of the conjunctions applies.

WRONG *We measure the particle's momentum and/or position.*

RIGHT *We measure the particle's momentum and position.*

RIGHT *We measure the particle's momentum or position.*

If *or* or *and* apply exclusively, the virgule doesn't properly state this:

Sometimes we measure momentum and position; other times, only one.

It may also stand for *and*:

WRONG *With the aid of the telescope, we see stars/galaxies.*

This is not proper for scientific writing and should be replaced:

RIGHT *With the aid of the telescope, we see stars and galaxies.*

Meta-Punctuation: Highlighting

You may highlight new terms through a change of font:

This is best done with *italics* since **bold** is too attention grabbing.

Do not use quotation marks, which connote doubt or sarcasm.

Highlight sparingly! It is generally unnecessary.

Do not use it to justify jargon.

Do not combine *so-called* (and the like) with highlighting;
it is redundant.

Meta-punctuation: References & Footnotes

In general, place references & footnotes at the ends of sentences or clauses:

WRONG *A previous experiment [3] measured a branching ratio of* 6.2×10^{-6}.

RIGHT *A previous experiment measured a branching ratio of* 6.2×10^{-6} *[3].*

WRONG *For both* D^0 *and* D^+*, we employ the technique*[1] *described below.*

RIGHT *For both* D^0 *and* D^+*, we employ the technique described below.*[1]

If the footnote is specifically about the technique,
you may be tempted to place it directly after *technique*.

But do you want your reader to look at the footnote in the middle of reading the sentence?

It is wise to put a nonbreaking space (“ ”) between a reference and its preceding text.

If multiple references appear in a single sentence
and you really need to highlight that they apply to separate topics,
you may place them immediately following the phrases they support.

> *Previous experiments measured the branching ratios for decay to $J/\psi K_S^0$ [3] and ϕK_S^0 [4].*

However, you usually don't need to cite them separately.
The following is perfectly fine:

> *Previous experiments measured the branching ratios for decay to $J/\psi K_S^0$ and ϕK_S^0 [3, 4].*

And is preferable with a long list:

> *Previous experiments measured the branching ratios for decay to $J/\psi K_S^0$ [3], ϕK_S^0 [4], $J/\psi K^+$ [5,6], and ϕK^+ [7].*

> *Previous experiments measured the branching ratios for decay to $J/\psi K_S^0$, ϕK_S^0, $J/\psi K^+$, and ϕK^+ [3–7].*

Meta-punctuation: Lists

All items in a list must be constructed of parallel elements.

Don't number items unless the numbering serves a purpose:

- to indicate order or
- to facilitate reference to individual items.

If the items in a list comprise complete sentences (or multiple sentences), punctuate each item properly.

If a list and its introductory sentence comprise **a single sentence**, consistently puncutate it. *That is,*

- *all items but the last one should end in commas or semicolons,*
- *a conjunction should follow the second-to-last item, and*
- *the last item should end in a period.*