ETH zürich

Department of Physics

Scientific writing and publishing

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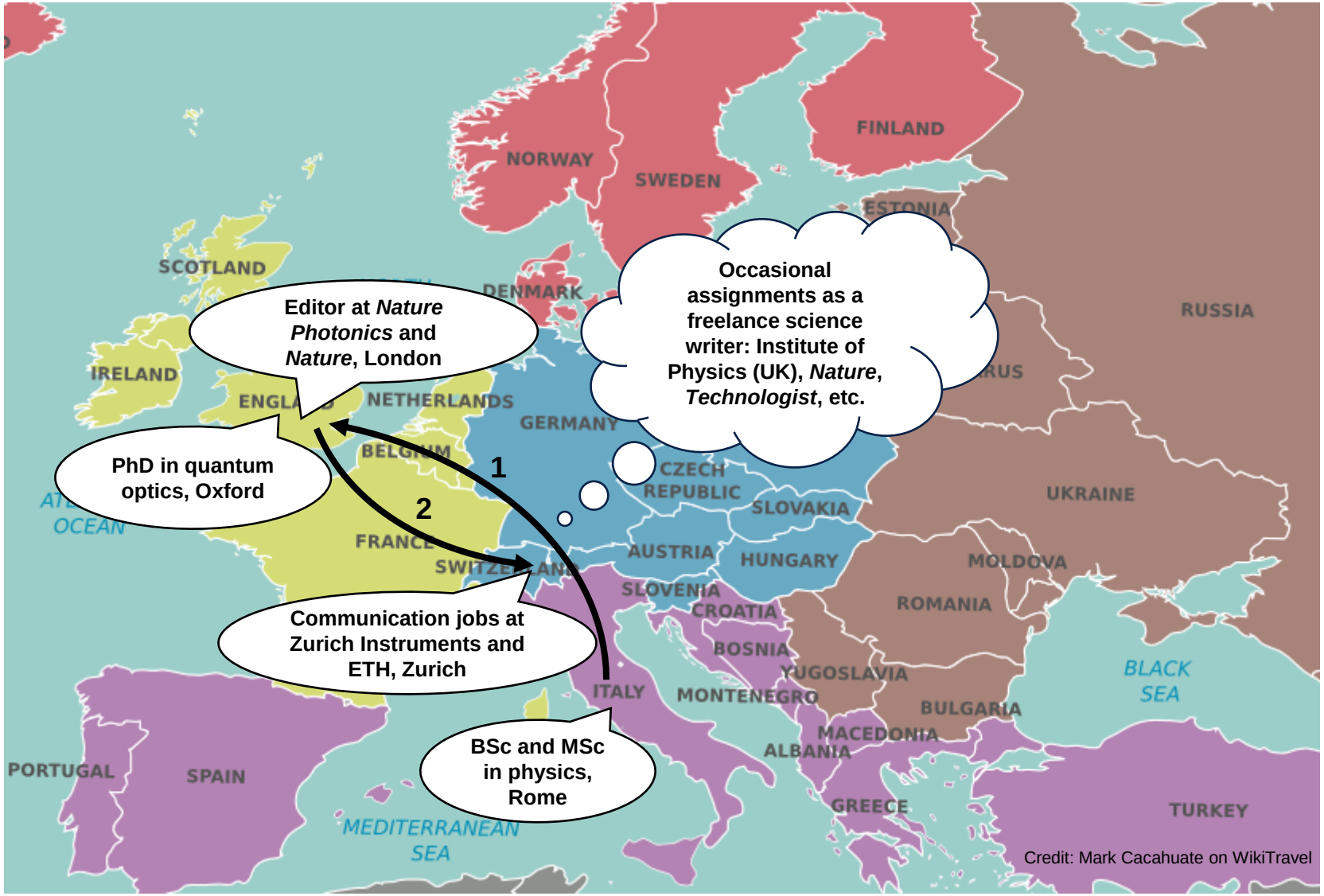
PhD Seminars Event, 20.12.2023

Outline

- A bit about me
- Part one: Writing a scientific paper
- Intermission: Your questions
- Part two: Publishing a scientific paper

A bit about me



Why write a paper about your research?

Possible answers

- To get a first-author publication so that I can finish my PhD.
- To get a job following my PhD.
- To show everyone we did it first/better/etc.
- Because that's how academic research works.
- Because I'd like my research community to know what I found out.

No matter your main objective – a paper must communicate effectively what you did.

Key questions

- What do I want to say?
- Who's my audience?

How do you know that you wrote a good paper?

None of this means your paper is badly written

- The manuscript is rejected by a journal.
- The published paper doesn’t get cited.
- The research isn’t highlighted or promoted by the journal.
- The paper isn’t picked up by the media.

A paper is badly written if relevant readers don’t understand what you did, how and why.

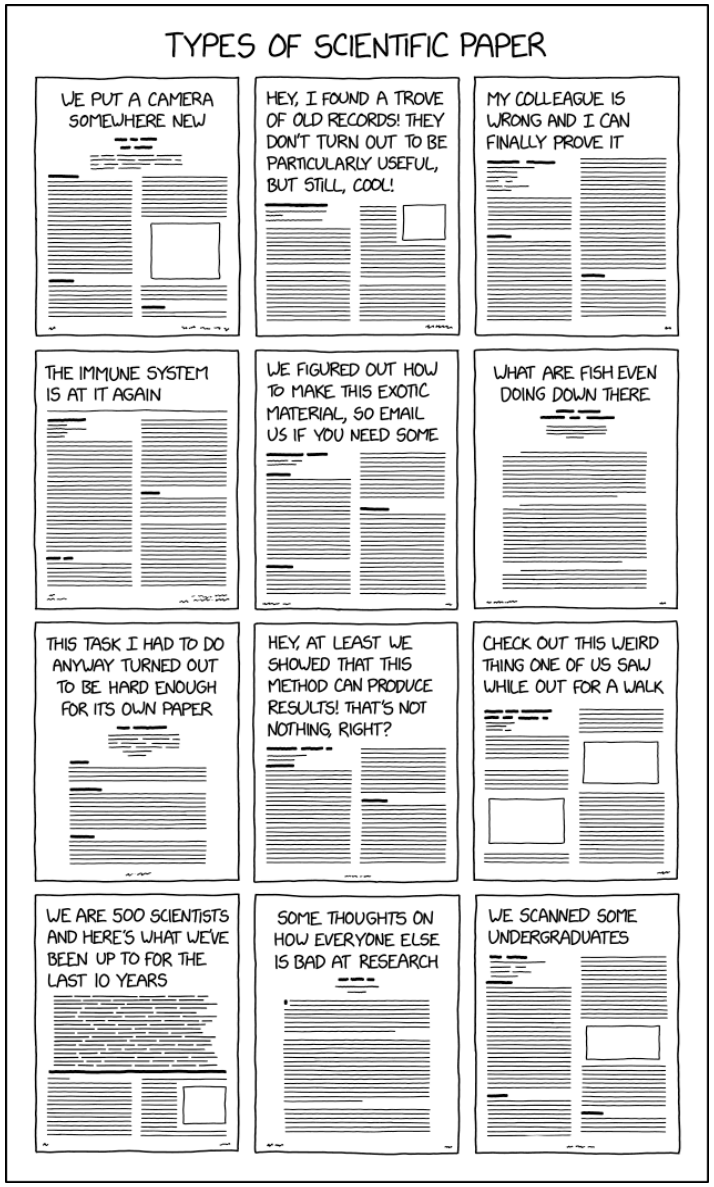
So how do you start?

Preparation work

- Identify your main finding(s): in general, one paper presents one key result.
- Classify your main finding(s): new observation or calculation, characterisation, new application, reproducibility study, etc.
- Identify the context of your research.

Points to discuss with your co-authors

- Everyone should be clear on their role.
- It’s best to limit the number of writers to 2 or 3.
- When asking a co-author for a draft review, be explicit on the kind of feedback you seek.



https://xkcd.com/2456/

So how do you start?

Possible ways to warm up

Option one:

- Write an ‘editorial summary’ of your study – it can be as short as 200 *characters*!
- Broaden that into an abstract – count about 200 *words*.

Option two:

- Draw a conceptual map with keywords linked to your work.
- From the terms – and connections! – on your map, identify a linear structure that can be turned into an abstract.

Once you have your ‘proto-abstract’, make a list of key sketches, plots, tables, etc.

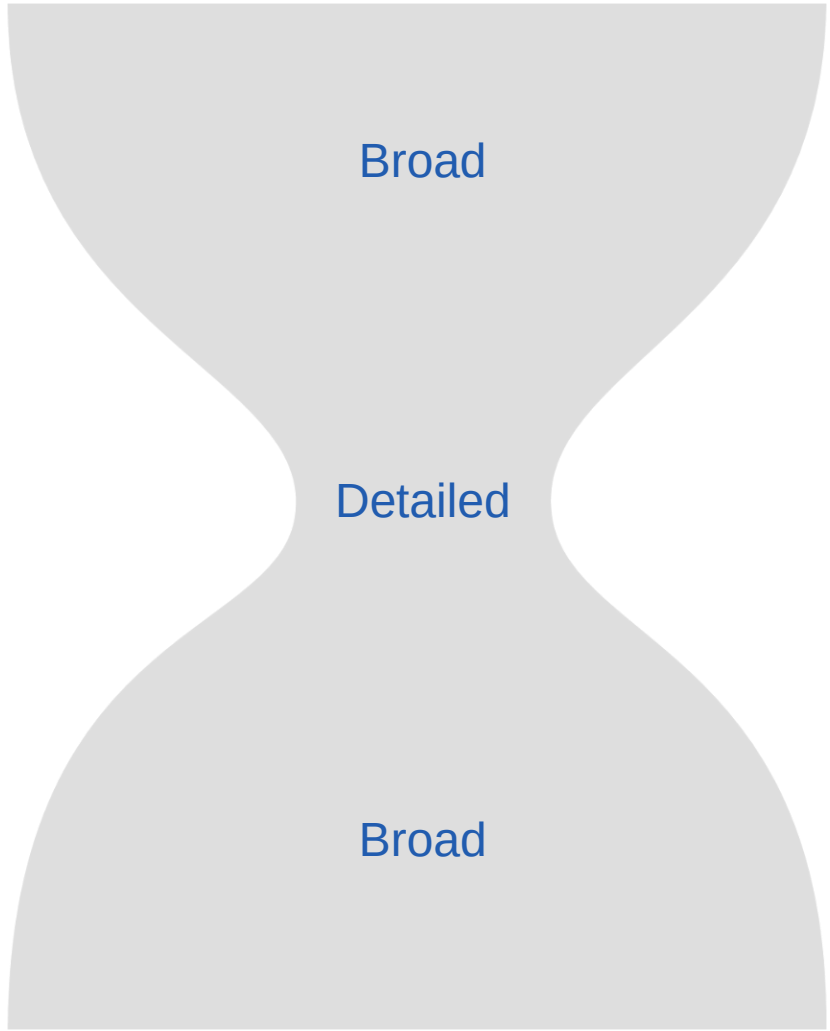
The structure of a paper

The IMRaD template

- **I**ntroduction
- **M**ethods
- **R**esults **a**nd
- **D**iscussion

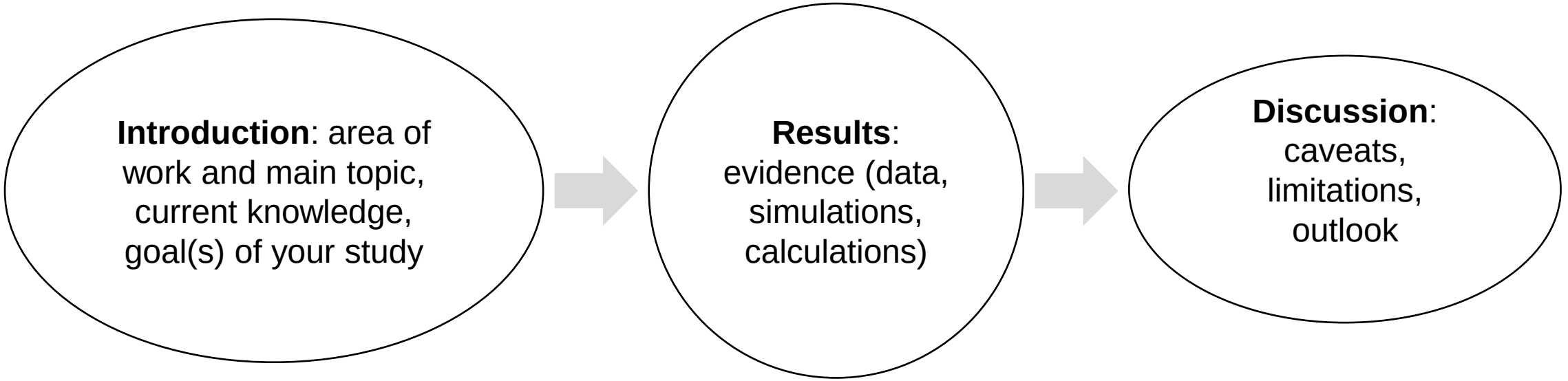
Examples of variants

- Methods at the end (see *Nature*) or found within results section
- Conclusions or outlook separate from discussion section



Articles not about primary research can have different structures, but the ‘hourglass’ remains.

The structure of a paper



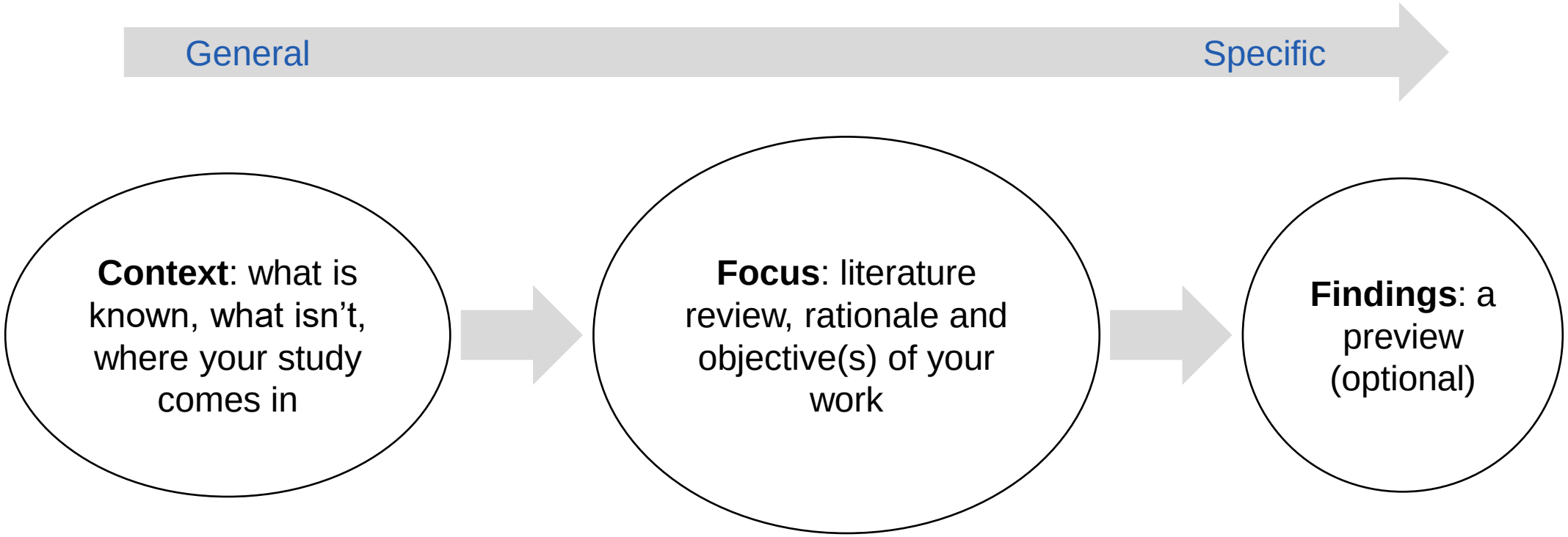
Can be one or few paragraphs

Generally divided into subsections with headings

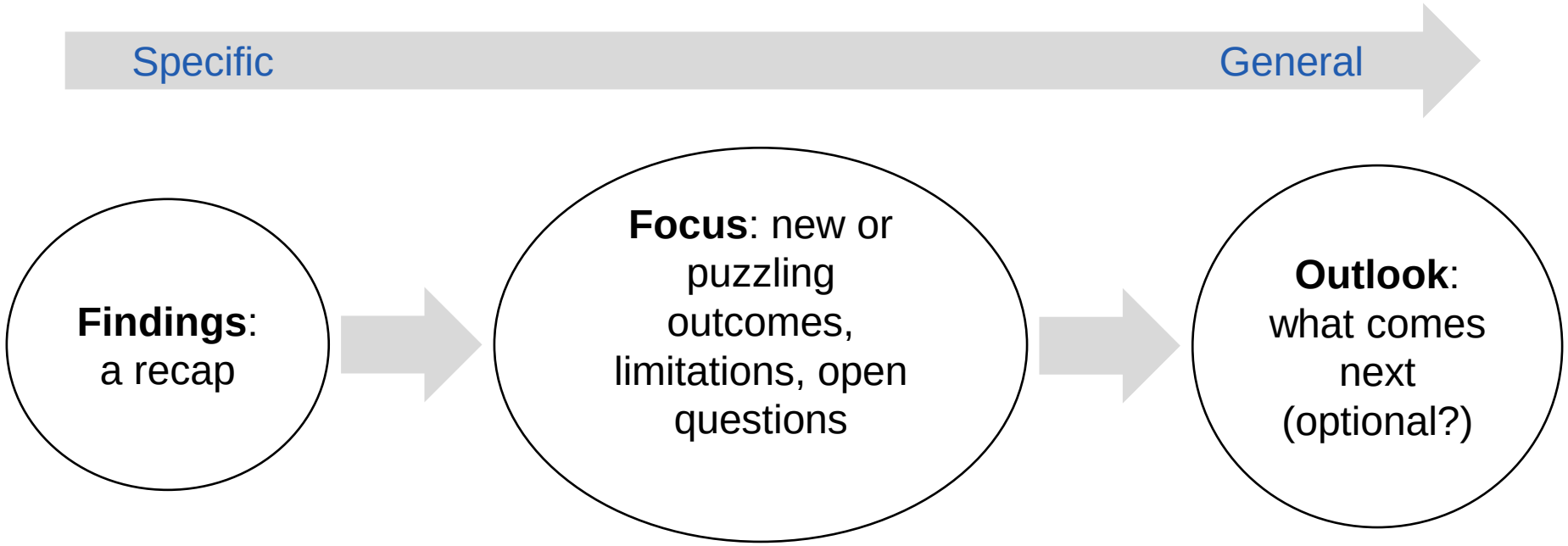
(Contains references to Methods and to supplementary material)

Can be one or few paragraphs

The structure of an introduction



The structure of a discussion



Zoom – Paragraphs

- The paragraph is the fundamental organisational unit in a paper.
- In general, a paragraph corresponds to one idea/sizable bit of information.
- It helps the reader to find clear transitions that connect paragraphs.
  - Continue: also, furthermore, in addition, etc.
  - Pause: for instance, similarly, likewise, etc.
  - Compare and contrast: by contrast, compared to/with, conversely, unlike, but, etc.
  - Express cause and effect: therefore, thus, consequently, because, as a result, etc.
- The start and the end of a paragraph should carry the most important input.

Zoom – Sentences

In a long sentence, readers often skip over the words in the middle, focussing instead on the words at the start and at the end…

… So here comes the “old before new” rule[1]:

- The beginning of a sentence makes a connection with what precedes it and sets the context.
- The ending of a sentence can emphasise known information or, crucially, introduce new and complex information.
- In any case, do your best to avoid long sentences!

[1] See “The craft of research” by Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, and William T. Fitzgerald, The University of Chicago Press, 4th edition (2016).

Tips – Hype and firsts

No need for hype

- Adverbs to avoid: surprisingly, strikingly, etc.
- Nouns and catch phrases to forget: breakthrough, holy grail, smoking gun, paradigm shift, etc.

No need for firsts

- “Here, we show for the first time …” – are you sure that you’re the first? And does it really matter?
- “To the best of our knowledge, this is the first demonstration/study/etc. …” is more mindful of potential ‘other firsts’.

Tips – Ambiguity and wordiness

Keep confusion at bay

- Repetition isn't necessarily bad, especially if it promotes clarity over confusion.
- The main causes of ambiguity are found in word choices, word order, pronouns and punctuation. Beware of the standalone "this"!
- Watch out for misplaced modifiers[2]: "Rising 24000 meters into the atmosphere in only 15 minutes, scientists estimated the height of the ash cloud."

Prefer action

"If rain forests are stripped to serve short-term economic interests, the earth's biosphere may be damaged." vs

"The stripping of rain forests in the service of short-term economic interests could result in damage to the earth's biosphere."

The first sentence is shorter and easier to read.[2]

[2] These examples are taken from "The craft of scientific writing" by Michael Alley, Springer, 4th edition (2018).

Tips – From acronyms to appendices

Acronyms

- Define them when you introduce them!
- When you revise your paper, monitor the density of acronyms and decrease it if necessary.

Figures

- Refer to all figures – in the right order – in the main text.
- Write figure captions so that they can be understood without having to check the main text.

References

- Cite papers you found useful, and prefer more recent articles to older ones (on a given topic).
- Check the journal's guidelines for constraints on the number of references.

Beyond the main text

- Don't use supplementary material/information or appendices as a dump… or a carpet.
- In the main text, refer to relevant sections and/or figures in the supplementary material.

The title of a paper

- It’s often the first visible piece of information about your work – make it stick.
- The title, like the abstract, should be searchable – think of the best keywords for your area of study.
- Avoid lengthy titles.
- Avoid questions, punctuation, puns, and acronyms (where possible).
- Aim for a (difficult!) balance between not being specific enough and being cryptic.

Examples of paper titles

Physics

Engineering Field-Insensitive Molecular Clock Transitions for Symmetry Violation Searches

Yuiki Takahashi, Chi Zhang, Arian Jadbabaie, and Nicholas R. Hutzler
Phys. Rev. Lett. **131**, 183003 – Published 31 October 2023

SYNOPSIS

Engineering Molecular Transitions for Symmetry-Violation Tests

October 31, 2023 • *Physics* 16, s154

Article | Open access | Published: 14 June 2023

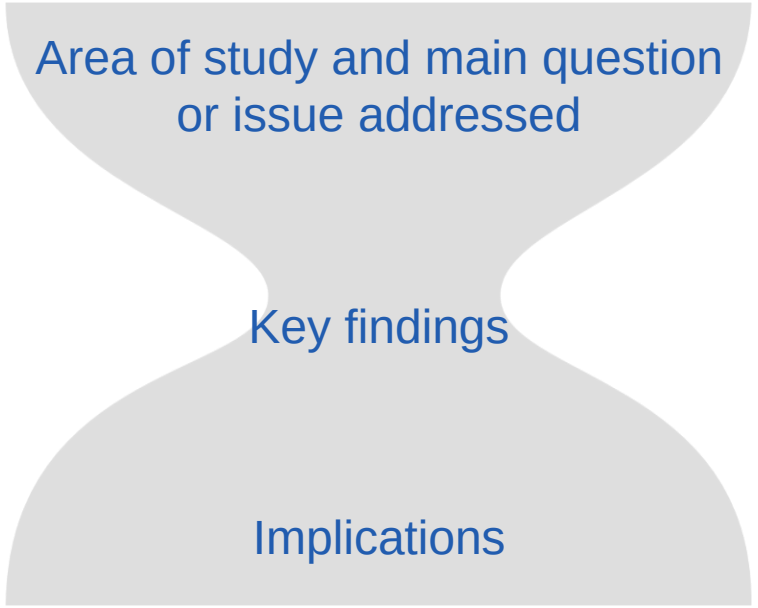
Evidence for the utility of quantum computing before fault tolerance

Youngseok Kim, Andrew Eddins, Sajant Anand, Ken Xuan Wei, Ewout van den Berg, Sami Rosenblatt, Hasan Nayfeh, Yantao Wu, Michael Zaletel, Kristan Temme & Abhinav Kandala

Nature **618**, 500–505 (2023) | Cite this article

Back to the abstract

- Once a first paper draft is ready, look at your ‘proto-abstract’ again (remember it?).
- How well does it match your main text in terms of key message?
- Make changes to the abstract to improve how it reflects the main text, because…
- … An abstract is a miniaturised paper.



A ‘classic’ abstract

“Quantum computing promises to offer substantial speed-ups over its classical counterpart for certain problems. However, the greatest impediment to realizing its full potential is noise that is inherent to these systems. The widely accepted solution to this challenge is the implementation of fault-tolerant quantum circuits, which is out of reach for current processors. Here we report experiments on a noisy 127-qubit processor and demonstrate the measurement of accurate expectation values for circuit volumes at a scale beyond brute-force classical computation. We argue that this represents evidence for the utility of quantum computing in a pre-fault-tolerant era. These experimental results are enabled by advances in the coherence and calibration of a superconducting processor at this scale and the ability to characterize[1] and controllably manipulate noise across such a large device. We establish the accuracy of the measured expectation values by comparing them with the output of exactly verifiable circuits. In the regime of strong entanglement, the quantum computer provides correct results for which leading classical approximations such as pure-state-based 1D (matrix product states, MPS) and 2D (isometric tensor network states, isoTNS) tensor network methods[2,3] break down. These experiments demonstrate a foundational tool for the realization of near-term quantum applications.” (*Nature* **618**, 500-505 (2023))

A reader-friendly abstract

“Molecules are a powerful platform to probe fundamental symmetry violations beyond the standard model, as they offer both large amplification factors and robustness against systematic errors. As experimental sensitivities improve, it is important to develop new methods to suppress sensitivity to external electromagnetic fields, as limits on the ability to control these fields are a major experimental concern. Here we show that sensitivity to both external magnetic and electric fields can be simultaneously suppressed using engineered radio frequency, microwave, or two-photon transitions that maintain large amplification of CP-violating effects. By performing a clock measurement on these transitions, CP-violating observables including the electron electric dipole moment, nuclear Schiff moment, and magnetic quadrupole moment can be measured with suppression of external field sensitivity of $\gtrsim$100 generically, and even more in many cases. Furthermore, the method is compatible with traditional Ramsey measurements, offers internal co-magnetometry, and is useful for systems with large angular momentum commonly present in molecular searches for nuclear CP violation.” (*Phys. Rev. Lett.* **131**, 183003 (2023))

An imbalanced abstract

“Einstein’s general theory of relativity from 1915[1] remains the most successful description of gravitation. From th 1919 solar eclipse[2] to the observation of gravitational waves[3], the theory has passed many crucial t that there is al theory o . It is thus pru 915. Dirac’s specula st be attracte antimat ce principl ucture. Here we ratus, behave out in this case. This experiment paves the way for precision studies of the magnitude of the gravitational acceleration between anti-atoms and the Earth to test the WEP.” (*Nature* **621**, 716–722 (2023))

Article | Open access | Published: 27 September 2023

Observation of the effect of gravity on the motion of antimatter

E. K. Anderson, C. J. Baker, W. Bertsche, N. M. Bhatt, G. Bonomi, A. Capra, I. Carli, C. L. Cesar, M. Charlton, A. Christensen, R. Collister, A. Cridland Mathad, D. Duque Quiceno, S. Eriksson, A. Evans, N. Evetts, S. Fabbri, J. Fajans, A. Ferwerda, T. Friesen, M. C. Fujiwara, D. R. Gill, L. M. Golino, M. B. Gomes Gonçalves, ... J. S. Wurtele + Show authors

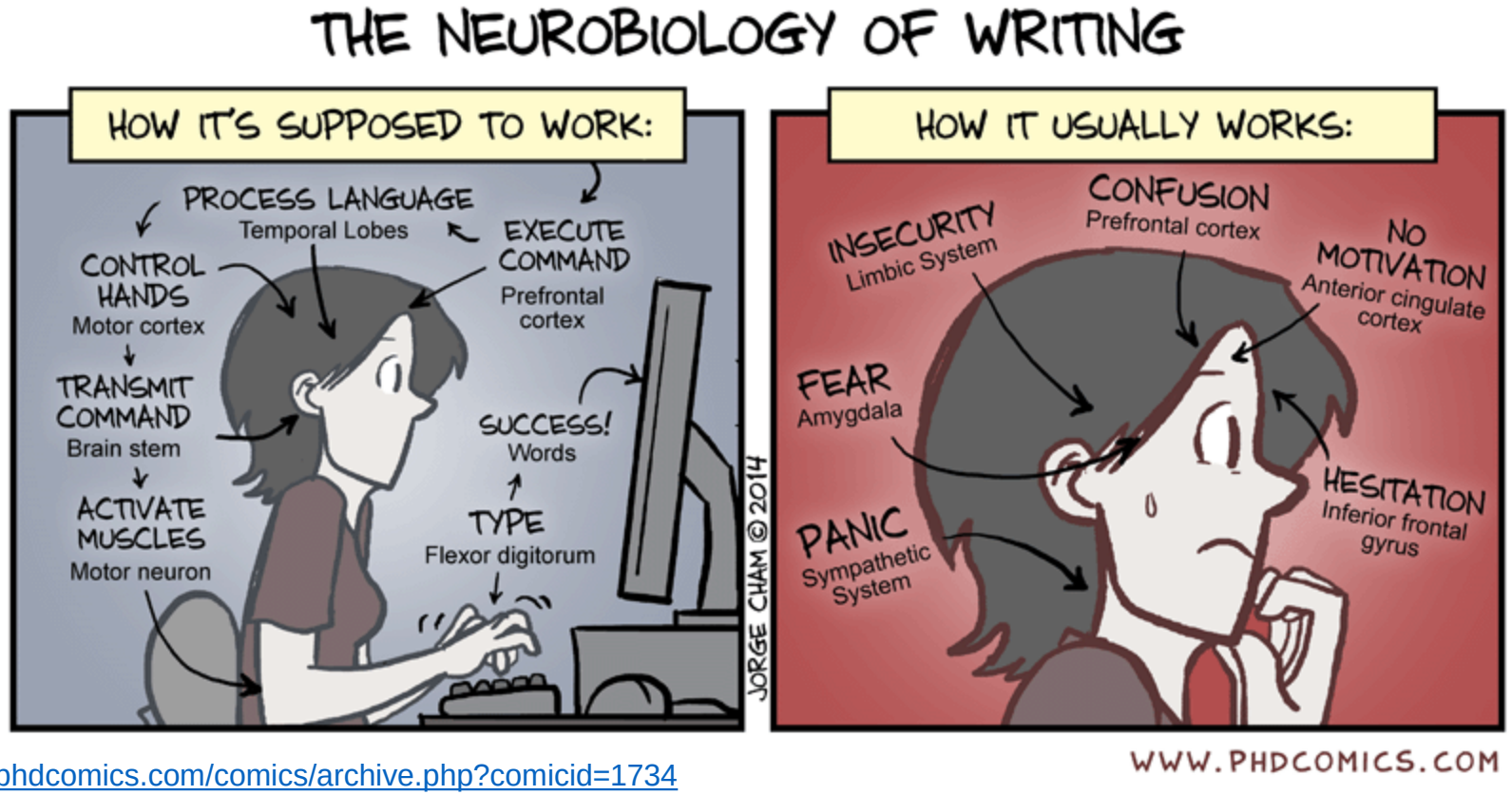
An imbalanced abstract

"Einstein's general theory of relativity from 1915[1] remains the most successful description of gravitation. From the 1919 solar eclipse[2] to the observation of gravitational waves[3], the theory has passed many crucial experimental tests. However, the evolving concepts of dark matter and dark energy illustrate that there is much to be learned about the gravitating content of the universe. Singularities in the general theory of relativity and the lack of a quantum theory of gravity suggest that our picture is incomplete. It is thus prudent to explore gravity in exotic physical systems. Antimatter was unknown to Einstein in 1915. Dirac's theory[4] appeared in 1928; the positron was observed[5] in 1932. There has since been much speculation about gravity and antimatter. The theoretical consensus is that any laboratory mass must be attracted[6] by the Earth, although some authors have considered the cosmological consequences if antimatter should be repelled by matter[7,8,9,10]. In the general theory of relativity, the weak equivalence principle (WEP) requires that all masses react identically to gravity, independent of their internal structure. Here we show that antihydrogen atoms, released from magnetic confinement in the ALPHA-g apparatus, behave in a way consistent with gravitational attraction to the Earth. Repulsive 'antigravity' is ruled out in this case. This experiment paves the way for precision studies of the magnitude of the gravitational acceleration between anti-atoms and the Earth to test the WEP." (*Nature* **621**, 716–722 (2023))

An imbalanced abstract

“Einstein’s general theory of relativity from 1915[1] remains the most successful description of gravitation, with many crucial experimental tests passed. However, singularities in general relativity and the lack of a quantum theory of gravity suggest that our picture is incomplete. Exploring gravity in exotic physical systems may thus lead to useful insights. Since the positron’s observation[5] in 1932, there has been much speculation about gravity and antimatter. The theoretical consensus is that any laboratory mass must be attracted[6] by the Earth, although some authors have considered the cosmological consequences if antimatter should be repelled by matter[7,8,9,10]. In the general theory of relativity, the weak equivalence principle (WEP) requires that all masses react identically to gravity, independent of their internal structure. Here we show that antihydrogen atoms, released from magnetic confinement in the ALPHA-g apparatus, behave in a way consistent with gravitational attraction to the Earth. Repulsive ‘antigravity’ is thus ruled out in this case. This experiment paves the way for precision studies of the magnitude of the gravitational acceleration between anti-atoms and the Earth that will test the WEP.” (*Nature* **621**, 716–722 (2023))

Intermission – Please ask questions!



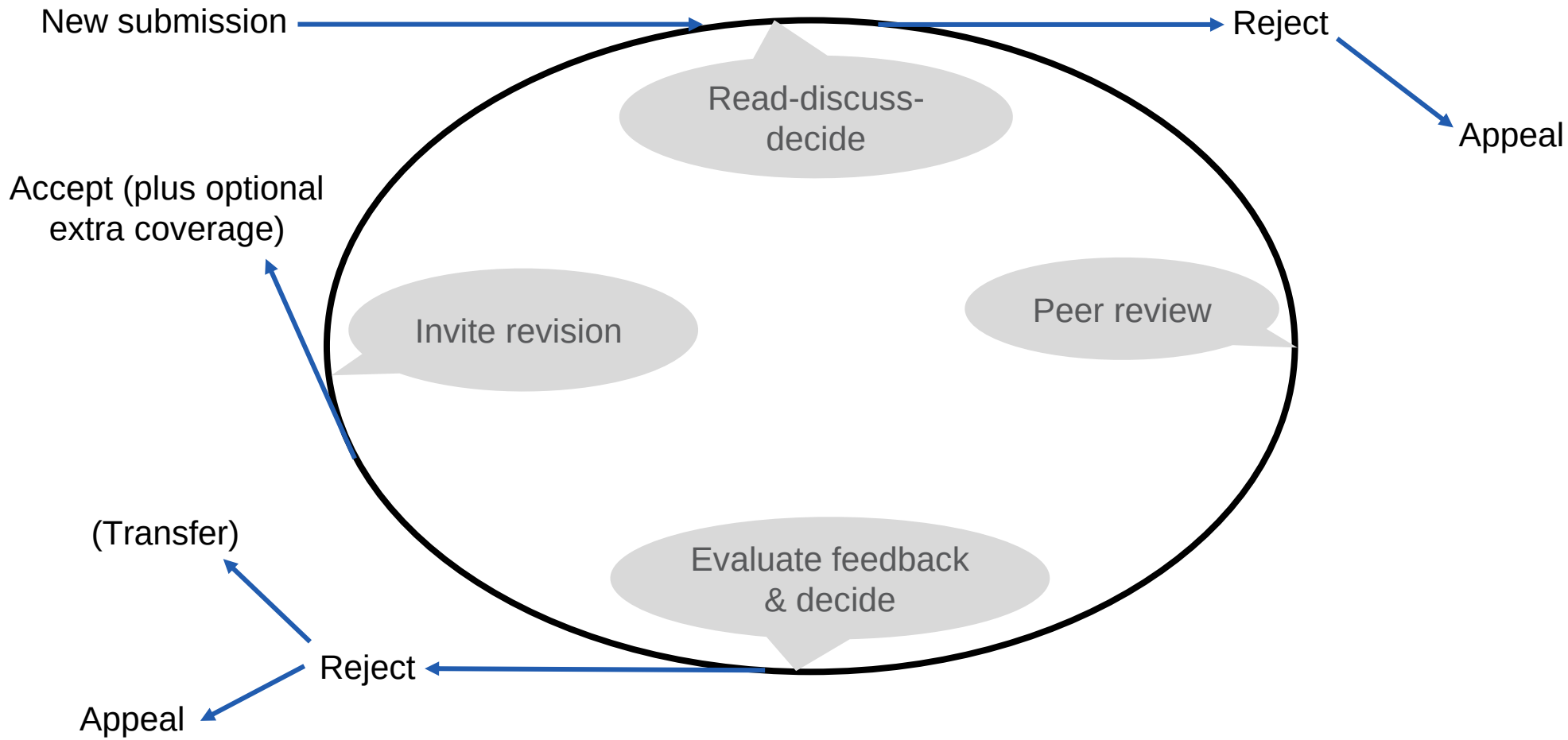
https://phdcomics.com/comics/archive.php?comicid=1734

Navigating the publishing landscape

Questions to discuss and answer with your co-authors

- Do your research funders have specific policies about publication strategies?
- What journals/information platforms cover your area of study?
- What publishing models do these journals/platforms offer?
- Are they highly selective journals (see *Science*) or are they mega-journals (see *Scientific Reports*)?
- Who are the editors responsible for manuscript assessment and the peer review process?
- How does peer review work?
- What is the offered level of curation – that is, how do these journals/platforms add context to a paper?

Shining some light on a journal's editorial process



Tips and thoughts from a former editor

- If you don’t value dissemination, transparency and reproducibility, this will show up in your paper.
- When they exist, use pre-submission enquiries to get prompt feedback (special tip for consortia papers!).
- Non-trivial suggestions for experts and reasonable requests for referee exclusions are great input for editors.
- Be honest about the limitations of your work – hiding shortcomings will not help.
- Don’t be lazy with your revisions – it will only slow down the review process.
- Authors and referees are two sides of one coin.

An editorial rejection isn’t a judgment on the quality of your research or of your writing.

Further food for thought

EDITORIAL

The Letters are getting out of hand again. This journal can fulfill its function only if each issue does not contain more than about a dozen Letters. Fifteen should be the maximum. But we receive over three times as many manuscripts and publish twice as many Letters as we believe to be right. Moreover, "Letters" have grown longer, which would not be objectionable if the increase had resulted in greater clarity.

It is impossible to set precise standards for the acceptance of "Letters"; it is thus also impossible to be consistent in our criteria. There are only a few Letters which obviously deserve rapid publication, and we receive many which clearly do not need this special service. The difficulty is to draw the line among the multitude of "Letters" which fall between these extreme categories. We shall have to be at times arbitrary in our decision.

The following are some of our pet peeves: an author who gets an interesting "Letter" published and now believes that all subsequent results of his work must be published in a series of "Letters"; another author arriving at a later result in the same subject who demands the right to have his work also published as a "Letter"; an author who uses the "Letters" merely to announce a later paper and whose Letter is incomprehensible by itself; an author who submits a "Letter" which is merely an amplification of a previously published meeting abstract; an author who submits many Letters hoping that statistics rather than quality will cause one to be accepted; an author who carries a chip on his shoulder and casts aspersions on the motives and integrity of a referee who gives an adverse report on his paper; an author who tries to sneak a Letter in to "scoop" a competitor who has already submitted a full Article; an author who fails to make clear in the introduction the scope and significance of his paper; an author who has so little regard for his paper that he doesn't check it for typographical errors and omissions; an author who pays no attention to Physical Review Letters style; etc., etc.

In view of these considerations we shall have to be stricter and thus more arbitrary in our rejection policy for Letters.

(*Phys. Rev. Lett.* **6**, 587)

When do you think this was written?

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(*Phys. Rev. Lett.* **6**, 587)

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1 June 1961

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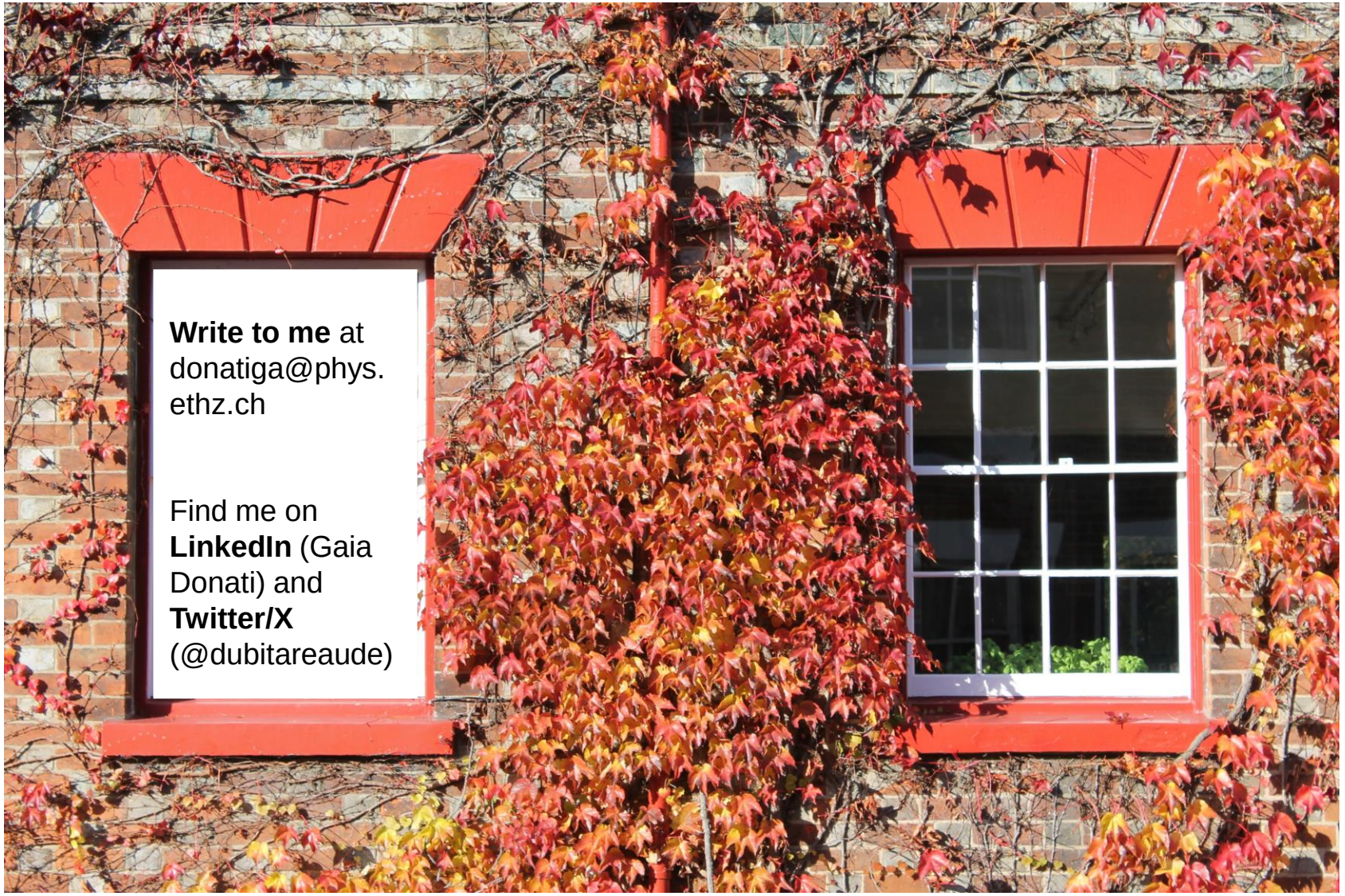
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