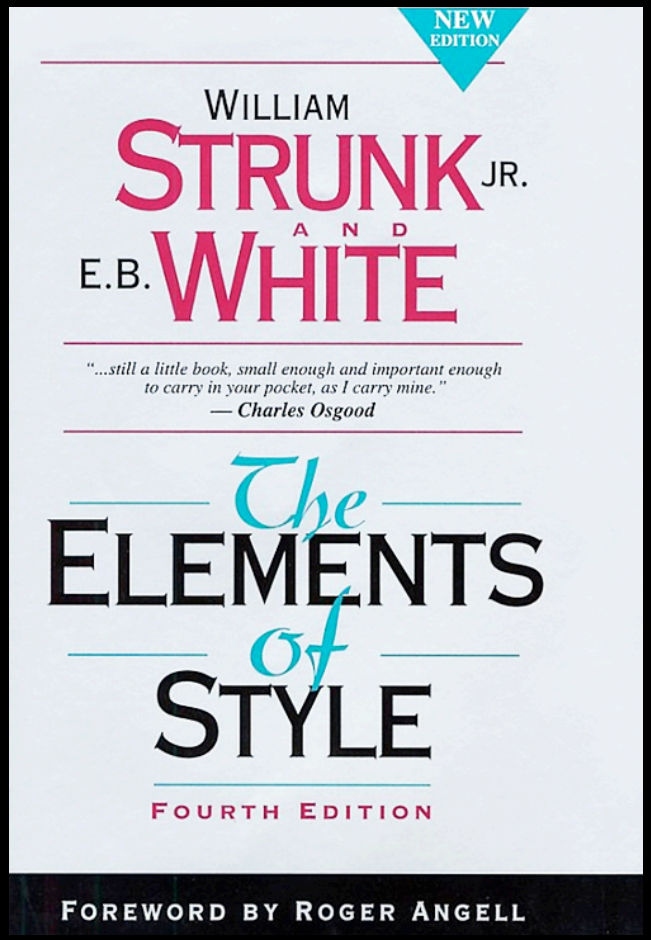
Effective Writing



John Kormendy
Department of Astronomy
University of Texas at Austin
&
Associate Editor, ARA&A

Please help yourself to a copy of Strunk & White.

It feels very risky – in fact: presumptuous – to give this talk!

Please forgive me for phrasing advice as instructions:
This is done only for brevity.

Some slides contain too much detail for a talk.
This talk will be posted as a pdf on my web site.

Begin at the beginning and go on until
you come to the end; then stop.

Lewis Carroll

Begin at the beginning and go on until
you come to the end; then stop.

Lewis Carroll

Everything should be made as simple as possible,
but not simpler.

Albert Einstein

Effective Writing

(A lecture in my graduate course on Judgment in Research).

GOAL:

To be one of the people who define the state of the art in your subject

REQUIREMENTS:

Important scientific contributions
Well-written papers
Persuasive presence

Effective Writing

1 – Scientific content: Emphasize fundamental science.
Ask yourself: Who will care?

2 – Presentation: Aims and mechanics of writing

3 – Style: To develop a personalized “voice”

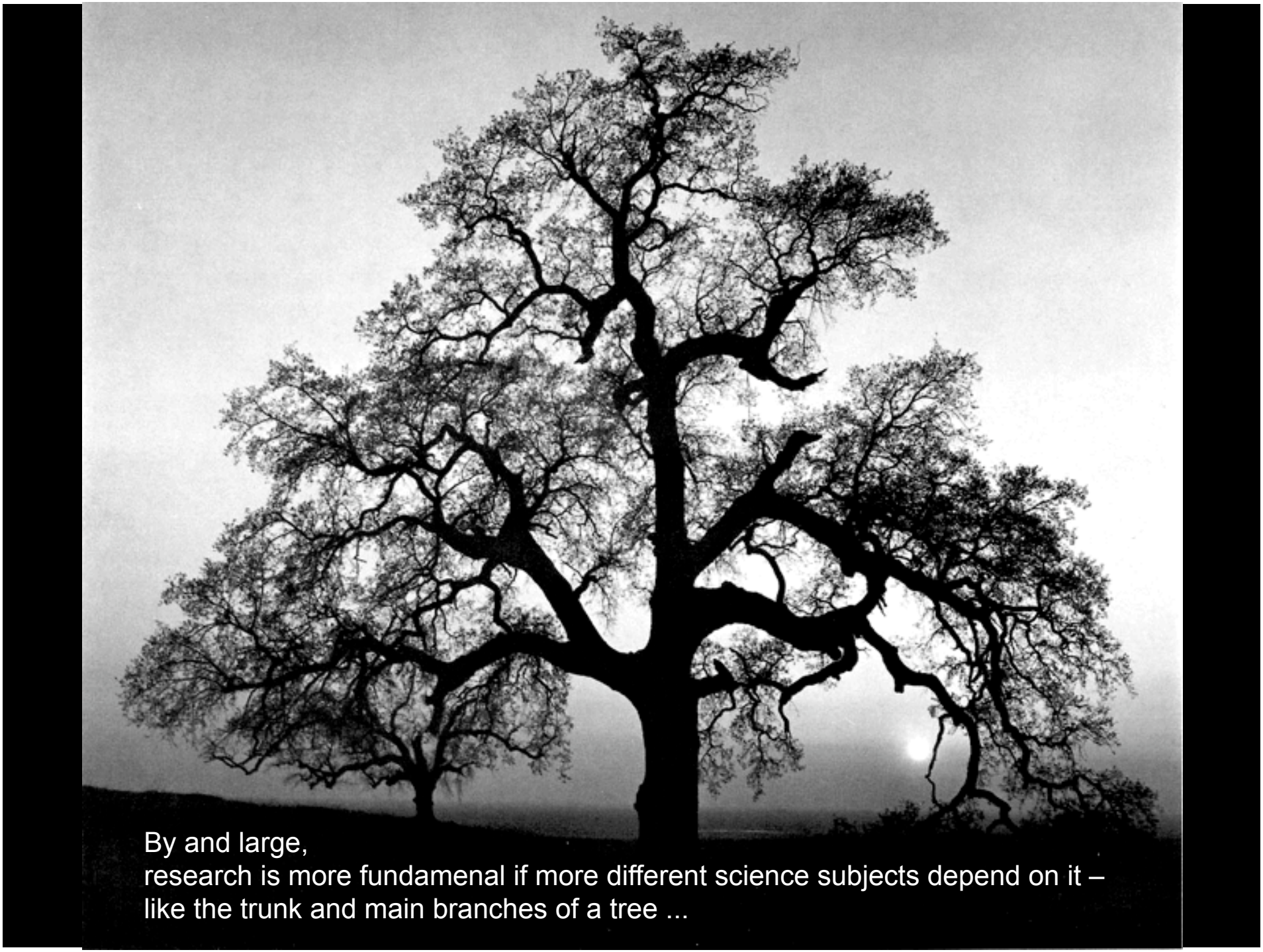
Scientific Content

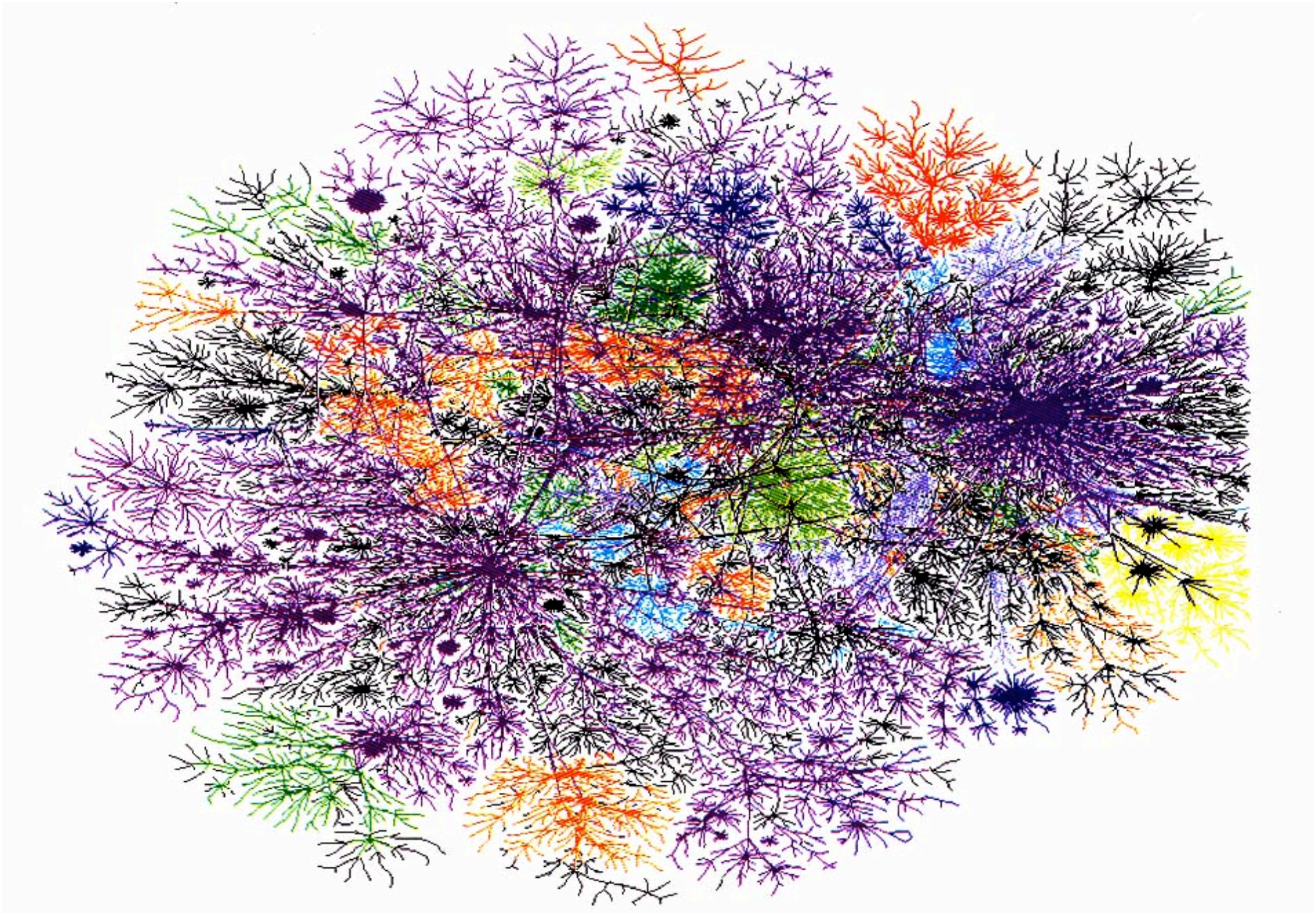
The Delicate Art of Judging Fundamental Science

Ask yourself: Who will care about my results?

The larger your audience – that is,
the wider the range of scientific research that is affected
by your work – the wider your impact.

Being judgmental may feel distasteful, but it is unavoidable:
Every potential reader makes a judgment about whether
to read your work or to believe it or to allocate resources to it.


By and large,
research is more fundamenal if more different science subjects depend on it –
like the trunk and main branches of a tree ...



… although science is more multiply connected – like the WWW – than are the branches of a tree.
This is one of its biggest strengths!

Advice to Students:

Sometimes, after a lot of hard work (e. g., on a PhD Thesis), the results veer more and more into unexpected directions that look wrong.

They may disagree with many things that you thought you knew.

This can be very discouraging.

It can look like your whole thesis is "falling apart".

My advice: Take heart and push on:
Get very confident in your measurements, calculations, and theory.

But don't assume that you must be "screwing up".

You may be discovering something much more interesting than you expected.

When Anomaly Turns Into Revolution

At the moment physics is again terribly confused. In any case, it is too difficult for me, and I wish I had been a movie comedian or something of the sort and had never heard of physics.

Wolfgang Pauli

(Just before the discovery of quantum mechanics)

Every major advance creates sooner or later new problems. These confusions are not to be deplored. Rather, those who participate experience them as a privilege. As Niels Bohr once said: “Tomorrow is going to be wonderful, because tonight I do not understand anything.”

Abraham Pais
Inward Bound

There are many ways to have impact:

Discoveries of new kinds of objects, physical processes, parameter correlations, theories, extreme objects that test theories, …

"Proof" of theories (e. g., CMB polarization)

More accurate measurements of important parameters
(e. g., Asplund et al. 2009, ARA&A, 47, 481: Chemical Composition of the Sun: > 400 citations in 2013; Supernova, WMAP, and Planck papers on precision cosmology: 700–1500 citations/year)

Scientifically powerful catalogs and data sets (e. g., SDSS)

New standard analysis machinery (e. g., HR diagram)
New instruments or software

Reviews that define and advance the history of a subject

Adding robust bricks to an existing scientific edifice is less exciting but adds up over many papers.
Active engagement in this "normal science" is the "buy-in cost" of being in the right place at the right time to recognize opportunity for discovery.

Presentation: Clarity of Argument

Have something to say and say it as clearly as you can.
That is the only secret of style.

Mathew Arnold

The most important advice in this talk:

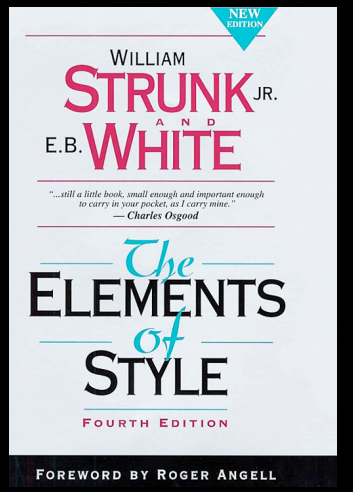
Develop a clear progression of ideas – with no gaps –
from the statement of your aims
through methods, analysis, and data,
to conclusions.

Presentation: Mechanics of Writing

Have something to say and say it as clearly as you can.
That is the only secret of style.

Mathew Arnold

Job 1 = Correct English



Some useful authorities: Strunk & White
: The Chicago Manual of Style
: Skillin et al. 1974, Words Into Type (Prentice Hall)
: Williams 1990, Style – Toward Clarity and Grace (U Chicago P)

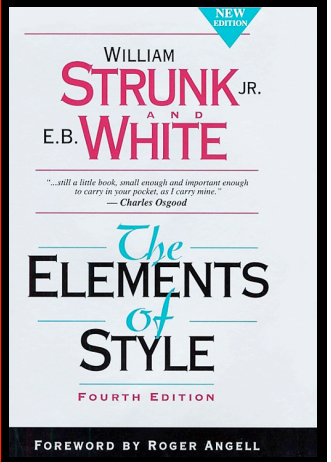
Presentation: Mechanics of Writing

Have something to say and say it as clearly as you can.
That is the only secret of style.

Mathew Arnold

Vigorous writing is concise. A sentence should contain
no unnecessary words, a paragraph no unnecessary sentences,
for the same reason that a drawing should contain
no unnecessary lines and a machine no unnecessary parts.
This requires not that the writer make all his sentences short,
or that he avoid all detail, but that every word tell.

William Strunk



The point I want to make here is that we can see that American policy in regard to foreign countries as the State Department in Washington and the White House have put it together and made it public to the world has given material and moral support to too many foreign factions in other countries that have controlled power and have then had to give up the power to other factions that have defeated them.

That is:

Our foreign policy has backed too many losers.

J. M. Williams: Style

The point I want to make here is that we can see that American policy in regard to foreign countries as the State Department in Washington and the White House have put it together and made it public to the world has given material and moral support to too many foreign factions in other countries that have controlled power and have then had to give up the power to other factions that have defeated them.

That is:

Our foreign policy has backed too many losers.

J. M. Williams: Style

In all pointed sentences, some accuracy must be sacrificed to conciseness.

Samuel Johnson

The most important slide in this talk:

Practical Hint 1:

Edit mercilessly for clarity.

Practical Hint 1:

Edit mercilessly for clarity.

E. g.: I like to write “camera-ready”, journal-emulated preprints.
Often, I have to edit mercilessly to make text fit in the space desired between figures or on lines or on pages.
I almost never let a few words wrap to a new line or to a new page.

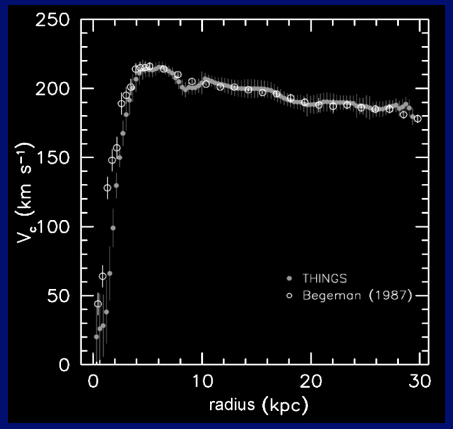
This discipline usually results in clearer text.
Shorter is clearer …
… modulo Samuel Johnson’s caution re: accuracy.

Calibration:
If an ApJ page wraps by 5 – 10 lines to a new page and I don’t like that, I can usually eliminate those lines by ferocious editing.

Practical Hint 2:

Express ideas directly, not in abstractions that depend on analysis tools.

Bad: “The peak rotation velocity is bigger than the outer asymptotic velocity.”



You have in mind a plot of velocity vs radius (abstract analysis tool) in which the V(r) curve resembles the skyline of a mountain range (a double abstraction).

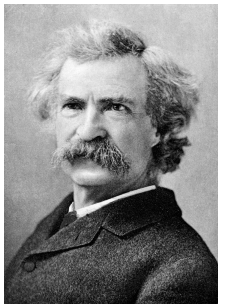
Better: “The largest rotation velocity is larger than the V ≈ constant value at large radii.”

This is more direct and clearer but longer. It illustrates the advantage of exploiting commonly-held analysis machinery.

Similar but worse example: “The merger history has a peak at z ~ 2.”

Mark Twain's 18 Rules on Writing Romantic Fiction

(Relevant excerpts form *Fenimore Cooper's Literary Offences*, in *The Complete Humorous Sketches and Tales of Mark Twain*, ed. C. Neider; Garden City, NY: Hanover House, 1961).



1 – The tale shall accomplish something and arrive somewhere.

2 – The episodes of a tale shall be necessary parts of the tale and shall help to develop it.

⋮

12 – The author shall *say* what he is proposing to say, not merely come near it.

13 – Use the right word, not its second cousin.

14 – Eschew surplusage.

15 – Do not omit necessary details.

16 – Avoid slovenliness of form. Many oral colloquialisms are deadly in print.

Example: "Writing well is difficult, but it's not that difficult."

17 – Use good grammar.

18 – Use a simple and straightforward style.

Examples of Awkward Writing

"Physical size [of an object] scales with distance and may be affected by [radio telescope] beam size."

No astronomical object cares about how we measure it. The author isn't saying what he means (M. Twain 12).

"A detection is a clear upper limit, while a non-detection being a lower limit requires very deep observations …"

This is too awkward to be understandable.

"We place the remaining [objects] at 10 kpc since the majority of distance constraints are at this distance and indirect distance constraints indicate there is not a large population of [objects] at distances significantly greater than this."

This is awkward in many ways. For example: We do not put astronomical objects anywhere. Nature did that.

"These results infer that …"

Results don't infer. People infer. The author isn't saying what he means (M. Twain 12).

"There is evidence for increasing luminosity with increasing z …"

Awkward present participles. Clearer is: "There is evidence that [object] luminosities are higher at higher z."

"The gas actually being in a galaxy halo is almost never certain."

Argh!

"This implies a stronger evolution of the infrared luminosity function of infrared galaxies than of optical ones."

This is both awkward and confusingly stated in terms of an abstract analysis tool.

Better: "This implies that the infrared luminosities of infrared-identified galaxies increase more rapidly with increasing redshift than do the [infrared or optical?] luminosities of optically-identified galaxies."

Note the parallel construction. Parallel constructions are usually effective.

Practical Hint 3

Use of present participles is weak writing. Often.

Give yourself “brownie points” when you can rewrite text more directly without using present participles.

Example:

The accretion disk is emitting jets in directions paralleling the black hole spin axis.
If that axis is pointing almost exactly at us, then relativistic knot motions look like they are moving faster than the speed of light.

Better:

The accretion disk emits jets parallel to the black hole spin axis.
If that axis points almost exactly at us, then knots that move at V ~ c look to us as though they move faster than the speed of light.

Practical Hint 4

Break rules sparingly and only for deliberate effect.

"To boldly go where no one has gone before …"

Here's one reason among many:

"This is the kind of arrant pedantry up with which I will not put."

attributed to Winston Churchill

Practical Hint 5

Very important: Know your audience.

Example 1: Minimize jargon and acronyms (else you disenfranchise novices and outsiders).
Writing for *Nature* is a good education in clear, jargon-free writing.

More Fundamental Example 2:

Understand the mindset of readers:

Will they welcome or resist your results?

Do they view "evidence" the same way that you do?

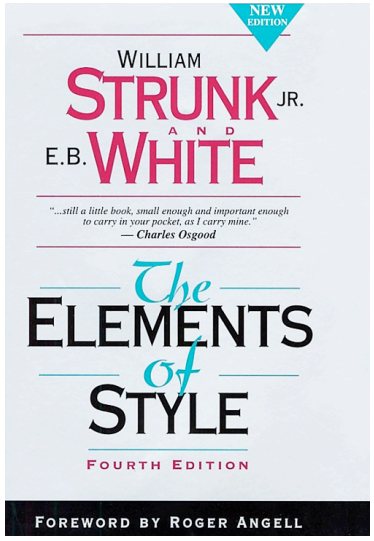
For example: Certain theorists cannot accept that observations can essentially prove
that some process happens
even in the absence of a clear physical understanding of how it happens.
Therefore: Results that you think are strong are, to them, "like water off a duck" –
They will not accept the results and will lose some respect for you because you interpret them.

Stronger example: For some theorists, observers are not "licensed" to think.

Caution: It is easy to be so captured by a theoretical picture that you stray into overinterpretation.
Overinterpretation is deadly.

Do not overstate [results]. When you overstate, the reader will be instantly on guard, and everything that has preceded your overstatement and everything that follows it will be suspect in his mind because he has lost confidence in your judgment or your poise.

W. Strunk and E. B. White



Additional Suggestions for Scientists

1 – **Always define symbols and acronyms** when they are first used.

2 – **Modular writing** is clearer for the same reason that modular programming is clearer and easier to debug. **Recommend:** Use sections & subsections to organize your story. **Price:** Section headings take space. This may be a problem for a Letters journal or for camera-ready copy.

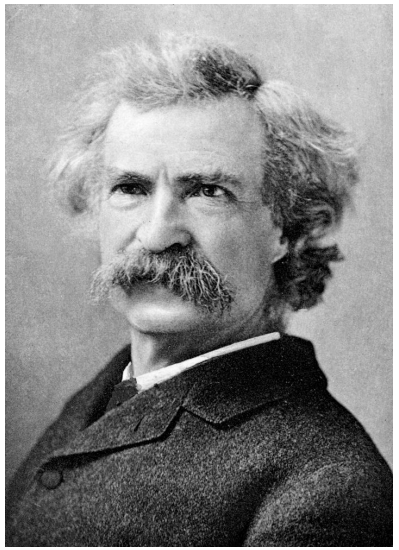
3 – Long technical sections may be necessary but are a potential barrier between you and the reader. Don't omit necessary detail but consider:

Provide a road map. E. g., "Readers interested mainly in astrophysical results can skip directly to Section 4."

Use Appendices (distasteful but sometimes helpful).

Or move extraneous technical material to another paper.

4 – The passive voice is common & has virtues. The active voice is clearer and more direct. Your choice depends on circumstances and on personal style.



The only people who have the right to say “we” are kings, editors, and people with tapeworm.

Mark Twain

Additional Suggestions for Scientists

5 – **Publish finished data.** E. g., don't quote radii in pixels or magnitudes without zeropoints or mass-to-light ratios without photometric bandpasses. If you state S/N, then specify "per pixel" or "per resolution element", etc. Specify all needed parameters (e. g., distance, Galactic absorption, …).

6 – **Make figures clear & self-sufficient. Recommend:** Explain stuff in keys, not in the caption. Especially avoid: "The curves are explained in the text." Include units in the axis labels. Photometric bandpasses are parts of units. **Recommend:** Summarize implications of the figure in the caption. Note that some journals don't like this. Resist. You often win the argument.

7 – **Make tables clear and self-sufficient.**
Recommend: Explain stuff in table notes under the table, not in the text.

Assume
that many readers will browse into the paper in the middle.
Try to make each part as independently understandable as possible.

Additional Suggestions for Scientists

Assume
that many readers will browse into the paper in the middle.
Try to make each part independent.

8 – Let the Abstract tell them everything that you want them to remember.

That is, don't just tell them what you will do; tell them results. Not this:

Title: The stellar population of the Magellanic clouds - A selective review
Authors: Frogel, J. A.

Abstract

The article considers evidence for an old metal-poor population in the Magellanic Clouds corresponding to that of the Galactic halo, and evidence for subsequent star-forming episodes. Particular emphasis is placed on cluster research and on observations of bright giants in clusters and the field as a means to understand the past and present stellar content of the Clouds. The color-magnitude diagrams and luminosity functions for bright giants in clusters and in a selected field of the LMC are compared to see if the stellar content of the field can be reproduced by a superposition of clusters. The small, but growing body of data on the chemical enrichment history of the Clouds is considered. Finally, some remarks on the gaseous content of the Clouds, and the implication for present-day star formation, are made.

NB another lesson: The above was written by the ADS folks – it is a paraphrase of Frogel's (much better) Abstract.

You can find good abstracts even long ago
(although abstracts then commonly just told you what the author intends to do).

EVIDENCE FROM THE MOTIONS OF OLD STARS THAT THE GALAXY COLLAPSED

O. J. Eggen, D. Lynden-Bell, and A. R. Sandage

ApJ, 136, 748 (1962)

ABSTRACT

The (U, V, W)-velocity vectors for 221 well-observed dwarf stars have been used to compute the eccentricities and angular momenta of the galactic orbits in a model galaxy. It is shown that the eccentricity and the observed ultraviolet excess are strongly correlated. The stars with the largest excess (i.e., lowest metal abundance) are invariably moving in highly elliptical orbits, whereas stars with little or no excess move in nearly circular orbits. Correlations also exist between the ultraviolet excess and the W-velocity. Finally, the excess and the angular momentum are correlated; stars with large ultraviolet excesses have small angular momenta.

These correlations are discussed in terms of the dynamics of a collapsing galaxy. The data require that the oldest stars were formed out of gas falling toward the galactic center in the radial direction and collapsing from the halo onto the plane. The collapse was very rapid and only a few times 10^8 years were required for the gas to attain circular orbits in equilibrium (i e., gravitational attraction balanced by centrifugal acceleration). The scale of the collapse is tentatively estimated to be at least 10 in the radial direction and 25 in the Z-direction. The initial contraction must have begun near the time of formation of the first stars, some 10^{10} years ago.

Some modern journals (e. g., *ApJL* and *ARA&A*)
restrict abstract lengths in ways that can be a problem. Resist.

Another *ApJL* example that gives the science question, methods, results, and implications for the motivating science question and in a more general context.

The abstract is a complete mini-paper.

DETECTION OF A PSEUDOBULGE HIDDEN INSIDE THE "BOX-SHAPED BULGE" OF NGC 4565

JOHN KORMENDY AND JOHN C. BARENTINE

THE ASTROPHYSICAL JOURNAL LETTERS, 715:L176–L179, 2010 June 1

ABSTRACT

Numerical simulations show that box-shaped bulges of edge-on galaxies are not bulges: they are bars seen side-on. Therefore, the two components that are seen in edge-on Sb galaxies such as NGC 4565 are a disk and a bar. But face-on SBb galaxies always show a disk, a bar, and a (pseudo)bulge. Where is the (pseudo)bulge in NGC 4565? We use archival *Hubble Space Telescope H*-band images and *Spitzer Space Telescope* 3.6 μm wavelength images, both calibrated to Two Micron All Sky Survey K_s band, to penetrate the prominent dust lane in NGC 4565. We find a high surface brightness, central stellar component that is clearly distinct from the boxy bar and from the disk. Its brightness profile is a Sérsic function with index $n = 1.55 \pm 0.07$ along the major axis and 1.33 ± 0.12 along the minor axis. Therefore, it is a pseudobulge. It is much less luminous than the boxy bar, so the true pseudobulge-to-total luminosity ratio of the galaxy is $PB/T = 0.06 \pm 0.01$, much less than the previously believed value of $B/T = 0.4$ for the "boxy bulge." We infer that published B/T luminosity ratios of edge-on galaxies with boxy bulges have been overestimated. Therefore, more galaxies than we thought contain little or no evidence of a merger-built classical bulge. From a formation point of view, NGC 4565 is a giant, pure-disk galaxy. This presents a challenge to our picture of galaxy formation by hierarchical clustering: it is difficult to grow galaxies as big as NGC 4565 without also making big classical bulges.

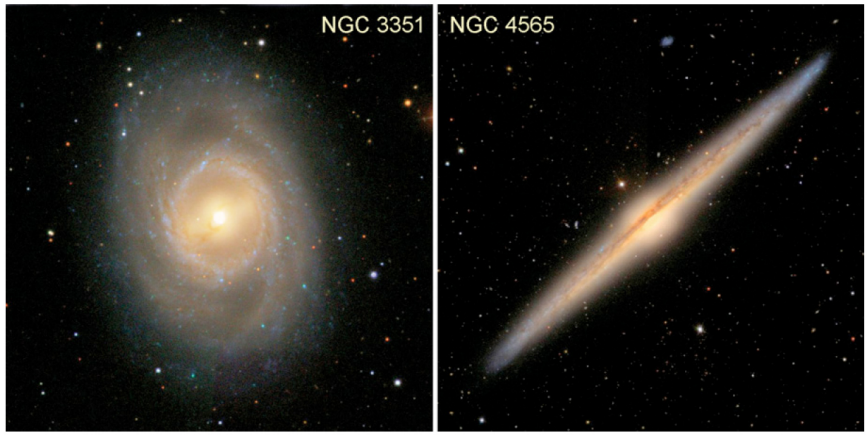


Figure 1. NGC 3351 (left) and NGC 4565 (right) in *gri* composite color images from the Sloan Digital Sky Survey (courtesy http://www.wikisky.org). Simien & de Vaucouleurs (1986) estimate that $B/T = 0.1$ in NGC 3351; this is smaller than $B/T \simeq 0.4$ in NGC 4565 in part because they do not include the bar as part of the bulge.

Additional Suggestions for Scientists

9 – Recall: Aim for a clear and well motivated line of argument.

Readers should always know where they are in the developing story, how they got here, and especially where they are going.

Aim for a fast pace and an inexorable flow of ideas, with no "speed bumps".

You have read novels and seen movies with a fast and inexorable pace.

Examples:

Movie: Terminator	(not The Godfather)
Opera: Tosca	(not Tristan und Isolde)
Novel: The Andromeda Strain	(not War and Peace)

Calibration: I edit until I have thought about every word many times.
I can defend every word.
I should have thought about alternative, more economical wording.

Additional Suggestions for Scientists

10 – Martin Schwarzschild's advice: One idea per paper.

**That is, consistent with scientific goals,
shorter is better.**

I break this rule MUCH too often.
My papers are at one extreme (too long) of the distribution of what works.
But I hope that they are not gratuitously wordy:
there is a lot of content.

Other people omit too much.

The "sweet spot" is probably between those people and me.

Additional Suggestions for Scientists

11 – John Bahcall's advice:

Tell them the important results "up front".

I almost never break this rule.

Often the place to do it is in the Abstract.

Another paraphrase:
Tell them what you will do and what you will discover (in Introduction);
then tell them the details;
then tell them what you did and what you discovered (in Conclusions).

Proposals

(Telescope time, funding, promotion & tenure)

1 – **State your objectives early, briefly, and clearly.** Elaborate later.

2 – **Don't dictate to Nature: Avoid: "Our purpose is to prove Theory X**."
Better: "We investigate [phenomena]. The results confirm Theory X."

A point of style – Avoid "This study is aimed at [proving …]." It's not a gun.

3 – **Explain why the science is interesting.** Who is your intended audience?

If you have convinced yourself, then you already have powerful arguments.

If you can't muster powerful arguments, why are you proposing this work?
("I know how to do it" is not a sufficient answer!)

Be specific. Promises that "This work will improve our understanding" of some subject are deadly.

4 – **Important: Describe a clear, convincing, and complete path** from specific scientific questions to observations, theory, or simulation to possible results. You do not know what the results will be, but you need to convince an evaluation committee that robust results will be achieved.

Proposals

5 – Most proposals need a technical justification. Style and format depend on the type of proposal, but the goal is to convince the committee that results will be robust within well defined rules of error analysis.

Often: Split up the science & technical justification into separate sections.

6 – Length restrictions and requirements for scientific and technical rigor often conflict. Which one gets sacrificed requires careful judgment.

7 – Committees judge the credibility, productivity, and impact of the proposer as well as the content of the proposal. This is tricky – it is unseemly to include a "technical justification" of the proposer. Address the implicit need:

Consummate professionalism breeds confidence.

Summaries of previous work can help but need to be forceful and related to the present proposal. In this regard:

Including figures (e.g., of previous results, and/or to demonstrate progress) is useful, but they need to have something specific to say. Don't write, "I am busy reducing my observations (Fig. 1)" with a Figure 1 caption like "Sample spectrum from my last run."

Proposals

8 – Often the committee that reads your proposal or application includes both experts and outsiders to your subfield. This is especially true of University promotion and tenure committees. Therefore:

Write your proposal to be understandable and scientifically appealing to outsiders and yet convincing to specialists.

These requirements almost always conflict. Aim for suitable balance.

The specialists may be forced to recuse themselves.
Competing scientists have conflicts of interest and may be forced to recuse themselves. This is not guaranteed.

Caution (important conflict!) – Can you risk having your ideas read by your competitors? This is the worst "Catch 22" situation in proposal writing: If you include your best arguments, then you may disclose them to poachers. But if you omit them, then you weaken your proposal. There is no simple solution.

Proposals

9 – Evaluation committees usually have too little time for too much work. Therefore:

Edit mercilessly for clarity.

The Right Stuff

People are too busy. So:
The community can be superficial in its response to papers:

- **Some people acquire a positive image: They are thought of as the people who define the state of the art in their subjects.**
- **Some papers acquire a positive image: They are regarded as the ones to quote in their subject. Once adopted by the paradigm, they often get quoted without being read.**
- **When this stage is reached, other relevant papers – even deserving papers – usually get ignored.**

It pays not to neglect this situation. Fundamental science has impact.
Personal factors matter, too:

- **Consummate professionalism**
- **Salesmanship: "It isn't finished until you have convinced them."**
- **Flair**

Consummate Professionalism

It pays to be exceedingly careful about

- **Scientific content – 1: Data: Don't make mistakes. Be thorough.**
- **Scientific content – 2: Interpretation: Be cautious & don't overstate, but don't be afraid to reach conclusions.**
- **Presentation: Write clearly and in correct English. Make figures and tables that are clear and effective.**

Citations – 1: Give credit fairly and generously. It is unfair to just quote the most recent paper on the subject. Do you really want readers to be furious because you did not quote them?

- **Citations – 2: Don't make mistakes in citations. (LaTeX makes it easy.)**

If the easy stuff looks unprofessionally sloppy and full of mistakes, then the reader naturally assumes that the science in the paper – the data analysis, calculations or modeling, and conclusions – are full of mistakes, too.

Consummate Professionalism

Don’t make mistakes in citations. (LaTeX makes this too easy.)

What Fraction of Literature References are Incorrect?

HELMUT A. ABT

Publications of the Astronomical Society of the Pacific **104:** 235–236, 1992 March

ABSTRACT. From a systematic study of 1009 references in *The Astrophysical Journal* it was found that 12.2% had errors. Only 0.4% of the referenced papers could not be found at all; another 3.0% were found by searching in volume, annual, and five-year indices and the remaining correctly and incorrectly referenced papers were found right away. Another 8.3% of the references have errors in the first authors’ names or in the journal names, and volume and page numbers such that they could be misplaced in the *Science Citation Index* (SCI). However, the compilers of SCI match all citations against a computerized file of the source papers and correct some of the citations, so that only 3.6% of the citations are missing or displaced in SCI. **ADS does not do this.**

It is never permissible to copy a reference from another paper without looking up the referenced paper. Some authors have been embarrassed when the references they copied are found to be incorrect so that their laziness is revealed to all. And the “It doesn’t matter” attitude shown by authors with up to 71% errors should not be condoned.

The Right Stuff

Personal factors matter:

- **Salesmanship:**

  1970s-era mantra: “It isn’t finished until it is published.”

  2000s mantra: “It isn’t finished until you have convinced them.”

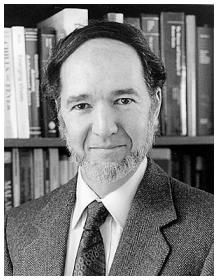
- **Flair:**

Flair

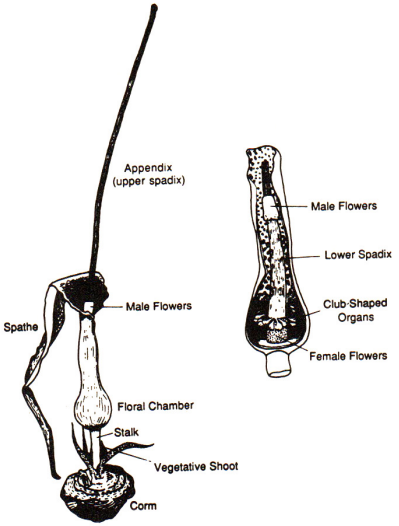
Hot sex in voodoo lilies

Jared M. Diamond

NATURE · VOL 339 · 25 MAY 1989



ALTHOUGH the use of metabolic heat to maintain body temperatures far above ambient is generally considered a hallmark of higher animals, particularly birds and mammals, it is also known to occur in flowers and inflorescences of at least six plant families, where a well-understood function of high temperature is to volatize compounds that attract insect pollinators[1]. *Arum* lilies such as skunk cabbage and the voodoo lily, for example, can increase the temperatures of their flowers in a brief burst by up to 22 °C above ambient. They thereby broadcast putrescent odours which have been compared with the smells of rotting flesh, decaying urine, faeces and sulphurous vapours[2], and which arise from volatile compounds including skatole, putrescine and ammonia[2,3]. A new study of the voodoo lily (*Sauromatum guttatum*) by Raskin *et al.*[4] now clarifies the triggering of heat production as well as revealing a second phase of heating with a separate function.



Inflorescence of the voodoo lily on D-day. Left, entire inflorescence; right, longitudinal cross section. (From ref. 4.)

The voodoo lily's inflorescence consists of a trap-like floral chamber containing the female flowers and club-shaped organs, accessible only via an opening containing the male flowers. Surmounting the floral chamber is a slender rod resembling a car's radio antenna, termed the appendix (see cover illustration). Until the day of blooming (D-day), the appendix is concealed within a sheath called the spathe.

The trigger for heat production turns out to be salicylic acid[5], whose concentration in the appendix begins to rise on the late afternoon of the day before D-day and peaks at 100 times the basal level. On the morning of D-day, the spathe unfolds to expose the antenna-like appendix (see figure), in which salicylic acid stimulates a metabolic explosion by the cyanide-insensitive mitochondrial respiratory transport system[6]. The resulting metabolic rate rivals that of hummingbirds in flight. Production of heat, and hence of stench, peaks between 3 and 5 hours after dawn on D-day. By late afternoon, the appendix's temperature has dropped back to ambient and its salicylic acid content has declined to basal levels.

The timing of this first phase of heat production depends on surges in three factors: salicylic acid production, tissue sensitivity to salicylic acid and light exposure, which enhances tissue sensitivity to the acid still more. (Until the spathe unfolds, the inside of the inflorescence remains dark.) Of 33 analogues of salicylic acid tested by Raskin *et al.*[4], the only ones that duplicate its stimulatory effect on heat production are acetyl-salicylic acid (aspirin), possibly because it is hydrolysed to salicylic acid, and the dihydroxy analogue of salicylic acid. The highest concentrations of salicylic acid are in the male and female flowers, but they do not produce heat. Thus, it remains unclear whether the acid is initially produced in the flowers and then transported to the heat-producing tissues of the inflorescence, or whether it is produced in the latter themselves.

The stench of the amines and indoles broadcast from the appendix lures insect pollinators to the floral chamber. From the night after D-day until dawn of the day after there is a second heating phase that differs from the first in originating between the male and female flowers in the centre of the floral chamber, producing less heat (temperatures 'only' 10 °C above ambient), and lasting longer (14 instead of 7 hours). Like phase 1, phase 2 is preceded and presumably triggered by a local 100-fold rise in levels of salicylic acid.

The heat of phase 2 stimulates activity of the insects attracted by the heat of phase 1 and trapped inside the flower chamber by the slippery concave walls and hedge of club-shaped organs. In addition, a sweet odour from the club-shaped organs may specifically stimulate insect mating behaviour. At the peak of phase 2, the male flowers shed their pollen into the hot floral chamber, where the bustling insects proceed to deposit pollen on the female flowers. The inflorescence then shrivels, permitting the insects to escape and cross-pollinate other inflorescences.

Devout scientists before Darwin would have cited this whole set of seemingly bizarre adaptations as evidence for a divine creator. In fact, the crucial ingredients of metabolic heat and volatile compounds are ubiquitous in plants. Because a slight increase in metabolic heating would produce a graded advantage in attracting insect pollinators, it can now be seen how natural selection led to hot voodoo lilies without prior design. □

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2. Chen, J. & Meeuse, B.J.D. *Acta Bot. Neerl.* **20**, 627–635 (1971).
3. Smith, B.N. & Meeuse, B.J.D. *Plant Physiol.* **41**, 343–347 (1966).
4. Raskin, I. *et al. Proc. natn. Acad. Sci. U.S.A.* **86**, 2214–2218 (1989).
5. Raskin, I. *et al. Science* **237**, 1601–1602 (1987).
6. Meeuse, B.J.D. *A. Rev. Plant Physiol.* **26**, 117–126 (1975).

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You need a healthy sense of what is tasteful.

You can get away with more as you get older, better known, and more respected.

But I recommend that you do not test the limits.

I recommend that you do not test the limits.

Coevolution (Or Not) of Supermassive Black Holes and Host Galaxies

John Kormendy and Luis C. Ho

Annu. Rev. Astron. Astrophys. 2013. 51:511–653

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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Style: I like short, "punchy" sentences.

Because M/L_K is likely to vary less from galaxy to galaxy than M/L_r, this suggests that we proceed by finding a way to estimate M/L_K. In particular, we want an algorithm that does not involve the use of uncertain effective radii r_e. Here's why:

Published studies often derive $M_{\rm bulge}$ dynamically from r_e, σ_e, and a virial-theorem-like relation $M_{\rm bulge} = k\sigma_e^2 r_e / G$, where k is, e.g., 3 (Marconi & Hunt 2003) or 5 (Cappellari et al. 2006, 2013a,b) or 8 (Wolf et al. 2010). This situation is unsatisfactory; different assumptions about the density profile are one reason why k is uncertain. Also, r_e values are less well measured than we think.

6.10.1. The $V_{\rm circ}$-σ correlation. **Figure 23*a*** shows the correlation as Ferrarese derived it except that incorrect σ measurements are omitted or corrected (see below) and that new measurements of bulgeless galaxies are added. **Figure 23*b*** includes more galaxies.

The Kormendy & Bender (2011) arguments are based on **Figure 23*a*** and on **Figure 23*b*** using the Gültekin et al. (2009c) subsample of the present, **Table 3** disk galaxies with dynamical BH detections. Ellipticals are not included; we cannot directly measure $V_{\rm circ}$ and do not have a sufficiently accurate way to measure dark matter that is not intimately connected with the stellar mass distribution. We already know that BHs correlate tightly with that stellar mass distribution.

Before we proceed, we need to be clear about what we are testing.

First, how do we measure dark matter? Here in Section 6.10.1, we assume that $V_{\rm circ}$ measures the inner parts of dark matter halos. Provided that the measurements reach out beyond most of the visible galaxy, rotation curve decompositions suggest that this is a good approximation. ...

6.16. Summary: Which Components Coevolve with BHs?

BH masses correlate tightly enough to imply coevolution with the properties of classical bulges and elliptical galaxies and with no other galaxy components.

7. CENTRAL BLACK HOLES IN BULGELESS GALAXIES

Kormendy 2013, in Secular Evolution of Galaxies, XXIII Canary Islands Winter School of Astrophysics, ed. Falcón-Barroso & Knapen, Cambridge Univ. Press, p. 1 (arXiv:1311.2609)

classification is based mainly on isophote shape, so it has been common to call galaxies like Leo I and NGC 205 "dwarf ellipticals" (e. g., Sandage 1961). *But there has never been any guarantee that structural morphology identifies physically different kinds of objects.* Figure 1.53 makes this point concrete.

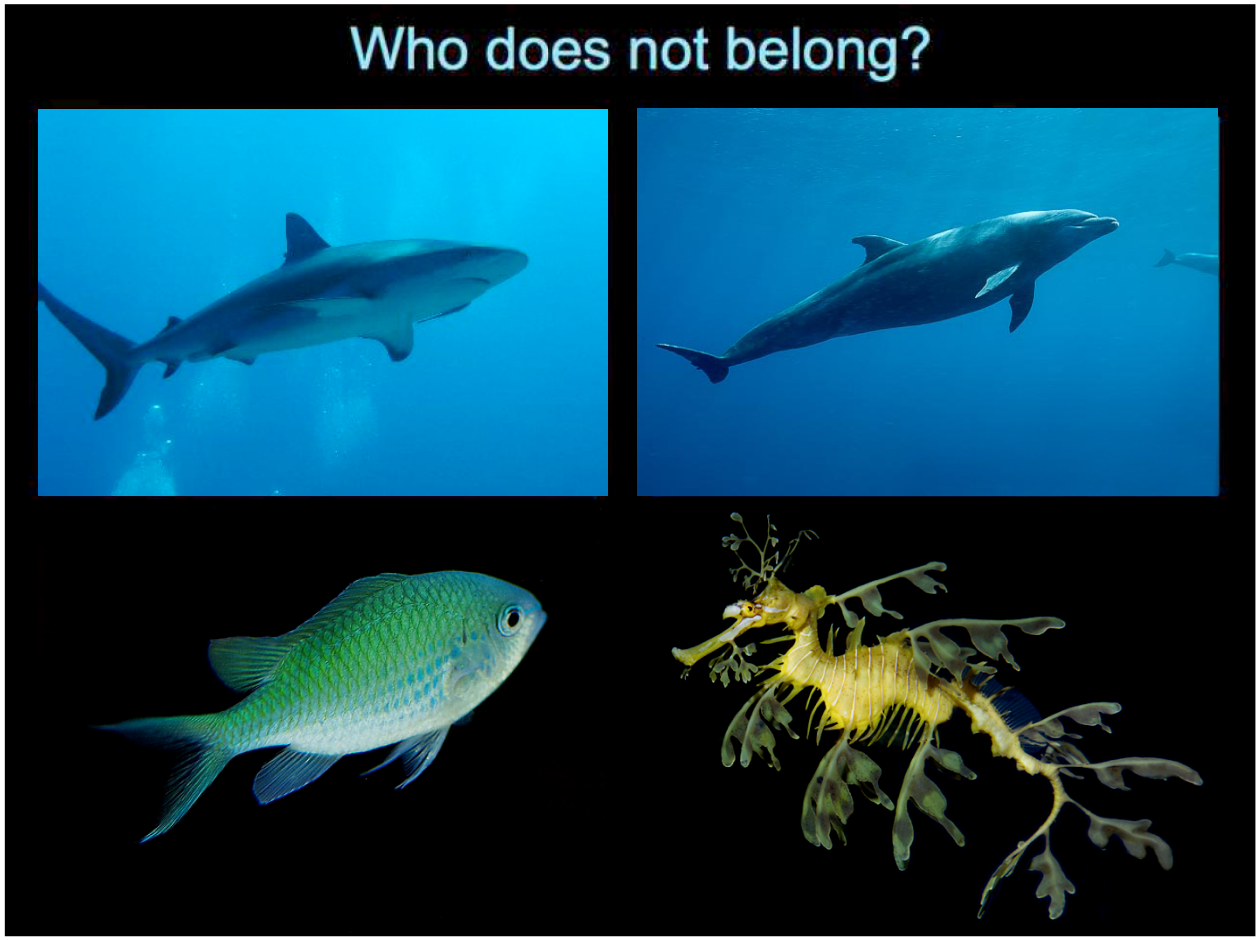

Fig. 1.53. The danger of classifying using only morphology. Who does not belong?

Kormendy 2013, in Secular Evolution of Galaxies, XXIII Canary Islands Winter School of Astrophysics, ed. Falcón-Barroso & Knapen, Cambridge Univ. Press, p. 1 (arXiv:1311.2609)

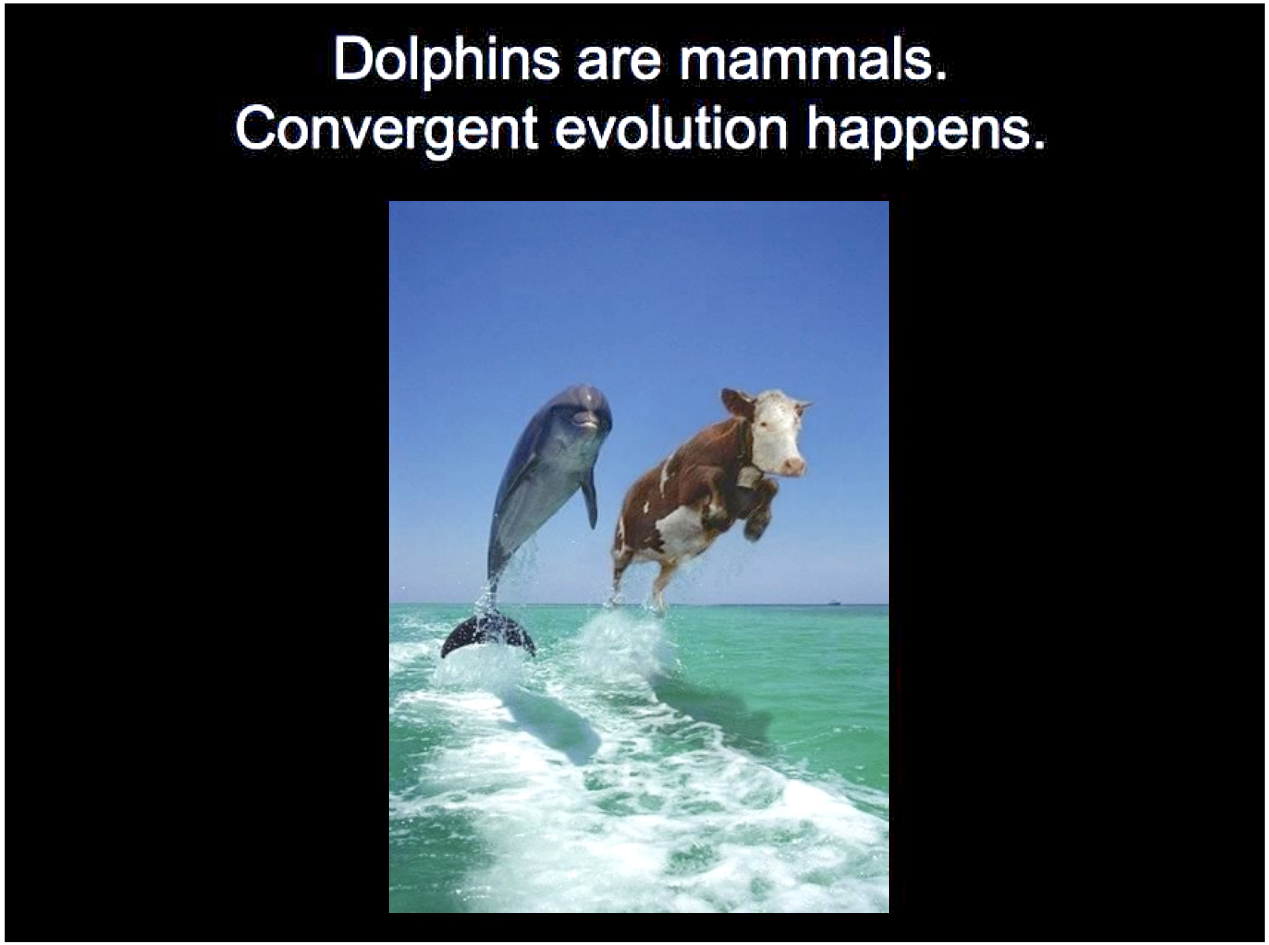

Fig. 1.54. Dolphins are Mammals. Convergent evolution happens. It happens to galaxies as well as to creatures on Earth, and elliptical and spheroidal galaxies prove to be examples. They look morphologically similar but have different formation histories. I warmly thank Douglas Martin (http://www.dolphinandcow.com) for permission to use this figure.

Who does not belong in Fig. 1.53? The answer is of course well known (Fig. 1.54). Dolphins (Fig. 1.53, top right) are mammals, ...

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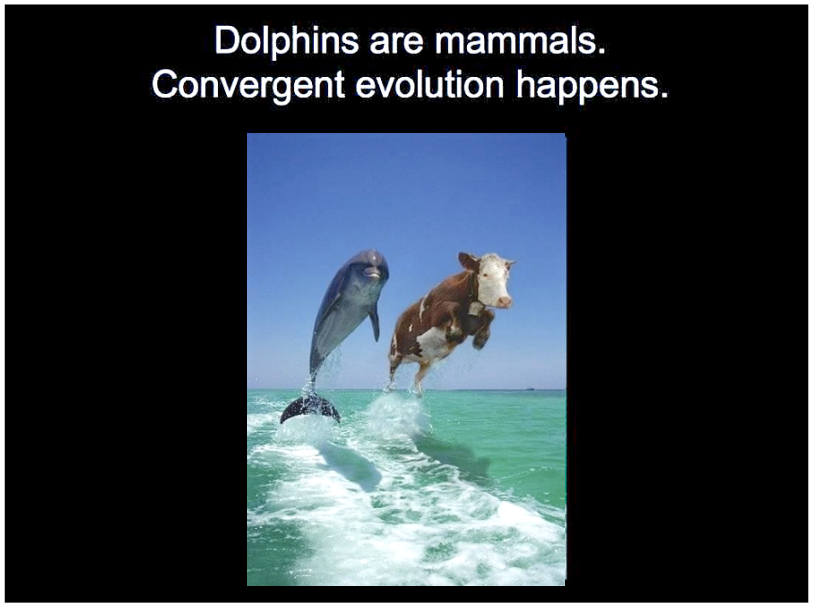


Fig. 1.54. Dolphins are Mammals. Convergent evolution happens. It happens to galaxies as well as to creatures on Earth, and elliptical and spheroidal galaxies prove to be examples. They look morphologically similar but have different formation histories. I warmly thank Douglas Martin (http://www.dolphinandcow.com) for permission to use this figure.

Who does not belong in Fig. 1.53? The answer is of course well known (Fig. 1.54). Dolphins (Fig. 1.53, top right) are mammals, even though they are morphologically similar to sharks (Fig. 1.53, top left). To make a living, both need to be well streamlined, strong swimmers. Convergent evolution made them that way. In contrast, a leafy seadragon (Fig. 1.53, bottom right: http://picasaweb.google.com/lh/photo/cEq5cwlB2_cmufKXlOKJcg) is a kind of seahorse whose main need is good camouflage to avoid predators. So, even though it is a fish, its morphology has evolved to be very different from that of a shark. A "Hubble classification" of sea animals that was superficially based on visible structural characteristics could mistakenly combine sharks and dolphins into the same or closely related classification bins and could miss the more subtle (but more important) differences that distinguish sharks and sea dragons from dolphins and cows. Which parameters best distinguish the physical differences that are most important to us is not necessarily obvious without detailed study.

Convergent evolution happens to galaxies, too.

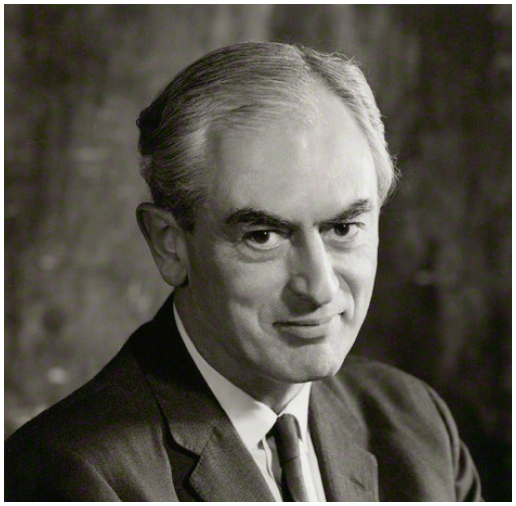
Try to develop a personal style.

Your personal "voice" can evolve as you get more experienced and more confident.

Important caution:
If you overdo it, you sound mannered*.
This is deadly.

But don't be shy to be yourself … and, if necessary, to defend your "voice" against pedantic editors.
Cautiously!

*Definition of "mannered" – Having an artificial or stilted character that is intended to impress other people.
Usually the feeling is that you are imitating yourself … but with too much "amplitude".



The bells which toll for mankind are – most of them, anyway – like the bells on Alpine cattle; they are attached to our own necks, and it must be *our* fault if they do not make a cheerful and harmonious sound.

Sir Peter Medawar
Reith Lectures (1959)