Physical English

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For Ginette, Michael, Sean, Peter, Micheon, Danielle, Rachel, Mia, James, Dylan, Christopher, and Liam

Contents

Preface

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Language

1.1 Talking, Reading, and Writing

Children learn to talk without going to school. Kids exposed to two languages learn both. Children learn by hearing people talk. Talking is a natural human activity.

Reading is not a natural human activity. It requires effort. It is a learned skill. Children go to school to learn to read.

Writing is even less natural than reading. Writing is unnatural. It requires more effort than reading. A writer must organize a network of thoughts into a **linear sequence** of words.

The best writing is transparent—the reader sees the message undistracted by the act of reading. **Good prose is easy to read.** Good writing makes reading easy.

Writers must explain things that they know but that their readers may not know. The reader is probably not one of your classmates or a member of your research group. So don't be afraid of explaining things that you learned years ago. Professors love to read explanations of things they already understand. It gives them confidence to continue reading.

Writing about physics is especially hard. Physicists must explain a web of definitions and concepts and describe a set of assumptions, theories, and experiments. Expressing this information as a sequence of words is hard. Doing it so that the reader's attention stays focused on the ideas and is not distracted by the writing is even harder.

In *Politics and the English Language*, George Orwell gave us six rules for writing English:

1. Never use a metaphor, simile, or other figure of speech which you are used to seeing in print.
2. Never use a long word where a short one will do.

3. If it is possible to cut a word out, always cut it out.
4. Never use the passive where you can use the active.
5. Never use a foreign phrase, a scientific word, or a jargon word if you can think of an everyday English equivalent.
6. Break any of these rules sooner than say anything outright barbarous.

In countries where English is the main language, the short words of everyday English are learned by children. The neurons of their brains represent the meanings of these common words and connect them to the meanings of other common words.

Polysyllabic words are learned later in life and so are supported by a much thinner fabric of neurons. Thus our brains react more strongly to a short common English word than to a polysyllabic word or to a word rarely used in English.

Examples of rule 1: Avoid the phrases *send a message* and *going forward* when they aren't needed.

Examples of rule 2: In his 1961 inaugural addrss, JFK said, "Ask not what your country can do for you – ask what you can do for your country." The only word with more than one syllable is *country*.

From Winston Churchill's 4 June 1940 speech to the House of Commons, "We shall go on to the end. We shall fight in France, we shall fight on the seas and oceans, we shall fight with growing confidence and growing strength in the air, we shall defend our island, whatever the cost may be. We shall fight on the beaches, we shall fight on the landing grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender..." Note that most of the words are of one syllable and of Anglo-Saxon origin, which also illustrates rule 5.

Use *use* instead of *utilize*. Use *many* instead of *multiple*. Use "now" instead of "at this time" or "at this point in time."

Examples of rule 3: Use *then* instead of *at that point in time*; use *now* instead of *at this point in time*. Nouns and verbs are the important words. Avoid useless adjectives and adverbs. As Gore Vidal said, "Might Updike not have allowed one blind noun to slip free of its seeing-eye adjective?"

Examples of rule 5: Use *formulas* instead of *formulae*; use *novas* instead of *novae*; use *supernovas* instead of *supernovae*. Follow Dirac and use *average* value instead of *expectation* value.

Examples of rule 6: Use the passive voice when you don't know or must conceal the identity of the subject as in "JFK was assassinated in November of 1963."

Sometimes the passive voice makes things clearer. Steven Pinker gives the story of Oedipus as an example: "A man arrives from Corinth ... It emerges that this messenger was formerly a shepherd on Mount Cithaeron, and that he was given a baby, which the childless Polybus then adopted. The baby, he says, was given to him by another shepherd from the Laius household, who had been told to get rid of the child." The passive voice keeps the focus on the baby.

If you follow Orwell's rules, your writing will be easier to read. It will be *tight* and free of extra words and phrases that distract and tire the reader.

Modern research in psychology, as described by Daniel Kahneman in *Thinking, Fast and Slow* (Kahneman, 2011) supports Orwell's rules 2–5. Kahneman writes, "If you care about being thought credible and intelligent, do not use complex language where simpler language will do." See, for example, Daniel Oppenheimer's article, "Consequences of Erudite Vernacular Utilized Irrespective of Necessity: Problems with Using Long Words Needlessly" (Oppenheimer, 2006).

Orwell's rules also make writing easier. When you are about to write a sentence, you may think of several choices of words and phrases. Instead of agonizing over the merits of each choice, you can use Orwell's rules to winnow the list of alternatives, often down to a unique choice.

Writing must be clear. The disastrous charge of the Light Brigade at Balaclava in the Crimean War was made because of a carelessly worded order to "charge for the guns," when what was intended was to haul some British guns to a safer place (Graves and Hodge, 1979, p. 95).

Boeing called their deadly software the "Maneuvering Characteristics Augmentation System (MCAS)." If they had called it "Anti-Stall Auto-Dive," airlines and pilots would have studied it more closely, and 346 people would still be alive.

William Strunk summarized Orwell's advice as "Omit needless words" (Strunk and White, 1999).

1.2 More Advice

Try to put more complicated phrases at the end of your sentences where the reader can pause to understand them without worrying about the rest of the sentence. Thus, Thomas Jefferson did not write "the pursuit of happiness, liberty, and life." He wrote "life, liberty, and the pursuit of happiness."

1.3 Questions and Answers

A preceptive reader might ask:

Question. What is important in general about the presentation of the physics content in a research paper?

Answer. You should make the physics clear so that the reader can easily understand it. It takes only a few words to define most terms and concepts. Definitions reassure the reader, and one undefined term that happens to be new to a reader can make the reader put your paper down and mark you as someone to avoid.

Question. What is the most important information of a research paper that should be included in the introduction and abstract apart from motivating the topic?

Answer. You should describe your main results briefly in the abstract and more clearly in the introduction. You should sketch the background in which your new physics makes sense briefly in the abstract and more completely in the introduction.

Question. What is a good introduction and abstract of a research paper in physics?

Answer. Brief is good, but clear is better. Ideally the background should convince the reader that your work is a step forward for physics.

Question. Won't I still get credit for my work even if my paper is poorly written and hard to read?

Answer. Your parents and members of your research group will give you the credit your deserve, but no one else will know what you did unless they talk to your colleagues. The top professors at Harvard write well. That is not a coincidence. They got their top jobs because they did great work and described their work in papers that people could read and understand.

1.4 A higher level

There is a higher level of writing, but I don't have anything much to tell you about that. You can read articles and books by some of the best writers, such as Richard Feynman, Sidney Coleman, Freeman Dyson, Sheldon Glashow, Roy Glauber, Steven Weinberg, Edward Witten, and Anthony Zee in the field of physics, Linus Pauling in chemistry, and the several authors of the book *Molecular Biology of the Cell*. And it would not hurt to read Tolstoy, Hemingway, Churchill, Tom Wolfe, F. Scott Fitzgerald, Oscar Wilde, James Joyce, ...

Orwell's rules aren't a recipe for great writing, but violating them can spoil a paper.

1.5 Know your audience

When talking with a friend of yours, you have some idea of what he or she knows and wants to learn from you. The exchange of information in both directions is immediate and effective. When face to face with someone new, you quickly see how the person reacts to what you say. You find out what background is needed and how fast to explain the physics.

But when giving a talk to a group of people you have less feedback and when writing a paper, you have none. So you somehow must learn something about your audience before you prepare your talk and before you write your paper.

If you are giving a talk to a small research group of which you are a member, then you have a good idea what they know, and you can focus on explaining your new results in terms of what you know they know.

But if you are giving a talk to a large audience or are writing an article for an international journal, then you must explain much more.

1.6 Explaining the physics

One way of communicating with a large audience of strangers is to explain the physics from scratch using only the concepts that you are sure they are familiar with. You should explain new ideas and results in terms of the concepts they already know. If you follow Orwell's rules, you will be able to explain the new terms and new ideas succinctly and efficiently.

The key task is to explain the new physics in ways that make it easy for your audience to learn it.

1.7 The ideal talk, the ideal paper

A second reason to know your audience is to find out what they want to learn. If you know your audience, you may know that they want to understand something that you understand. If you explain that to them clearly, they will love you.

1.8 Some tips

Vary the lengths of your sentences. A short sentence can have a big impact on the reader, if it follows longer ones. Here's an example from a paper on two colliding clusters of galaxies (Clowe et al., 2006)

The actual existence of dark matter can only be confirmed either by a laboratory detection or, in an astronomical context, by the discovery of a system in which the observed baryons and the inferred dark matter are spatially segregated. An ongoing galaxy-cluster merger is such a system.

Use a speller. But if the word is technical, google it.

Use correct grammar. Mistakes distract readers and annoy listeners. Grammatical errors also can lower the level of trust your audience has in you. You can use Google to answer most questions about grammar.

1.9 What's in it for the reader?

Your article is more likely to be read or published if it seems to offer something that would benefit the reader. Thus papers that announce a better measurement of an important observable or the discovery of a new particle get published immediately. Talks with such content are well attended.

Usually our content is less striking. What to do? We must tell the reader or listener why what we have to say is something that they want to know about. We can, for example, review the present state of confusion about an issue and then say how we can clarify it. Some journals of biology and medicine have a highly stylized (and unfortunate) format in which the first paragraphs say that an answer is unknown and in later paragraphs say what answer the authors have discovered.

1.10 General advice

Choose a title that is succinct, informative, and tempting. People love stories. Your paper should tell a story. Its first paragraph should tell the essence of that story and say why it is worth telling. Write clearly and simply. Avoid surplus adjectives and adverbs. Don't hype. If your argument or experiment has a gap or a shortcoming, say so and say that you hope that future work will fix that problem.

1.11 Further Reading

Harry Guinness urges us to write many drafts of our papers and books in "How to Edit Your Own Writing" (The New York Times 4 April 2020). Steven Pinker tells a brilliant and amusing tale in his book *The Sense of Style*, which he describes in the video `youtube.com/watch?v=xkxUV5p_RIO&t=4009s`. *Clear and Simple as the Truth: Writing Classic Prose* by Francis-Noël Thomas and Mark Turner is a gem.

2
Rules

2.1 Latin and Greek

One of Orwell's six rules is to avoid using "a foreign phrase, a scientific word, or a jargon word if you can think of an everyday English equivalent." But sometimes you may need to use a word that the English language has borrowed from Latin or Greek. Don't confuse the singular and plural forms. When in doubt, google the foreign word.

If one does use English words borrowed from Latin or Greek, it will be helpful to know the most basic rules of these languages. Latin has several declensions but the most common ones are feminine, masculine, and neuter nouns follow these simple rules:

Table 2.1 *Singular and plural forms of some Latin words*

Latin	feminine	masculine	neuter
singluar	nova	nucleus	bacterium
plural	novae	nuclei	bacteria

The corresponding rules for English versions of Greek words are less simply related to gender. Here are some common patterns

Table 2.2 *Singular and plural forms of some Greek words*

singluar	thesis	hypothesis	helix	criterion	phenomenon	lemma
plural	theses	hypotheses	helices	criteria	phenomena	lemmata

Table 2.3 lists more borrowings from Greek listed with the singular form

Table 2.3 *English words derived from Greek*

singular	Greek plural	English plural
colon		colons
criterion	criteria	criterions
demon		demons
lexicon	lexica	lexicons
mitochondrion	mitochondria	mitochondrions
pentagon		pentagons
pentathlon		pentathlons
phenomenon	phenomena	phenomena
tetrahedron	tetrahedra	tetrahedrons
zoon	zoa	zoons
analysis	analyses	analyses
basis	bases	bases
crisis	crises	crises
hypothesis	hypotheses	hypotheses
parenthesis	parentheses	parentheses
synthesis	syntheses	syntheses
thesis	theses	theses
lemma	lemmata	lemmas
schema	schemata	schemas
stigma	stigmata	stigmas
helix		helices/helixes

followed first by the Greek plural when available and then by the English plural when available:

Here are some borrowings from Latin listed with the singular followed first by the Latin plural when available and then by the English plural when available:

Languages evolve. Meanings change. The rates of change are high for Latin and Greek words and for irregular verbs. Thus in modern English the Latin pair *agendum, agenda* has morphed into the singular word *agenda* meaning a list of things to do. The Latin plural *trivia* is often used in English, but its singular form *trivium* is archaic. The Latin pair, one *minutia* and two *minutiae*, is so often misused that you risk being misunderstood if you use these words correctly.

Pronunciations also change. Italians pronounce Latin plurals ending in -*ae* so that they rhyme with *May* and *day*. Yet in modern English these words rhyme either with *me* or *I*. Italians pronounce Latin better than we do. These Latin words whose singular forms end in -*a* have English plurals that

Table 2.4 *English words derived from Latin*

singular	Latin plural	English plural
alga	algae	algae/algas
alumna	alumnae	alumnas
formula	formulae	formulas
larva	larvae	larvae/larvas
minutia	minutiae	minutiae/minutias
nova	novae	novas
persona	personae	personas
vertebra	vertabrae	vertebras
supernova	supernovae	supernovas
alumnus	alumni	alumni
cactus	cacti	cacti/cactuses/cactus
hiatus	hiati	hiatuses
nucleus	nuclei	nuclei/nucleuses
octopus	octopi	octopuses
phallus	phalli	phalluses
prospectus	prospectus	prospectuses
sinus	sinus	sinuses
virus		viruses
addendum	addenda	addendums
aquarium	aquaria	aquariums
bacterium	bacteria	bacteria
curriculum	curricula	curriculums
datum	data	data
desideratum	desiderata	desiderata
gymnasium	gymnasia	gymnasiums
maximum	maxima	maximums
medium	media	media/mediums
memorandum	memoranda	memorandums
minimum	minima	minimums
moratorium	moratoria	moratoriums
referendum	referenda	referendums
spectrum	spectra	spectrums
stratum	strata	strata
trivium	trivia	trivia
genus	genera	
index	indices	indices/indexes
matrix	matrices	matrices/matrixes
vertex	vertices	vertices/vertexes

simply add an *s*, for example, *formula, formulas*. One can avoid confusion by using the unpretentious English plurals *alumnas, formulas, novas, vertebras, supernovas, . . .*

One of the rules of English grammar is that adjectives always are singular; we say "tall trees," not "talls trees." Using the simple English pairs *formula, formulas, supernova, supernovas, . . .* one naturally respects this rule. People who use Latin plurals sometimes use *supernovae* as an adjective, forgetting that they should use *supernova* instead. In the May 2018 issue of APSNEWS, for example, one finds "various CMB calculations of the Hubble constant differ from stellar and supernovae versions by more than 5 percent."

Avoid Latin and Greek whenever you can.

If you must use Latin or Greek words, try to get them right. A common error is to assume that a Latin or Greek word that ends in the letter *a* is singular. That rule holds for some Latin and Greek words but not for others. In papers on physics and math, we often need to use the Latin pairs one *minimum*, two *minima* and one *maximum*, two *maxima*.

The unnecessary use of Latin leads to many problems. The use of the Latin plural *supernovae* of the word supernova is leading in some circles to the use of the word supernova to mean supernovas.

2.2 Irregular verbs

Languages evolve. Usage changes over periods as short as a few years. I like informal speech such as, "Me and him went fishing." Such usage may become standard in 100 years.

But one should avoid rapidly changing usage and outright grammatical mistakes when writing a physics article or talking giving a talk about physics.

The irregular English verbs are slowly changing, so in formal writing and speaking one should either avoid irregular verbs or use them correctly.

2.3 Avoid These Traps

Note that "lets" means "permits," as in, "John lets Jim have ice cream." But "let's" means "let us," as in, "Let's go to the movies."

2.4 False Rules

It's okay to split infinitives. The prohibition never was justified.

It's okay to end a sentence with a preposition. Someone once said "This is a rule up with which I will not put."

Table 2.5: *Irregular English verbs*

Base form	Past tense	Past participle
be	was/were	been
begin	began	begun
break	broke	broken
bring	brought	brought
buy	bought	bought
build	built	built
choose	chose	chosen
come	came	come
cost	cost	cost
cut	cut	cut
do	did	done
draw	drew	drawn
drive	drove	driven
eat	ate	eaten
feel	felt	felt
find	found	found
get	got	got
give	gave	given
go	went	gone
have	had	had
hear	heard	heard
hold	held	held
keep	kept	kept
know	knew	known
leave	left	left
lead	led	led
let	let	let
lay	laid	laid
lie	lay	lain
lose	lost	lost
make	made	made
mean	meant	meant
meet	met	met
pay	paid	paid
put	put	put
run	ran	run
say	said	said
see	saw	seen
sell	sold	sold
send	sent	sent
set	set	set
sit	sat	sat
speak	spoke	spoken
spend	spent	spent
stand	stood	stood
take	took	taken
teach	taught	taught
tell	told	told
think	thought	thought
understand	understood	understood
wear	wore	worn
win	won	won
write	wrote	written

3

LaTeX

3.1 TeX and Latex

Donald Knuth invented TeX when he found that publishers could not suitably format the equations of a book he was writing. Instead of copywriting TeX, he released it free to the public in 1978. In 1985, Leslie Lamport added macros that made TeX easier to use, and described them in his book *Latex* (Lamport, 1994). Latex has become the standard way to write physics and math papers.

Latex runs on Linux, Mac OS, and Windows, and also is available online. The Latex Project `www.latex-project.org/get` is a good place to start.

If you want to run Latex on your own computer so you can use it when you are not connected to the internet, then you should download the free distribution of Latex that is appropriate for your operating system. If you run Linux, then you should download and install the TeX Live distribution `www.tug.org/texlive`. If you run Mac OS, you should download and install the MacTeX distribution `www.tug.org/mactex`. If you run Windows, you have a choice of three distributions—MikTeX `miktex.org`, proTeXt `www.tug.org/protext`, and TeX Live `www.tug.org/texlive`.

Once you have Latex installed, you probably should get a good editing program. Some editors are very good, and most are free. I will list only the free ones that I have heard good things about. TeXstudio `www.texstudio.org` and TeXworks `www.tug.org/texworks` run on all major operating systems. TeXShop `pages.uoregon.edu/koch/texshop` runs only on Mac OS and was the model for TeXworks.

As far as I know, the better online Latex programs are not free or cheap. The best known such program is Overleaf `www.overleaf.com` which costs $10 per month or $15 if you want all the premium features. Frankly, I recommend you download Latex and a good editor and skip Overleaf and other pricey programs.

Installing Latex on a Chromebook involves several steps. You probably should first install Linux `support.google.com/chromebook/answer/9145439?hl=en`. Then you can follow the steps mentioned above for how to install Latex on a Linux system. Alternatively, you could try `github.com/macbuse/Chromebook/blob/master/LaTeX.md`.

3.2 Automatic Numbering

Display equations are important parts of most physics papers. We usually number our equations to make them easy to find. Latex numbers them automatically. For instance,

```
The range $\lambda_{L} = h /m_L c$ of
the corresponding Yukawa potential is
\begin{equation}
\lambda_L > 4.5 \times 10^{-7} \, \text{m}.
\label{range of potential}
\end{equation}
```

formats the equation with its number:

The range $\lambda_L = h/m_L c$ of the corresponding Yukawa potential is

$$\lambda_L > 4.5 \times 10^{-7}\,\text{m}. \tag{7}$$

In the manuscript of a book, the script

```
\begin{equation}
f^{(n)}(z) ={}  \frac{n!}{2\pi i} \,
\oint \, dz' \, \frac{f(z')}
{(z' - z)^{n+1}} .
\label {f(n)}
\end{equation}
```

produces the numbered equation

$$f^{(n)}(z) = \frac{n!}{2\pi i} \oint dz' \, \frac{f(z')}{(z' - z)^{n+1}} \tag{3.1}$$

in which the number of the chapter is followed by the number of the equation. Articles usually don't have chapters, so in the manuscript of an article only the number of the equation appears as in the case (7) of the Yukawa potential. One may avoid numbering an equation by adding an asterisk:

```
\begin{equation*}
f^{(n)}(z) ={}  \frac{n!}{2\pi i} \,
\oint \, dz' \, \frac{f(z')}
{(z' - z)^{n+1}} .
\label {f(n)}
\end{equation*}
```

which makes the display equation

$$f^{(n)}(z) = \frac{n!}{2\pi i} \oint dz' \frac{f(z')}{(z' - z)^{n+1}}$$

without a number.

The advantage of numbering one's equations is that one can refer to them for instance by writing

```
Cauchy's integral formula (\ref{f(n)}) gives us
the \(n\)th derivative \(f^{(n)}(z)\) of
the function \( f(z)\) at the point \(z\).
```

we get

Cauchy's integral formula (3.1) gives us the nth derivative $f^{(n)}(z)$ of the function $f(z)$ at the point z.

3.3 Give Your Readers a Break

Some writers take undue advantage of numbered equations, writing sentences like,

Combining (5), (14), and (39), one gets . . .

forcing readers to search the paper for these equations. Writers who care about their readers write instead,

Combining the definition (5) of the Gamma function with our formulas for the flux (14) and the cross-section (39), we get . . .

So try to describe each equation you refer to, as in

Cauchy's integral formula (3.1) gives

rather than

Eq. (3.1) gives .

Your papers will be easier to read.

4

Examples of mediocre writing and how to fix them

Boeing called its auto-dive software the Maneuvering Characteristics Augmentation System. There's no explanation of the MCAS – nor the steps needed to counter it – in the Max's U.S. and European pilot manuals. Boeing reasoned that crews were already drilled to counter similar behavior by the 737's horizontal stabilizer, running through a checklist to flip two center-console switches. The Federal Aviation Administration reviewed the U.S. company's analysis and agreed.

`https://www.bloomberg.com/news/articles/2019-03-29/boeing-s-stall-prevention-s`

Raw text:

"We want to see established an international order based upon mutual understanding and mutual confidence, and we cannot build such an order unless it conforms to certain principles, which are essential to the establishment of confidence and trust." [Neville Chamberlain]

Graves and Hodge (Graves and Hodge, 1979, p. 103) reduce that repetitious sentence to:

"The international order that we wish to establish must conform to certain principles of mutual understanding and trust."

Raw text:

The goal of this chapter is to develop a sense of the kinds of quantitative data that are being obtained in all fields of biology and the models that must be put forth to greet this data. Like with any useful map, we will argue that any good model has to overlook some of the full complexity and detail of a given biological problem in order to generate an abstraction that is simple enough to be easily grasped by the human mind, as an aid to developing intuition and insight. At the same time, it is critical that useful models make meaningful predictions, so they must include at least some of the realistic details of the biological system. The art of model building lies in striking the proper balance between too little detail and too much. Part of our emphasis on model building centers on the role of having a feeling for the numbers: sizes, shapes, times, and energies associated with biological processes. Here we introduce the style of making numerical estimates that will be used throughout the book.

A first pass at improving this text:

The goal of this chapter is to learn about the kinds of quantitative data that are being measured in biology and the models that can interpret these data. A good model overlooks some of the complexity of the biological system in order to be simple enough to be easily understood. But useful models make predictions, so they must include enough detail to do that. The art of model building lies in striking the proper balance between too little detail and too much. The first step in building a useful model is to learn the sizes, shapes, times, and energies of the biological system. Here we show how to estimate such things.

A second pass at improving this text:

The goal of this chapter is to learn about the kinds of quantitative data that are being measured in biology and the models that can interpret the data. A good model overlooks some of the biological complexity but includes enough detail to make predictions. The first step in making useful models is to learn to estimate the sizes, shapes, times, and energies of representative biological systems.

Raw text:

This small scale study aims to find patterns and disparities of non-linguists' views on English dialectal differences in the United States. The study itself is influenced by social psychologist Wallace Lambert's study on "matched guise" and Nancy Niedzielski and Dennis Preston's studies on folk linguistics. In Wallace Lambert's 1960s matched guise study-a method measuring language attitudes mentioned in Niedzielski and Preston's work- speech samples were produced by the same person but vary in some domain. An example of this variation is a single person speaking with different accents. Within this study, Lambert presented a bilingual speaker who produced speech samples-one language per sample- in both French and English. "Guise" here references characteristics of a given language. Participants were asked to rate the French Guise and English Guise of the speaker. Participants were unaware that the samples were produced by the same speaker. Studies following this format have had a consistent split of ratings between Status and Solidarity.

A first pass at improving this text:

This small-scale study aims to find patterns and disparities in how non-linguists perceive English dialectal differences in the United States. The study is influenced by the work of social psychologist Wallace Lambert on "matched guise" and by the work of Nancy Niedzielski and Dennis Preston on folk linguistics. In Wallace Lambert's c1965 matched-guise work—a method measuring language attitudes cited by Niedzielski and Preston—speech samples were produced by the same person but in different ways. For example, a single person might speak with different accents. In this work, Lambert presented a bilingual speaker who produced speech samples—one language per sample—in French and English. "Guise" here refers to the characteristics of a given language. Participants were asked to rate the French guise and English guise of the speaker. Participants were unaware that the samples were produced by the same speaker. Studies following this format have had a consistent split of ratings between status and solidarity.

Raw text:

This version addresses a mechanistic, realist worldview. That my present situation, which seems to be "this particular universe right now", leads to multiple futures seems to violate the conservation of mass or energy (actually, energy is not conserved in cosmology). It is good to pick people up where they are at, so this version, aimed at engineers rather than linguist philosophers, starts with established science: In the physicists' empirically established, fundamental descriptions, a universe does not exist in some empty three dimensions called "the only space" as if there is therefore no more space for another universe, perhaps on grounds of that our universe is already infinitely large and so there is no space left for another one. Our cosmos produces its own space; space is "in" it not it in space. More generally speaking: If you start with the assumption that our "universe" is something that exists by itself without physics correlating it with other, different universes, then a universe can exist all by itself by assumption, all by itself from its own inside. So, therefore, by assumption, there is nothing that this world could do to stop any other possible alternative world from existing just like this one does, in its own inside, too! And this obviously also applies to all possible initial conditions and all possible gods and their choices when arranging initial conditions or whatever else you can suggest short of stamping on the ground and shouting "The absoluteness of the absolute is that it is just not relative from a next higher meta-level, praise the one and only, you shall have no one beside him!"

A first pass at improving this text:

This version addresses a mechanistic, realist worldview. That my present situation, which seems to be "this particular universe right now," leads to multiple futures seems to violate the conservation of mass or energy (energy is conserved in cosmology). It is good to pick people up where they are, so this version, aimed at engineers rather than linguists and philosophers, starts with established science: In the physicists' empirically established, fundamental descriptions, a universe does not exist in some empty three dimensions called "the only space" as if there is therefore no more space for another universe, perhaps on grounds of that our universe is already infinitely large, and so there is no space left for another one. Our cosmos produces its own space; space is "in" it not it in space. More generally speaking: If you start with the assumption that our "universe" is something that exists by itself without physics correlating it with other, different universes, then a universe can exist all by itself by assumption, all by itself from its own inside. So, therefore, by assumption, there is nothing that this world could do to stop any other possible alternative world from existing just like this one does, in its own inside, too! And this obviously also applies to all possible initial conditions and all possible gods and their choices when arranging initial conditions or whatever else you can suggest short of stamping on the ground and shouting "The absoluteness of the absolute is that it is just not relative from a next higher meta-level, praise the one and only, you shall have no one beside him!"

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In 2004, Ferron et al. [165] carried out molecular dynamics simulations relying on EAM interactions. They saw long jumps as well as rebound (recrossing) jumps in self-diffusion on Cu(111) and claimed that at 500 K, 95% of jumps were correlated; at 100K this decreased to 50%. They continued their simulations using the DYNAMO code and atomic interactions derived from EAM potentials [166]. A number of correlated jumps, including atomic long events as well as ballistic transitions were identified at temperatures ranging from 7% to 55% of the melting temperature of copper, with the likelihood of correlations increasing with increasing temperature. Also observed was a linear increase of the characteristic jump length with temperature. The average distance covered by adatoms increased faster than expected for a random walk between nearest-neighbor sites.

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In this paper we will propose a model of Berezin integral as a literal limit of the Riemann sum that corresponds to surface integral. Thus, the fact that Berezin integral coincides with the derivative is a simple consequence of divergence theorem. The fact that Berezin integral doesn't obey the scaling properties expected of ordinary integrals is attributted to the fact that the Berezin integral is claimed to give the expected value only if the volume enclosed by the sphere is $1/D$, where D is the dimension of spacetime (that is sent to infinity at the end) and, therefore, the rescaled surface no longer gives the expected value of the integral. Finally, the Berezin integral can return scalar value due to the richer structure, referred to geometric algebra, that combines the anticommutting wedge product with the Clifford product. While the “finite” part of the integral has wedge product, as always, the product betrween “finite” and “infinitesimal” part is Clifford, which is what ultimately allows for the outcome to be a scalar.

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Raw text:

Buddhist architecture is defined by the presence of three particular structures; the *stupa* (the cosmic egg), the *vihara* (a monastery), and the *chaitya* (a prayer hall). Images of the Buddha are often times incorporated into the architecture through paintings and reliefs which differentiates it from Hindu caves. The Hindu caves exempted the Buddha for more deity-oriented representations such as Shiva and Ganesh. Unlike Hinduism and Buddhism, there seems to be no cave complexes dedicated entirely to Jainism. Instead, Hindu and Buddhist caves tend to have Jainist elements such as the *Ahimsa*.

To have sacred places carved into mountains is a testament to the mathematical prowess of the ancient Indians that constructed these caves, so much so that the methods the architects used to carve into the face of the cliff sides still baffles historians today. The intensity also speaks to the importance of the earth in the religions of India. These caves and their elements became a house for the supernatural as their careful attention to the way light plays with the inside highlights the importance of certain subjects. The warm tones of the paintings coupled with the round figure which it portrays accentuates the importance of lighting and the shape of the spaces. Although Buddhist architecture slowly lost its individuality as it adopted more Hindu doctrines, the survival of Ajanta speaks to the importance that Buddhism still has in Indian culture, separate of Hinduism.

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What makes a croissant so delectable? Not surprisingly, a croissant owes its wonderful flakiness to the fat which makes it — specifically the fat's stress and strain characteristics, along with its overall structure. Braulio Rodriguez and Alejandro Marangoni of University of Guelph in Ontario, Canada studied exactly this.

They began by analyzing the stress and strain of croissants made with two different kinds of fat, roll-in and all-purpose. With a method that measured the material's response to oscillations, called large amplitude oscillatory shear (LAOS), they plotted the stress by strain. The strain is presumably measured as a percentage of the croissant's final length by the original length, while the stress is the applied pressure to the croissant. In these plots, the all-purpose-fat croissant exhibited a sharp peak in stress at low percentages or strain — suggesting a collapse of the internal structure - whereas the roll-in fat had a subtle peak and overall flat curve - no collapse. Therefore, while roll-in fats do not excel in effects on cardiovascular health, they at least demonstrate better textures for the croissant.

Images of the croissants' structure were made through electron and x-ray scattering. The roll-in croissants had three main substructures. In the first nano-scale, the roll-in fats showed small platelets of the fatty triglyceride molecules and smooth platelet boundaries. In the second larger scale, these platelets created stout cylindrical crystal groups, which then created adhered to each other to create the clusters apparent in the third scale. The all-purpose fats had a similar first nano-scale, though these platelets were larger and had more rigid boundaries. Additionally, the all-purpose fats did not exhibit any complex structure beyond the first scale. Thus, these second and third structures present in roll-in fats could be the supporting factor in the stress-strain plot.

Rodriguez and Marangoni continue to analyze the fat structures of croissants in hope of finding alternative fats for the characteristic texture while avoiding the health risks.

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Special relativity offers incredible benefits to those interested in reaching a distant point in space. The star Betelgeuse is approximated to be 640 light years from earth, and the minimum travel time for anything coming to or from Betelgeuse, from an observer at rest on earth, is 640 years. However, things look quite different from the perspective of the traveler. For a star 640 light years away, using one Rocketdyne F-1 engine (7,700 kN thrust) strapped to some ship about the mass of a car, a system sitting at approximately 10,000 kg passenger included, this journey would take just under 98 days, with an acceleration of 770m/s^2. This is incredible! Has this powerful rocket punched through the universal speed limit? Not by any measure! In fact, the journey has taken quite a long time to oversee from mission control: 640 years and 9 days. Nations have been born and have fallen, two thirds a millennium of human history passed while our explorer sat cozy in its ship for 3 or so months, all to reach a star that is a relatively near neighbor in our galactic neighborhood. Now let's send our explorer to the center of the galaxy, to learn about Sagittarius A* and for the incredible view! Using the midpoint of distance approximations, the center of the galaxy lies about 26,000 light years from earth. With the same acceleration as before, to accelerate at a constant rate until the midpoint of earth and the center is reached before decelerating, the journey takes just over 131 days for our explorer! Back on earth, 26,000 years have passed, more time than four time the length of current recorded human history. This is unfortunate, perhaps if we increase acceleration, say, one thousand-fold, we'll be able to see our friends and family once more. Lucky for our traveler, it only needs to wait four and a half hours to see the core, how exciting! Including time to reach the center, performing a day of experiments, and traveling home. About 52,000 years (and a day) have still passed back home. Humanity as the traveler once knew it is dust. This is the failure of the mechanics of special relativity to provide a reasonable road for galactic, or intergalactic travel to become possible.

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Special relativity offers incredible benefits to those interested in reaching a distant point in space. The star Betelgeuse is approximately 640 light years from earth, and the minimum travel time for anything coming to or from Betelgeuse, in the rest frame of an observer on Earth, is 640 years. However, in the frame of a traveler in a 10,000 kg spaceship propelled by a Rocketdyne F-1 engine with 7,700 kN of thrust and an acceleration of $770 \mathrm{m/s}^2$, this journey would take just under 98 days. This is incredible! Has this powerful rocket punched through the universal speed limit? Not by any measure! In fact, the journey has taken quite a long time to oversee from mission control: 640 years and 9 days. Nations have been born and have fallen, two thirds a millennium of human history has passed while our explorer sat cozily in a spaceship for 3 or so months, all to reach a star that is a relatively near neighbor in our galactic neighborhood. Now let's send our explorer to the center of the galaxy, to learn about Sagittarius A* and for the incredible view! Using the midpoint of distance approximations, the center of the galaxy lies about 26,000 light years from earth. With the same acceleration as before, to accelerate at a constant rate until the midpoint of earth and the center is reached before decelerating, the journey takes just over 131 days for our explorer! Back on earth, 26,000 years have passed, more time than four time the length of current recorded human history. This is unfortunate, perhaps if we increase acceleration, say, one thousand-fold, we'll be able to see our friends and family once more. Lucky for our traveler, it only needs to wait four and a half hours to see the core, how exciting! Including time to reach the center, performing a day of experiments, and traveling home. Yet about 52,000 years (and a day) still would have passed back home. Humanity as the traveler once knew it is dust. This is the failure of the mechanics of special relativity to provide a reasonable road for galactic or intergalactic travel to become possible.

5
Examples of good writing

Cathode Rays
J. J. Thomson
The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science (S. 5. Vol. 44:. No. 269. Oct. 1897)

The experiments discussed in this paper were undertaken in the hope of gaining some information as to the nature of the Cathode Rays. The most diverse opinions are held as to these rays; according to the almost unanimous opinion of German physicists they are due to some process in the aether to which—inasmuch as in a uniform magnetic field their course is circular and not rectilinear—no phenomenon hitherto observed is analogous : another view of these rays is that, so far from being wholly aetherial, they are in fact wholly material, and that they mark the paths of particles of mutter charged with negative electricity. It would seem at first sight that it ought not to be difficult to discriminate between views so different, yet experience shows that this is not the case, as amongst the physicists who have most deeply studied the subject can be found supporters of either theory.

A QUANTUM THEORY OF THE SCATTERING OF X-RAYS BY LIGHT ELEMENTS
Arthur H. Compton
THE PHYSICAL REVIEW (**21**, 483) May 1923

Abstract
A quantum theory of the scattering of X-rays and γ-rays by light elements.
—The hypothesis is suggested that when an X-ray quantum is scattered

it spends all of its energy and momentum upon some particular electron. This electron in turn scatters the ray in some definite direction. The change in momentum of the X-ray quantum due to the change in its direction of propagation results in a recoil of the scattering electron. The energy in the scattered quantum is thus less than the energy in the primary quantum by the kinetic energy of recoil of the scattering electron. ...

J. J. Thomson's classical theory of the scattering of X-rays, though supported by the early experiments of Barkla and others, has been found incapable of explaining many of the more recent experiments. ...

The Quantum Hypothesis of Scattering

According to the classical theory, each X-ray affects every electron in the matter traversed, and the scattering observed is that due to the combined effects of all the electrons. From the point of view of the quantum theory, we may suppose that any particular quantum of X-rays is not scattered by all the electrons in the radiator, but spends all of its energy upon some particular electron. This electron will in turn scatter the ray in some definite direction, at an angle with the incident beam. This bending of the path of the quantum of radiation results in a change in its momentum. As a consequence, the scattering electron will recoil with a momentum equal to the change in momentum of the X-ray. The energy in the scattered ray will be equal to that in the incident ray minus the kinetic energy of the recoil of the scattering electron; and since the scattered ray must be a complete quantum, the frequency will be reduced in the same ratio as is the energy. Thus on the quantum theory we should expect the wave-length of the scattered X-rays to be greater than that of the incident rays.

A Solution of the Solar-Neutrino Problem
John N. Bahcall and H. A. Bethe
PHYSICAL REVIEW LETTERS (**65**, 2233) 29 OCTOBER 1990

Abstract

Comparison of the results from the Kamiokande neutrino-electron scattering experiment with those from the chlorine experiment and with solar models shows that the explanation of the solar-neutrino problem probably requires physics beyond the standard electroweak model with zero neutrino masses. The experimental results, including the shape of the electron-recoil energy spectrum measured by Kamiokande, are in excellent agreement with

a nonadiabatic solution of the Mikheyev-Smirnov-Wolfenstein effect, yielding a neutrino mass difference of $\Delta m^2 = 1 \times 10^{-8} \sin^{-2} \Theta_\nu$ eV^2.

Recently,[1] the Kamiokande II Collaboration has reported on 1040 days of observations of solar neutrinos via neutrino-electron scattering. These results are of fundamental significance since the angular dependence of the scattered electrons shows that the detected neutrinos originate in the Sun and since the observation provides a specific measurement of the scattering rate of the highest-energy ^{8}B solar neutrinos. Moreover, the Kamiokande II results show that the ^{8}B neutrino flux is independent of time, despite strong hints from the chlorine observations of a time dependence.[2]

In this paper we assume the correctness of the following experimental results, a chlorine detection rate[3] of

$$\langle \phi\sigma \rangle_{\text{Cl,expt}} = 2.1 \pm 0.3 \text{ SNU } (1\,\sigma\,\text{error}) \tag{5.1}$$

(where SNU denotes solar-neutrino units) for neutrinos above the 0.81-MeV threshold energy and a neutrino-electron scattering rate of[1]

$$\langle \phi\sigma \rangle_{e-\nu} = [0.46 \pm 0.05(\text{stat}) \pm 0.06(\text{syst})] \langle \phi\sigma \rangle_{\text{stnd}} \tag{5.2}$$

for recoil electrons with energies greater than 7.5 MeV. Here stnd refers to the rate calculated[4] assuming the correctness of the standard solar model and the standard electroweak theory with zero neutrino masses. The chlorine detector is sensitive to lower-energy neutrinos ($E < 2$ MeV) from the *pep* reaction, from ^{7}Be electron capture, and from the decay of ^{13}N, ^{15}0, and ^{17}F, as well as the higher-energy ^{8}B neutrinos. The theoretical expectation for the event rate in the chlorine detector is[4]

$$\langle \phi\sigma \rangle_{\text{Cl,theory}} = 7.9 \pm 2.6 \text{ SNU}, \tag{5.3}$$

where the indicated error refers to the total theoretical uncertainty. The difference between the values given in Eqs. (1) and (3) has constituted for two decades the "solar-neutrino problem." The measurement cited in Eq. (2) points the way to a solution of this long-standing puzzle.

We do not know of any modifications of the astrophysical calculations of the state of the solar interior that could lead to the reconciliation of Eqs. (1)-(3) without requiring new physics for the neutrino.

Inflationary universe: A possible solution to the horizon and flatness problems
Alan H. Guth
Phys. Rev. 23(2), 347 (1981)

The standard model of hot big-bang cosmology relies on the assumption of initial conditions which are very puzzling in two ways which I will explain below. The purpose of this paper is to suggest a modified scenario which avoids both of these puzzles.

By "standard model," I refer to an adiabatically expanding radiation-dominated universe described by a Robertson-Walker metric. Details will be given in Sec. II.

Before explaining the puzzles, I would first like to clarify my notion of "initial conditions." The standard model has a singularity which is conventionally taken to be at time $t = 0$. As $t \to 0$, the temperature $T \to \infty$. Thus, no initial-value problem can be defined at $t = 0$. However, when T is of the order of the Planck mass ($M_P \equiv 1/\sqrt{g} = 1.22 \times 10^{19}$ GeV) or greater, the equations of the standard model are undoubtedly meaningless, since quantum gravitational effects are expected to become essential. Thus, within the scope of our knowledge, it is sensible to begin the hot big-bang scenario at some temperature T_0 which is comfortably below M_P, let us say $T_0 = 10^{17}$ GeV. At this time one can take the description of the universe as a set of initial conditions, and the equations of motion then describe the subsequent evolution. Of course, the equation of state for matter at these temperatures is not really known, but one can make various hypotheses and pursue the consequences.

In the standard model, the initial universe is taken to be homogeneous and isotropic, and filled with a gas of effectively massless particles in thermal equilibrium at temperature T_0. The initial value of the Hubble expansion "constant" H is taken to be H_0, and the model universe is then completely described.

Now I can explain the puzzles. The first is the well-known horizon problem. The initial universe is assumed to be homogeneous, yet it consists of at least $\sim 10^{83}$ separate regions which are causally disconnected (i.e., these regions have not yet had time to communicate with each other via light signals). (The precise assumptions which lead to these numbers will be spelled out in Sec. II.) Thus, one must assume that the forces which created these initial conditions were capable of violating causality.

The second puzzle is the flatness problem. This puzzle seems to be much less celebrated than the first, but it has been stressed by Dicke and Peebles. I feel that it is of comparable importance to the first. It is known that the energy density ρ of the universe today is near the critical value $\rho_{\rm cr}$ (corresponding to the borderline between an open and closed universe).

All Possible Symmetries of the S Matrix
Sidney Coleman and Jeffrey Mandula
Phys. Rev. 159(5), 1251 (1967)

Until a few years ago, most physicists believed that the exact or approximate symmetry groups of the world were (locally) isomorphic to direct products of the Poincaré group and compact Lie groups. This world-view changed drastically with the publication of the first papers on $SU(6)$[1]; these raised the dazzling possibility of a relativistic symmetry group which was not simply such a direct product. Unfortunately, all attempts to find such a group came to disastrous ends, and the situation was finally settled by the discovery of a set of theorems[2] which showed that, for a wide class of Lie groups, any group which contained the Poincaré group and admitted supermultiplets containing finite numbers of particles was necessarily a direct product.

Fate of the false vacuum: Semiclassical theory
Sidney Coleman [Phys. Rev. D 15(10), 2929 (1977)]

It is possible for a classical field theory to have two homogeneous stable equilibrium states with different energy densities. In the quantum version of the theory, the state of higher energy density becomes unstable through barrier penetration; it is a false vacuum. . . .
This is the first of two papers developing the quantitative theory of the decay of such false vacuums . . .
The qualitative features of such decay processes have long been understood.[4] They closely parallel the nucleation processes of statistical physics, the crystallization of a supersaturated solution or the boiling of a superheated fluid. Imagine Fig. 1 to be a plot of the free energy of a fluid as a function of density. The false vacuum corresponds to the superheated fluid phase and the true vacuum to the vapor phase. Thermodynamic fluctuations are continually causing bubbles of the vapor phase to materialize in the fluid phase. If the bubble is too small, the gain in volume energy caused by the materialization of the bubble is more than compensated for by the loss in surface energy, and the bubble shrinks to nothing. However, once in a while, a bubble is formed large enough so that it is energetically favorable for the bubble to grow. Once this occurs, the bubble expands until it converts the available fluid to vapor.

An identical picture describes the decay of the false vacuum, with quantum fluctuations replacing thermodynamic ones. Once in a while, a bubble of true vacuum will form large enough so that it is classically energetically favorable for the bubble to grow. Once this happens, the bubble spreads throughout the universe converting false vacuum to true.

Why opposites attract
Y. Aharonov, A. Casher, Sidney Coleman, and S. Nussinov
Phys. Rev. D 46(4), 1877 (1992)

Oppositely electrically or magnetically charged point particles attract at all distances. However, it is not obvious that this is also true for extended objects, like the magnetic monopoles discovered in spontaneously broken gauge theories by 't Hooft [l] and Polyakov [2]. Certainly the long-range part of the force between these objects is attractive, but one might suspect a short-range repulsion when their cores overlap. In this paper we show that this suspicion is groundless: oppositely charged 't Hooft-Polyakov monopoles attract at all distances, just like point particles. The most surprising part of this result is how easy it is to prove.

We stress that our proof is for 't Hooft-Polyakov monopoles as extended objects in classical field theory; we have nothing to say about quantum effects. Also, our proof is for the original 't Hooft-Polyakov monopoles only, the objects that arise in the theory of a triplet of real scalar fields with spontaneously broken SO(3) gauge symmetry. We shall discuss possible generalizations to other cases after we give the proof.

A MODEL OF LEPTONS
Steven Weinberg
PRL 19(21), 1264 (1967)

Leptons interact only with photons, and with the intermediate bosons that presumably mediate weak interactions. What could be more natural than to unite these spin-one bosons into a multiplet of gauge fields? Standing in the way of this synthesis are the obvious differences in the masses of the photon and intermediate meson, and in their couplings. We might hope to understand these differences by imagining that the symmetries relating the weak and electromagnetic interactions are exact symmetries of the Lagrangian but are broken by the vacuum. However, this raises the specter of unwanted massless Goldstone bosons. This note will describe a model in which the symmetry between the electromagnetic and weak interactions is spontaneously broken, but in which the Goldstone bosons are avoided by introducing the photon and the intermediate-boson fields as gauge fields. The model may be renormalizable.

The Quantum Theory of Optical Coherence
Roy J. Glauber
Phys. Rev. 130(6), 2529 (1963)

We are led then to distinguish among various orders of incomplete coherence, according to the number of conditions satisfied. The fields traditionally described as coherent in optics are shown to have only first-order coherence. The fields generated by the optical maser, on the other hand, may have a considerably higher order of coherence. ...

It would hardly seem that any justification is necessary for discussing the theory of light quanta in quantum theoretical terms....

Coherent and Incoherent States of the Radiation Field
Roy J. Glauber
Phys. Rev. 131(6), 2766 (1963)

Methods are developed for discussing the photon statistics of arbitrary radiation fields in fully quantum-mechanical terms. In order to keep the classical limit of quantum electrodynamics plainly in view, extensive use is made of the coherent states of the field. These states, which reduce the field correlation functions to factorized forms, are shown to offer a convenient basis for the description of fields of all types. Although they are not orthogonal to one another, the coherent states form a complete set. It is shown that any quantum state of the field may be expanded in terms of them in a unique way. Expansions are also developed for arbitrary operators in terms of products of the coherent state vectors. These expansions are discussed as a general method of representing the density operator for the field. A particular form is exhibited for the density operator which makes it possible to carry out many quantum-mechanical calculations by methods resembling those of classical theory. This representation permits clear insights into the essential distinction between the quantum and classical descriptions of the field. It leads, in addition, to a simple formulation of a superposition law for photon fields. Detailed discussions are given of the incoherent fields which are generated by superposing the outputs of many stationary sources. These fields are all shown to have intimately related properties, some of which have been known for the particular case of blackbody radiation.

A birthday toy
I. Bernard Cohen
Einstein Gravity in a Nutshell by A. Zee

At last I was taking my leave. Suddenly Einstein turned and called "Wait. Wait. I must show you my birthday present." Back in the study I saw Einstein take from the corner of the room what looked like a curtain rod five feet tall, at the top of which was a plastic sphere about four inches in diameter. "You see," said Einstein, "this is designed as a model to illustrate the equivalence principle. . . . " A big grin spread across his face and his eyes twinkled with delight as he said, "And now the equivalence principle." Grasping the gadget in the middle of the long brass curtain rod, he thrust it upwards until the sphere touched the ceiling. "Now I will let it drop," he said, "and according to the equivalence principle there will be no gravitational force. So the spring will now be strong enough to bring the little ball into the plastic tube." With that he suddenly let the gadget fall freely and vertically, guiding it with his hand, until the bottom reached the floor. The plastic sphere at the top was now at eye level. Sure enough, the ball rested in the tube.

U.S. v. Internet Research Agency, et al (1:18-cr-32, District of Columbia)
Indictment
Special Counsel Mueller
https://www.justice.gov/file/1035477/download

Use of U.S. Computer Infrastructure

39. To hide their Russian identities and ORGANIZATION affiliation, Defendants and their co-conspirators—particularly POLOZOV and the ORGANIZATION's IT department—purchased space on computer servers located inside the United States in order to set up virtual private networks ("VPNs"). Defendants and their co-conspirators connected from Russia to the U.S.-based infrastructure by way of these VPNs and conducted activity inside the United States—including accessing online social media accounts, opening new accounts, and communicating with real U.S. persons—while masking the Russian origin and control of the activity.

40. Defendants and their co-conspirators also registered and controlled hundreds of web-based email accounts hosted by U.S. email providers under false names so as to appear to be U.S. persons and groups. From these accounts, Defendants and their co-conspirators registered or linked to online social media accounts in order to monitor them; posed as U.S. persons when requesting assistance from real U.S. persons; contacted media outlets in order to promote activities inside the United States; and conducted other operations, such as those set forth below.

Use of Stolen U.S. Identities

41. In or around 2016, Defendants and their co-conspirators also used, possessed, and transferred, without lawful authority, the social security numbers and dates of birth of real U.S. persons without those persons' knowledge or consent. Using these means of identification, Defendants and their co-conspirators opened accounts at PayPal, a digital payment service provider; created false means of identification, including fake driver's licenses; and posted on ORGANIZATION-controlled social media accounts using the identities of these U.S. victims. Defendants and their co-conspirators also obtained, and attempted to obtain, false identification documents to use as proof of identity in connection with maintaining accounts and purchasing advertisements on social media sites.

HARVARD UNIVERSITY

DEPARTMENT OF PHYSICS

January 12, 1950

LYMAN LABORATORY OF PHYSICS
CAMBRIDGE 38, MASSACHUSETTS

Dr. Harlow Shapley
Harvard College Observatory
Cambridge 38, Massachusetts

Dear Dr. Shapley:

This letter is an application for a grant from the Rumford Fund of the American Academy of Arts and Sciences. The research project for which assistance is sought is an effort to detect, in the microwave radiation from interstellar space, a sharp line at the frequency associated with the hyperfine structure of the ground state of atomic hydrogen. The experiment has been undertaken as a Ph.D. thesis problem by Mr. Harold I. Ewen, a graduate student in the Department of Physics, under my direction. I shall outline briefly the background of the problem, and the method we plan to use.

The ground state of the hydrogen atom is split into two "hyperfine-structure" levels by the interaction between the spinning electron and the magnetic moment of the proton. The frequency associated with transitions between these levels has been measured very precisely by Nafe and Nelson at Columbia, using Rabi's method of atomic beams. It is 1420.41 megacycles/second, corresponding to a wavelength of 21.10 centimeters. Microwave radiation of this wavelength can be absorbed or emitted by free neutral hydrogen atoms, of which interstellar space contains a supply abundant for our purpose. We propose to search for this transition by studying the apparent noise temperature, in the neighborhood of the wavelength in question, of a microwave antenna directed toward the Milky Way. At this sharply defined wavelength we expect to find either a peak (bright line) or a dip (Fraunhofer line) in the apparent temperature, depending on whether the temperature of the hydrogen is higher or lower than that of the background of galactic radiation in this part of the spectrum. It is conceivable that the temperature of the hydrogen is so close to that of the background that no effect will be detected, but it seems unlikely that this situation will prevail in every direction. I have computed the transition probability and, on the basis of available astrophysical evidence, I believe there is a good chance that the line can be observed.

The techniques to be used are those now familiar in radio-astronomy with an important simplification permitted by the fact that we are here - for the first time - dealing with a sharp spectral line. The antenna itself will consist of an electromagnetic horn mounted outside the upper floor of the Lyman Laboratory. The associated equipment consists of waveguides, a microwave oscillator and superheterodyne receiver, and various auxiliary microwave and low frequency circuits.

I need not point out to you the astrophysical implications of the experiment, if successful; it would give fairly direct access to the condition of the interstellar hydrogen, since by suitable calibration a direct temperature measurement would be possible. It would be interesting also to study the red shift of this line. As physicists we have another reason to be interested

HARVARD UNIVERSITY

DEPARTMENT OF PHYSICS

LYMAN LABORATORY OF PHYSICS
CAMBRIDGE 38, MASSACHUSETTS

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in the transition, as in any property of the hydrogen atom that can be measured with precision: our best values of the fundamental atomic constants are based, in part, on the measured frequency of this transition. It is possible that the interstellar line, because of the absence of collision broadening, will afford an even more precise determination of the frequency.

An experiment of the sort described has been in the minds of many people, I am sure, and it is not unlikely that someone will beat us to it. However, we have been in touch with the principal radio-astronomy projects in this country, and it appears that although exploration of the 1400 Mc region is included on some of the long-range programs, the present effort is going in other directions. We have set ourselves the limited objective of detecting the line, if possible. Clearly, once the existence of the effect is established, many more elaborate investigations would suggest themselves.

Of the equipment mentioned above, some parts are already available, and some can be borrowed. Certain critical items must be purchased or built in the laboratory, and it is to defray these expenses that I request a grant, in the amount of $500, to be spent approximately as follows:

Construction and mounting of horn	$150
Purchase of war surplus transmitter (APT-5) for use as local oscillator	100
Material for and construction of power supply for oscillator	75
Construction of microwave mixer	100
Construction of special waveguide circuit elements	75
Total	$500

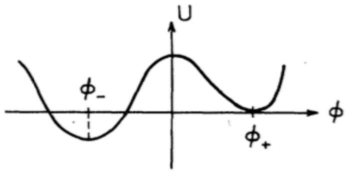
Any apparatus of permanent value so obtained would be suitably marked as acquired by a grant from the Rumford Fund, and would be made available subsequently to other researches, or disposed of in any way you might designate. None of the funds requested would be used to pay research assistants. Money budgeted for items requiring construction would be used to defray machine shop and carpenter shop charges.

I hope that the Rumford Committee will feel that this project is a suitable one for support by the Rumford Fund and is worthy of the assistance requested. Naturally I shall be very happy to provide any additional information the Committee may need.

Sincerely yours,

E. M. Purcell
Professor of Physics

EMP/pb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THE UNIVERSAL FEATURES OF CELLS ON EARTH

All Cells Replicate Their Hereditary Information by Templated Polymerization

The mechanisms that make life possible depend on the structure of the double-stranded DNA molecule. Each monomer in a single DNA strand—that is, each **nucleotide**—consists of two parts: a sugar (deoxyribose) with a phosphate group attached to it, and a *base*, which may be either adenine (A), guanine (G), cytosine (C) or thymine (T) (**Figure 1–2**). Each sugar is linked to the next via the phosphate group, creating a polymer chain composed of a repetitive sugar-phosphate backbone with a series of bases protruding from it. The DNA polymer is extended by adding monomers at one end. For a single isolated strand, these can, in principle, be added in any order, because each one links to the next in the same way, through the part of the molecule that is the same for all of them. In the living cell, however, DNA is not synthesized as a free strand in isolation, but on a template formed by a preexisting DNA strand. The bases protruding from the existing strand bind to bases of the strand being synthesized, according to a strict rule defined by the complementary structures of the bases: A binds to T, and C binds to G. This base-pairing holds fresh monomers in place and thereby controls the selection of which one of the four monomers shall be added to the growing strand next. In this way, a double-stranded structure is created, consisting of two exactly complementary sequences of As, Cs, Ts, and Gs. The two strands twist around each other, forming a double helix (Figure 1–2E).

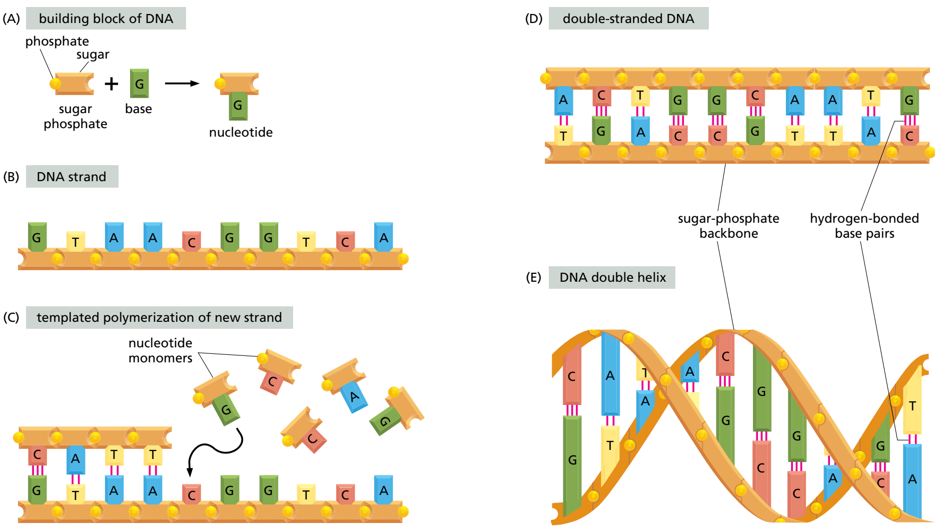

Figure 1–2 DNA and its building blocks. (A) DNA is made from simple subunits, called nucleotides, each consisting of a sugar-phosphate molecule with a nitrogen-containing sidegroup, or base, attached to it. The bases are of four types (adenine, guanine, cytosine, and thymine), corresponding to four distinct nucleotides, labeled A, G, C, and T. (B) A single strand of DNA consists of nucleotides joined together by sugar-phosphate linkages. Note that the individual sugar-phosphate units are asymmetric, giving the backbone of the strand a definite directionality or polarity. This directionality guides the molecular processes by which the information in DNA is interpreted and copied in cells: the information is always "read" in a consistent order, just as written English text is read from left to right. (C) Through templated polymerization, the sequence of nucleotides in an existing DNA strand controls the sequence in which nucleotides are joined together in a new DNA strand; T in one strand pairs with A in the other, and G in one strand with C in the other. The new strand has a nucleotide sequence complementary to that of the old strand, and a backbone with opposite directionality: corresponding to the GTAA... of the original strand, it has ...TTAC.
(D) A normal DNA molecule consists of two such complementary strands. The nucleotides within each strand are linked by strong (covalent) chemical bonds; the complementary nucleotides on opposite strands are held together more weakly, by hydrogen bonds. (E) The two strands twist around each other to form a double helix—a robust structure that can accommodate any sequence of nucleotides without altering its basic structure.

Figure 5.1 Page 37 of Molecular Biology of the Cell, 5th edition, by BruceAlberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.

6
Odds and ends

The indefinite article *a* changes to *an* when it comes immediately before a word that begins with a vowel **sound**. Thus *a lake* but *an ocean*, *an ulcer*. Some vowels sound like consonants: *a universe*, *a university*, *a utopia*, *a Europe*. And some consonants and numbers sound like vowels: *an hour*, *an F*, *an 8*. So say the word out loud and listen to it. If its initial sound is a vowel, use *an*; if it's a consonant, use *a*.

Don't confuse *let's*, which means *let us*, with *lets* which means *allows*, as in *Congress lets gun makers get away with murder*.

Don't repeat the verb *is* unnecessarily. It's okay to say, *It depends upon what the meaning of the word is is.* But don't say, *The basic idea is is day follows night.*

Avoid *hopefully*, which means *in a manner full of hope*. It does not mean *I hope*.

Advancement is a process that helps advances happen, as in *The American Association for the Advancement of Science*; it does not mean *advance*.

There is an adverb meaning *in that place*. It cannot be the subject of a sentence. *There are nine justices of the Supreme Court.* The subject is *nine justices*.

How is an adverb. It cannot be the object of the preposition *like*. Thus, never say *how this looks like*, which is Germlish, not English. Say *what this looks like* or *how this looks*.

Where is an adverb. It cannot be the object of the preposition *at*. So ask not *Where are you at?* ask *Where are you?*

The adverbs *farther* and *further* mean almost the same thing; the difference is that *farther* refers to distance while *further* is more abstract.

A compound adjective that precedes the noun it modifies should be hyphenated. Thus, *high-energy physics*, but *the LHC runs at a very high energy*.

Some compound nouns should be hyphenated. Thus, *cross-section* avoids the implication that the section is angry.

Say "like you and me," not "like you and I, " as said by Matt Bevin, Republican Governor of Kentucky, on 24 Feb 2019 at the Winter Meeting of the National Governors Association.

Examples of the rules for *who* and *whom*:

- Who made this decision? [who is the subject of the sentence]
- Whom do you think we should support? [whom is the object of the verb support]
- Whom do you think we should support? [whom is the object of the verb support]
- To whom do you wish to speak? [whom is the object of the preposition to]
- The man whom you met yesterday is coming to dinner. [whom is the object of the verb met]
- The children, who had been as good as gold, then suddenly started misbehaving. [who is the subject of the verb had been]
- The people to whom the funds were supposedly directed benefited little from them. [whom is the object of the preposition to]
- The room accommodates 300 students, all of whom are now seated. [whom is the object of the preposition of]
- Congratulations to all the winners, most of whom are reading this blog! [whom is the object of the preposition of]
- *Who* can be used in most places where *whom* is more correct, but it is necessary to write and say *of whom* and never *of who*.]

Use *that* to refer to a thing that is being defined or specified and *which* to refer to something without defining it. Examples of rules for *that* and *which*:

- This is the house that Jack built. [restrictive, no comma]
- A table of contents would have made it easier to use this history book, which also lacks maps. [nonrestrictive, comma]
- They got into the van, which had Ohio plates. [nonrestrictive, comma]
- I was driving the van that had Ohio plates. [restrictive, no comma]

It's okay to split infinitives.

It's okay to end a sentence with a preposition, especially when the alternative would be absurd, as in Churchill's joke, "This is something up with which I will not put."

Use the objective (or accusative) case for the "subject" of an infinitive. Thus write *Now, the task is for President Trump and him to meet . . .* and not “Now, the task is for President Trump and he to meet . . . ,” as U.S. Secretary of State Mike Pompeo did on Fox News Sunday for 13 May 2018.

Spontaneous speech is loaded with extraneous words and phrases that speakers use to stall while they think of what they want to say and of how to say it. Some of these are just sounds like “uh” or “err” and so are obviously just ways to pause. Others are actual words or phrases that the speaker has recently heard or are phrases uttered consciously. These ways to slow down one’s rate of speaking are parts of spontaneous speech. They are okay. But writing is different from speech. It is inherently slow. There is no excuse for wasting a readers time with phrases used to slow down speech. As Orwell advised, try to avoid meaningless phrases that are spreading like viruses. In particular, avoid ending sentences with “going forward.” Avoid starting sentences with, “If you look at.”

Use the simple past tense to indicate that something happened at a particular time or times in the past: *John cut the grass* and *John cut the grass yesterday* and even *John cut the grass for years*. Use the continuous past tense to indicate that something happened at an unspecified time or times in the past. *John has cut the grass* and *John has cut the grass for years*. But one should *not* say *John has cut the grass yesterday.*

I will try to find something about *should* and *ought to*, which are nearly equivalent.

The subjunctive mood is fading out. Among some in England, it is nearly gone. I still use it. I’ll try to say more about it.

7

Parts of speech

A noun is a person, place, or thing.

A pronoun is a word that represents a noun in some way. The words *I, me, mine, he, him, his, she, her, hers, . . .* are pronouns. The words *that, which, who, anything, myself* are or can be pronouns.

An article tells us how unique a noun is. The articles are *a, an, the*; they stand before the noun they modify.

An adjective describes a noun or a pronoun. Adjectives may precede their nouns or follow them and a form of the verb *to be*. Adjectives are singular. One says *blue eyes* not *blues eyes*.

A verb is a word that denotes action or a state of being.

An adverb is a word that describes a verb, an adjective, or an adverb.

A conjunction is a word that joins words or sentences (often with the help of a comma). Examples are *and, but, for, or, nor, so, yet*. But other words such as *that* can be conjunctions (He said that she was nice.)

A preposition combines with an article and a noun to form a phrase that describes a verb, noun, pronoun, or adjective.

From the first page of *War and Peace* by Leo Tolstoy:

He was wearing an embroidered court uniform, stockings, shoes, and stars, and had a bright expression on his flat face.

He spoke that refined French in which our grandparents not only spoke but thought, and with those quiet, patronizing intonations which are proper to a significant man who has grown old in society and at court. He went over to Anna Pavlovna, kissed her hand, presenting her with his perfumed and shining bald pate, and settled comfortably on the sofa.

In these three sentences, Tolstoy used only a single adverb.

Verbs have many forms. They can be active (Jack saw Mary in class) or passive (Mary was seen in class). *Be, do, have* are auxilliary verbs. A **participle** is a word formed from a verb, usually by the addition of *d*, *ed*, or *ing*.

A present participle can play the role of a noun. A present participle acting like a noun is a **gerund**. Gerunds take the possessive. Some examples:

- *Rumfeld's handling* of the Iraq war has been criticized.
- *Mary's snoring* drove John mad.
- Harry's favorite activity is *sleeping*.

8

Fixing sentences

Here are some sentences using concepts we discussed last week:
Here are some sentences that involve concepts we discussed last week:

He smiled condescendingly at her, thinking he knew what was best.

Many supernovae bewildered ancient civilizations with their brilliance, which was sometimes even apparent in the morning sky.
Many supernovas bewildered ancient civilizations with their brilliance; some were so bright as to be apparent in the morning sky.

Optics and photonics — one in the same thing, really.
Optics and photonics — one and the same thing, really.

How do you truly measure the beginning of the Universe?
How do you truly measure the beginning of the universe?

He stood at the chalkboard, madly writing and scribbling equations. The students watched— confused, but intrigued.
He stood at the chalkboard, madly writing and scribbling equations. The students watched—confused, but intrigued.

The tea steamed, the laptop keys clicked, but all that night none of their MATLAB codes would work.
The tea steamed, the laptop keys clicked, but all that night none of the MATLAB codes worked.

As they started dinner at the campsite, it began to snow more and more heavily. They worried they would have to go home soon.
As they started dinner at the campsite, it began to snow more and more

heavily. They worried that they would have to go home soon.

The rocket car zipped across the regener lecture hall, ejecting many pounds of CO2 behind it as it went.
The rocket car zipped across Regener lecture hall, ejecting many pounds of CO2 behind it as it went.

Dr. Who spared those whom registered for physics day. As for the others, their fate was unclear but certainly doomed.
Dr. Who spared those who registered for Physics Day. The fate of the others was unclear.

How important following some of these rules are in professional scientific papers and articles ...
How important following some of these rules is in professional scientific papers and articles ...
or
How important it is to follow some of these rules in professional scientific papers and articles ...

9

Resources

John Eastwood's *Oxford Guide to English Grammar* is freely available online.

`https://www.uop.edu.jo/download/research/members/`

`oxford_guide_to_english_grammar.pdf`

The Reader Over Your Shoulder by Robert Graves and Alan Hodge has a lot of good advice but is very English.

10

General rules

In their book *The Reader Over Your Shoulder*, Robert Graves and Alan Hodge list and illustrate many general rules that we all ought to follow.

10.1 Principles of Clear Statement I

They call the first set of rules Principles of Clear Statement I:

1. It should always be made clear who is addressing whom, and on the subject of whom.
2. It should always be made clear which of two or more things already mentioned is being discussed.
3. Every unfamiliar subject or concept should be clearly defined; and neither discussed as if the reader knew all about it already nor stylistically disguised.
4. There should never be any doubt left as to where something happened or is expected to happen.
5. There should never be any doubt left as to when.
6. There should never be any doubt left as to how much, or how long.
7. There should never be any doubt left as to how many.

10.2 Principles of Clear Statement II

They call the second set of rules Principles of Clear Statement II:

8. Every word or phrase should be appropriate to its context.
9. No word or phrase should be ambiguous.
10. Every word or phrase should be in its right place in the sentence.
11. No unintentional contrast between two ideas should be allowed to suggest itself.

12. Unless for rhetorical emphasis, or necessary recapitulation, no idea should be presented more than once in the same prose passage.
13. No statement should be self-evident. Graves and Hodge illustrate this rule by their comment on "things that are of inestimable value , but have no price": All things with no price . . . are of inestimable value.
14. No important detail should be omitted from any phrase, sentence or paragraph.
15. No phrase should be allowed to raise expectations that are not fulfilled.
16. No theme should be suddenly abandoned.

10.3 Principles of Clear Statement III

They call the third set of rules Principles of Clear Statement III:

17. Sentences and paragraphs should be linked together logically and intelligibly.
18. Punctuation should be consistent and should denote the quality of connexion, rather than length of pause, between sentences or parts of sentences. Graves and Hodge mention in particular that question marks and exclamation points can appear in the middle of a sentence without ending it. An apostrophe denotes the possessive of a plural noun: *teachers' union*. An apostrophe-s denotes the possessive of a singular noun even when the noun ends in an s: *John's son, Thomas's daughter*. Special rules apply to Latin and Greek names; google them.
19. The order of ideas in a sentence or paragraph should be such that the reader need not rearrange them in his mind. They write that "The natural arrangement of ideas in a critical argument is

    - Statement of problem.
    - Marshalling of evidence, first on main points, then on subsidiary ones—the same sequence kept throughout the argument.
    - Credibility of evidence examined.
    - Statement of possible implications of all evidence not wholly rejected.
    - The weighing of conflicting evidence in the scale of probability.
    - Verdict."

    "They further write that the natural arrangement of ideas in familiar correspondence is:

    - Acknowledgement of previous letter.
    - Comment on the points raised in it, in order of importance—the recipient's interests being given priority.

- New information in order of importance—the recipient's interests being given priority.
- Questions.
- Postscript."

20. No unnecessary idea, phrase or word should be included in a sentence.
21. All antitheses should be true ones. For example, Graves and Hodge would change "Our spirit has not weakened; our spirit has deepened" to "Our spirit has not weakened; our spirit has strengthened."
22. Over-emphasis of the illogical sort tolerated in conversation should be avoided in prose.
23. Ideas should not contradict one another, or otherwise violate logic.
24. The writer should not, without clear warning, change his standpoint in the course of a sentence or paragraph.
25. In each list of people or things all the words used should belong to the same category of ideas.

10.4 The Graces of Prose

Graves and Hodge call their second set of principles The Graces of Prose. The first set is

A Metaphors should not be mated in such a way as to confuse or distract the reader.

B Metaphors should not be piled on top of one another.

C Metaphors should not be used in such close association with unmetaphorical language as to produce absurdity or confusion. For example in a Graham Greene novel, the sentence, "Kay Rimmer sat with her head in her hands and her eyes on the floor," invited the comment "And her teeth on the mantelpiece?" from Graves and Hodge.

D Characteristically poetical expressions should not be used in prose. Except in quotations.

11

Further reading

- Graves, Robert R., and Hodge, Alan, *The Reader Over Your Shoulder*, 2d ed., 1979, Random House
- Leslie Perelman and Edward Barrett, *The Mayfield Handbook of Technical and Scientific Writing*, 1997, McGraw-Hill, `http://web.mit.edu/course/21/21.guide/`
- Leslie Lamport, *LaTeX*, 2d ed., 1985, Addison-Wesley

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