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HOW TO WRITE A PAPER?

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November 2025

Why write a paper?

Bad reasons:

- “*Cosí fan tutte*” (“Everybody else does it”): this is what academics do for living;
- I have been busy doing research, have been getting results and now I want the world to know about it;
- It is competitive out there and unless I rush to record *my* achievements, they might be recognised as somebody else’s achievements;
- I want dissertation, postdoc, career, tenure, fame! I want the world to be at my feet.
- I suffered doing this research, now it is your turn!

A good reason: (embarrassing in its simplicity)

- I want to communicate ideas to other people.

Why is this important?

Because every good text *must* be considered first and foremost **from the point of view of its target audience.**

The Moore Library* holds about 75000 volumes of more than 2100 mathematics and theoretical physics journals. This is plenty of dead trees! Your paper needs to compete with thousands of other papers in a very crowded marketplace of ideas for the (very) limited attention of busy academics. Nobody has a God-given right to be read: it is **your** duty to persuade them that they should expand time and attention on your paper.

A good rule of a thumb is: ***Ask yourself which sort of paper would you like to read – and then write it!***

*The library of Centre for Mathematical Sciences in Cambridge.

Good reason 1 to read a paper:

Good title and abstract

A title and an abstract are your shop window. Most potential readers browse journals, whether in a library or on Internet, like shoppers on High Street. By this stage the purpose of the exercise is to grab their attention sufficiently to motivate them to read on:

1. Good title uses few well-chosen words to place your paper at a highly-visible corner of the mathematical universe. Good abstract states clearly what is the subject area of the paper and its main results.
2. Use non-technical language. Your abstract should be understandable not just to few experts but to everybody in its wider constituency. This is particularly important if the results are relevant beyond your narrow specialism.
3. Never use in the abstract (or the title!) concepts that you define later in the paper.
4. Avoid complicated mathematical formulæ and references to bibliography. Titles and abstracts should stand on their own (hence no references) and be easily translatable to **HTML** (which, except for its **XML** manifestation, is hopeless with mathematical symbols).
5. Like at High Street, a major reason to pay attention to a product is because of its **branding** – in our context this means the visibility and renown of the author(s). Of course, these are early days for you and in this stage of your career you are at a disadvantage – but remember that your papers now shape your future ‘brand’!

Good reason 2 to read a paper:

Good introduction

The attention span of busy academics is very short: your challenge, once you persuaded people to look beyond the abstract, is to keep them reading.

1. Explain very clearly what exactly is the problem that you are addressing in the paper – and **why**. Remember: you have worked on the wretched thing for months and months, for you the motivation is clear. But you are trying to persuade people that perhaps never thought about your problem. Mathematical results are worthwhile not simply because they interest **you**. It is always a good idea to commence with broad-brush context, explaining why the theme of your paper is relevant and important.
2. Sketch the main results of the paper. No need to seek the greatest generality, which often depends on mathematical machinery that you'll introduce later. It is better to explain clearly and accessibly the main ideas, methodology and applications.
3. Use profusely examples, toy problems and figures.
4. Place everything into context. You aren't the first to consider this problem, neither the first to say something worthwhile about it.
5. Provide continuity with relevant previous work. Not everybody remembers everything in papers underlying your argument. And sending the hapless reader to consult five different references in each paragraph is anti-social and (between me and you) they will not do it – and probably stop reading your paper altogether!

It is a well-known fact that readers form their opinion of a document after reading its first few paragraphs: all that follows just reinforces their views.* And yes, this includes the referees who, all rumours to the contrary, are also human – for better and for worse. **That's why the first few paragraphs of the paper are crucial: inform the reader what is the problem you are solving and what is the **USP**: Unique Selling Point of your paper.** Be factual yet informative. Avoid praising or bigging-up your own work: it is up to your readers to decide if it is indeed a revolutionary, groundbreaking, paradigm-shifting work of genius!

Provide references to your problem and major previous attempts to address it *but never use more than 5–6 references!* Your readers are not interested in your esoteric pastimes: you might have read 500 papers but, believe me, in this cold, dark universe nobody cares! Choose important references, by respected researchers and from top journals.

*There are good reasons, associated with brain sciences, why this is so.

Good reason 3 to read a paper:

Good presentation

There are a number of issues that improve presentation:

Structure. Plan in advance the structure of the paper: sections, subsections and their content. Structure should be logical. It should *never* follow specific personal meanderings of your research (i.e., your personal logic) but the logic of a person trying to assimilate this information. Remember: ***Research is nonlinear, presentation must be linear.***

Sections should not be too long and, as necessary, might be broken into subsections: information is absorbed better in digestible chunks. Your argument should be illustrated by examples, tables and figures. It is sometimes a good idea to use a single running example to illustrate different stages of your argument.

New concepts should be introduced at the point where they make sense and where their relevance is clear from the context.

It is often useful to the reader to conclude your paper with a brief overview of the results and with pointers for future research.

Notation. Much of the clarity of your argument depends on notation. It is a good policy to decide on notation in advance (think how messy it is to change it mid-stream) according to a number of general rules of the thumb:

- Consider the use of notation as an opportunity to clarify your argument and inform the reader, not just as a technical burden.
- Don't invent your personal notation if an agreed notation already exists in your subject.
- Keep to convention: thus, “for every $\varepsilon > 0$ there exists a $\delta > 0$ ” (not the other way around), $\varepsilon > 0$ is small and $R > r$. Clever dickerly is a silly distraction.
- Consistency in notation helps the reader to organise information. For example, **boldface** for vectors, UPPER CASE for matrices, SHELL CAPITALS for sets and **Gothic** – well, best avoided except for Gothic novels. . .
- Avoid a profusion of subscripts, superscripts, multiple indices, hats, inverted hats, tildes, double tildes, The fact that it can be done with \LaTeX is not a sufficient reason to do it!
- You might have defined something-or-other on page 5. This doesn't mean that the reader will remember it on page 27. Sometimes it is a good policy to recall important definitions and notation.
- Never, but never, overload notation!

Language. Papers are not written in Mathematese, they are written in English. Remember: language is the main tool to convey information. Endless bright ideas have been rendered obscure and impenetrable by poor language.

- First and foremost, even if your native language isn't English, **avoid poor or careless linguistic presentation**. Be sensitive to the language, its grammar, idiom and rhythm.
- Presentation shouldn't be overly flowery or informal: this is not a paper in literary criticism and you are primarily judged on your ideas and their clear presentation, not on linguistic virtuosity. The language should be clear, unambiguous and informative.
- Avoid like the plague the sort of lifeless formalism and dry linguistic economy that made Bourbaki books declared as torture under the European Human Rights Act.
- Occasional flash of lighthearted humour or informal language is fine. Mathematics stand-up style is not.
- Be verbose enough to be clear – yet concise enough to privilege your core mathematical argument over its presentation.
- Not using a spell-checker is major folly. Relying totally on a spell-checker is carelessness: no spell-checker will distinguish between “some” and “same”. And it might lead to unexpected outcomes. . .
- Polishing your language with CHAT-GPT (or similar) software is an excellent idea – but the outcome must be checked carefully by a well-qualified, functioning human. Remember, LLMs don't *understand* mathematics, just Hoover existing results from the Internet.

An unfortunate outcome of an automatic language translation...



References:

- [1] Menu in a restaurant near JiaoTong University, Xi'an, China (2014).

Proofs & co. Your argument – in particular your own contribution to the subject – should be self-contained. Only trivial issues may be “left to the reader”. If you present a statement, say, and promise a proof elsewhere, there is a good reason to believe that your paper should not have been written at the first place. Having said so, there is often a good reason to relegate gory technicalities to an appendix, while providing enough information in the body of the paper for the reader to understand the gist of your argument.

Once presenting material of others – as is sometimes necessary, whether to explain your narrative or place it in context – you may skip technicalities and unnecessary details or proofs (always with proper reference).

Presenting your own results, it is a good strategy in long proofs or constructions to explain in advance the main chain of argument. **You are not writing a detective story but a mathematical paper!** Also, it is a good idea to explain exactly how your statements, definitions, theorems, proofs and numerical results differ (for better or for worse) from other work.

Your claims. Be careful to give credit where credit is due, refer generously to the work of others* and graciously acknowledge their help. This is not just a matter of basic decency or of long-term calculation to generate goodwill and avoid tit-for-tat spats. Clarity in referring to the work of others helps the reader to identify your own contribution to the subject.

Nobody expects you to change human knowledge as we know it in this paper. **You are standing on the shoulders of giants: what was good for Isaac Newton is good enough for you!** Never overstate your results: you may occasionally mislead the ignorant but experts will laugh with audible scorn.

Remember: Every mathematical innovation has limited scope. A new theory, result or algorithm is typically good for something, inferior (or irrelevant) for something else. Being honest about the scope of your new results is elementary academic duty, it is also the right long-term strategy.

*Incidentally, referring to detail in a book, it is useful to provide a page number.

Multimedia. A good, well-crafted picture is *not* worth a thousand words but it can admirably illustrate and clarify your argument.

- The correct way of displaying graphic information often calls for a great deal of imagination. It is not just displaying a number of curves on a graph in an obscure fashion. A picture should make a specific point and its presentation must be geared towards this.
- Make the picture easy to understand. Thus, avoid information overload. Thus, label precisely and concisely. Thus, avoid a plethora of solid, dashed, dotted, dot-dashed, dot-dash-dot-dotted etc. lines – you are not sending a Morse code message! Thus, remember that your figure might be in the most vivid technicolour but the journal might be printed in monochrome and information might be lost. Thus, explicitly link figures to text and explain in words their significance.
- Too many figures spoil the argument: you are writing for mathematicians, not for the *Hello* magazine.
- There is no need for trivial figures: do you really think that plotting a linear function or a circle will add to your presentation?
- The practice of following the main body of the paper by endless figures and drawings is singularly unhelpful, often seen (often rightly) as bulking lightweight material with graphics and often disregarded by weary readers. Consider graphic information as an integral part of your information flow, rather than as an add-on.

T_EXpertise. Write yours papers in L^AT_EX, A^MS_TE_X or plain T_EX. **Not** in MS Word unless you wish your paper to look clumsy and unprofessional.

- It is a good idea to use from the outset the class file of the relevant journal. Once the paper is accepted, this will make copy-editing easy but (more importantly from your point of view) prevent massive changes over which you might have little control and which can introduce unexpected errors.
- It is sound policy to use macros since this practice minimises typos and makes late changes safer. (Note that some journals frown upon this.)
- Unless you know exactly what you are doing, don't tinker with build-in parameters, like `\parindent`, `\parskip` or `\topfraction`: they are there for a reason.
- Avoid **too many** font CHANGES, **funny** ^{SIZE} letters and other juvenile tricks.
- Clumsy, careless T_EXing is obvious to the experts (i.e., most of us) and demonstrates lack of respect to readers (and to referees!). Thus, consistently avoid overfull or underfull `\hboxes` and `\vboxes`. Break equations sensitively in regard to both mathematical content and aesthetics. **Always** typeset maths in maths style.
- References must *always* be in alphabetic order of authors.
- Using BibT_EX is good policy, both in minimising eventual effort and in making stylistic changes easier.
- Don't let a preoccupation with endless minutiae of T_EXing become an obsession. With all its importance, typesetting is just a tool.

That extra professional touch. A carefully written paper is like roses for Valentine: it demonstrates to your readers (and this includes your referees) that you care and that you respect them.

- You may write in English or in American, but **never** mix the two in a single paper. This is not just “behaviour” vs “behavior” or “maths” vs “math” but more subtle issues. For example, in OED English (but not in American) an abbreviation that ends with the same letter as the original word (Mr, Ms, Dr, Revd – but not Prof.) comes without full stop.
- There is also difference between UK and US maths presentation. Thus, in UK maths, constants are typeset in Roman (`\mathrm{ }`):

in Cambridge, Mass $e^{i\pi} = -1$, in real Cambridge $e^{i\pi} = -1$.

After a while, this becomes second nature.

- Typically, figures are produced with MATLAB, MAPLE or MATHEMATICA. None of these uses the same font as T_EX (Computer Modern) and some make the use of Greek or nonstandard letters difficult in captions. It is possible, though (with moderate difficulty) to tweak an .eps file, changing the font from Helvetica to Times-Roman and even generating Greek letters and nonstandard symbols with the Symbol font.
- In multi-author papers it is vital that the final version is written (or at least thoroughly copy edited) by a single person. You know, clumsy stitches show and they a'int pretty!

Good reason 4 to read a paper: Relevance

To write or not to write? There exists natural temptation to take any half-decent piece of research and use it like soup concentrate: add some leftovers and huge amounts of water and publish it as several incremental papers. By the end of your PhD you'll have a long publication list: enough to impress the bureaucrat, the careless or the unwary. ***But no professional will fall for it!*** Unless you have something both new and substantive to say, don't say it! Good reputations are built on **good** publications, not on **plentiful** publications.

If more than a third of your paper is devoted to reviewing (your or others') previous work, rather than to new results, you probably don't have enough substance to justify a paper. And referees will notice it.

On the other hand, don't be intimidated by all the wonderful and hard-to-understand papers that you've read. Yes, you can understand your paper easily – but that's because you've been working on it for a long time. As long as it has a substantive body of significant results, it will probably be an important (and difficult) contribution to scholarship and a good publication!

The paper mill

Every good paper should mature in oak (or silicon). Have you finished a paper? Read it again. And again. And again. Correct it. Give it to colleagues for their reaction. Correct it again. Then let it rest in a computer folder for a week or two. Then read it again – you'll be amazed by the number of corrections! **And then stop.** There comes a point where you can't go on and on with corrections.

Off to Internet. Even before you send the paper to a journal, it is a good idea to share it on your (or your group's) website. You may also deposit it in one of subject-specific Internet archives, ideally **arXiv**.

You can let interested parties (or appropriate websites) know about your paper and send them the abstract or the URL – but unless you are completely confident that they will welcome it, don't jam their in-boxes with the pdf file. They will not thank you for this.

Golden age vs golden access? The traditional model of publishing:

- Journals are all printed in hard copy;
- Authors surrender their copyright to the publisher;
- If you wish to read a paper, either find a library subscribing to the journal, or ask the author for a copy or photocopy from somebody else's hard copy.
- The costs of editing, copy-editing, typesetting, printing, marketing etc., plus (hopefully reasonable) profit of the publisher are covered by the (usually pretty steep) cost of subscription, which typically falls on university libraries.*

This model served the scientific community well for more than 350 years[†] but it is now being increasingly challenged by alternative models of **electronic publishing**.

*Hence, my friend, you don't notice it.

[†]For your attention, **Trivial Pursuit** players: the oldest scientific journal, "*Philosophical Transactions of the Royal Society*", was established in 1665. The oldest purely mathematical journal, "*Journal für die reine und angewandte Mathematik*" (a.k.a. the *Crelle journal*), started in 1826.

Model 1: Green Open Access:

- The journal is printed and distributed in the usual way, except that. . .
- It is accompanied by an electronic copy on a dedicated website.
- Access to the paper on the website for the first n months is limited to subscribers (this usually means all personnel and students of subscribing institutions).
- After n months (typically $6 \leq n \leq 12$) access to a paper becomes unlimited – alternatively, after this cutoff time, authors have the right to post on their website and distribute the pdf file of their published (as distinct from the original draft) paper.
- Access to papers posted before Green Open Access came into effect requires subscription or payment.

Model 2: Gold Open Access:

- Fully electronic journal, freely available to everybody on the Internet;
- Authors are responsible for paying either page charges or article processing charges;
- Authors typically retain the copyright and are free to distribute the article in its final form, either as a hard copy or electronically.

Model 3: **Mixed** Open Access:

- Typically both printed and published electronically;
- Subscribers pay, whether for hard copy or electronic access – so far, everything like in the traditional model;
- Authors may choose to publish in a traditional manner or . . .
- . . . may opt to pay page charges – in that case the electronic copy is Open Access and the authors are free to distribute the **pdf** file with no restrictions.
- Often considered as an immoral *double dipping*: authors pay page charges and universities pay subscription. . .

Model 4: **S2O** (Subscribe to Publish):

- A journal is printed in the usual way;
- Subscribers pay, whether for hard copy or electronic access and the journal retains the copyright – so far, everything like in the traditional model;
- Once the number of subscriptions reaches certain magic number (enough to sustain the costs of the journal), the journal becomes freely accessible on the Internet.

Model 5: **Diamond** Open Access:

- Purely electronic journal;
- All articles are **Open Access** but. . .
- There are no page charges: everything is **free**. Forever.

. . .and if this sounds too good to be true that's 'cause it is too good to be true: Diamond Open Access exists only as a concept, except for a small number of journals with external (mostly governmental, mostly in France) funding. And like all government funding, 'forever' might mean 'for the next few years': diamonds ain't forever. . .

The case for Open Access

1. The public funds academic research, hence members of the public deserve access to academic research: this freedom of information is crucial in an open science-driven society and economy.

This argument might be relevant to papers in medicine, climate or law, say. But negligibly few members of the public are interested in Tate cohomology groups or Wigner measures and most of them already have access to reasonably well-stocked mathematical libraries.

2. Journal subscription is expensive, beyond reach of Third World universities and even of many universities in developed countries. Page charges are in reality **cheaper** than subscription costs and they shift the cost of publication to richer universities, from where most of publishable research originates.

This is a strong argument, but only as long as universities establish a viable and transparent mechanism to cover page charge of their faculty and students, rather than relying on charity, grants and foundations. Will substantial savings from subscription costs be ploughed into the payment of page charges or diverted by university administrators to hire more administrators?

3. Governments and funding agencies have already started to insist on Open Access of all publicly-funded research. Whether right or wrong, it is not practical to argue with them.

This is already the case with EU, UK Research Councils and with US NSF and National Institutes of Health. Yes, you can refuse to follow their rules but don't be surprised if they stop your grant. . .

The case against Open Access

1. Traditional journals have had many years to establish themselves. We, as a community, know which are the top journals, with strict editorial process, sky-high acceptance criteria and top authors, and which journals are worthless. We know that some papers are likely to be better and more trustworthy because they have been published in, say, *Journal of American Mathematical Society* or *Mathematische Annalen*, whereas some journals have demonstrably less claim on our time and trust. What about electronic journals?

Caveat emptor! Once faced by *any* journal, have first a look at the publisher (is it familiar, respectable and trustworthy?), then at the Editorial Board (are the names familiar to you and do they include world-class people in your area?). Unless you are persuaded that this is a good journal with good reputation, don't submit and exercise great caution reading papers therein. All this is equally valid for electronic and traditional journals.

2. An Open Access journal might have nothing to do with lofty academic goals and be just a commercial operation, publishing possibly useless or wrong papers in exchange for hard cash.

We are all confronted by spam from dubious and predatory publishers essentially offering bogus “publications” in exchange for real cash. (Check out “Jeffrey Beall” on Wikipedia for a brave attempt to unmask predatory journals.). However... traditional journals can also be of low or non-existing quality and traditional publishers might also be unethical. (Check out <http://thecostofknowledge.com/index.php> or google “Elsevier”.) Don’t cooperate with predatory or unethical publishers: don’t edit, don’t submit, don’t referee and treat them with the contempt they deserve!

3. Electronic journals might come and go: what will happen to my electronic paper once the journal is gone? Will an archive be maintained and will it remain accessible on the Internet, in an up-to-date format?

This is a serious issue: the last thing you want is for your paper to evaporate off the Internet or be accessible only in an obsolete format! In current state of play, it is a healthy policy to restrict your ‘electronic interest’ to journals associated with learned societies, major university presses and few reputable publishers – and even then explore carefully their archival policies.

Final word on Open Access

Open Access is upon us and, for better or worse, cannot be wished away. Nobody – neither publishers nor academics, funding agencies and universities – knows where it is going and what will be the situation in a decade or so: to paraphrase Heisenberg, “if you think you understand the future of journal publishing, you don’t!”. The best policy is to hedge our bets. In the circumstances, meantime,

- Submit **only** to journals you trust – whether by their reputation, editorial board or the reputation of their publishers. **Ideally, journals published by learned societies and university presses, because they are less likely to sell their reputation for hard currency!** This applies equally to traditional and electronic journals.
- Once your funding agency or university insists on Open Access, you usually have the option of **Green OA** in a traditional journal, without any money changing hands: cf. <https://openpolicyfinder.jisc.ac.uk> for an up-to-date list and for compliance rules of different funding agencies.
- If the sponsor of your research – a university or a funding agency – wishes you to publish in **Gold OA**, it is incumbent on them to provide you with the page charges. **The author should never, but never, pay from their own pocket!**

Transformative agreements: Major publishers have ‘transformative agreements’ with universities, clusters of universities or funding organisations and, once a paper is accepted by ‘their’ journal, you can easily confirm the APCs on a website and they will be duly paid.

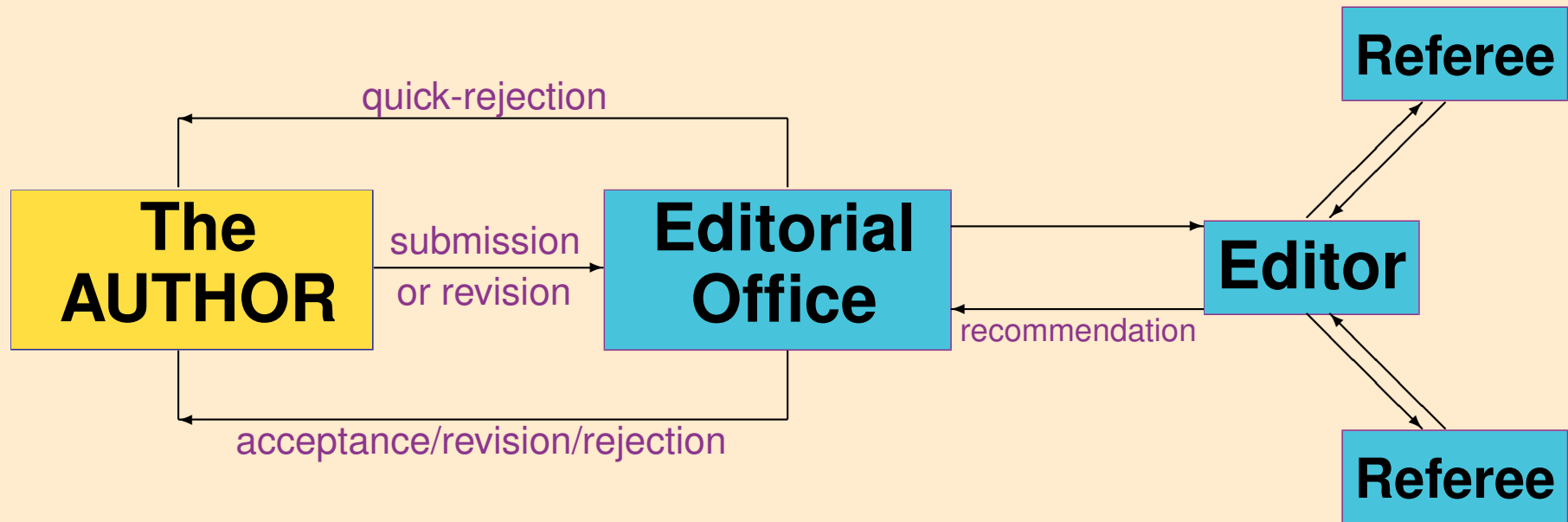
How to choose a journal? Not all journals are equal. In each and every discipline there exists an implicit pecking order. (And an explicit “impact factor”, for whatever it is worth – not much!)* It is surprisingly easy to publish in a mediocre journal but becomes increasingly more difficult the higher you go in respectability stakes.

It is a good idea to ask around and to form your own impressions: Where have you seen the best papers? Which journals are cited more frequently? Have a look at editorial boards, both to discern quality and to identify editors with an expertise to handle your papers.

So, should you submit to the **best** journal? Not necessarily, unless your paper is of the highest quality – and it is good to consult experts on that, not just relying on your intuition. However, unless you feel confident to submit to a **good** journal, you shouldn't have probably written the paper at the first place.

*If somebody puts a gun to your head and demands metrics, it is far better to consult **Math-SciNet**, run by the American Mathematical Society, which publishes a much more reputable pecking order of mathematical journals.

The editorial process Once you've submitted a paper to a journal, it follows a set pattern:



This procedure might have mild variations (e.g., the paper might be rejected with resubmission being encouraged).^{*} These days the entire procedure is conducted via the Internet, often through dedicated websites.

^{*}Some top journals, e.g. *“Journal of American Mathematical Society”*, *“Journal of European Mathematical Society”* and *“Forum of Mathematics”* have an additional stage: an incoming paper is sent for a quick opinion to one or more experts and is subsequently sent to referees only subject to this initial screening.

Rejection: Whatever I might tell you,

REJECTION = DEJECTION.

Your natural defence mechanisms will kick in: the referees were ignorant, the editor a prat, the editor-in-chief high-handed. . . This might – or might not – be the case. Yet, you should not jump into two extreme alternatives: **neither send the paper at once to a different journal nor give up research altogether.**

Read *carefully* the reports. Not everything in a referee report is gospel truth but usually referees make important points. Also, take it as an axiom: **If the referee misunderstood you, this is your fault – next time explain better and more clearly.** Write a new, revised version of the paper, *anticipating* and taking on board all valid criticisms. This might require more research or computation – do it.

Never resubmit the rejected paper to the same journal or argue with editors. Submit to a different journal, but only once you are confident that your paper is genuinely better: the chances of it reaching the same referee again are non-negligible.

Revision: Resist two natural temptations, either to revise and reply by return of post or to put the job to the side (after all, you are busy with something new and exciting!), where it will languish until further notice.

Read **very carefully** referee reports and the editorial letter. Address each issue therein and carefully prepare a revision.

Write a detailed record of how you've addressed the referees' comments, point-by-point. There is no need to agree to everything a referee said but there is an absolute need to explain (clearly, firmly yet respectfully) why you disagree. Enclose this record with your revision: it is immensely useful for editors and referees and will speed up the second refereeing round: the referees will need to read only the relevant bits, rather than reread the entire paper.*

*And you don't want them to reread it from scratch, because they will find more to disagree with...

Acceptance: It happens very rarely that a paper is accepted at once in a quality journal but eventually, hopefully, after a round or two of revision, you'll receive an *"I am delighted to let you know"* letter.

Your labour is not over yet.

- You need to provide the publishers with a 'clean' source file and all other files that you've used: class files, macros, graphics, Now, if you were clever and used the journal's house style and class files, this should be a painless exercise. If you need to convert to the house style you deserve all the extra grief.
- Typically you also need to sign and send a copyright form or arrange for article processing charges: this is the norm, don't argue.
- Some top journals (*Nature, Proc. Royal Soc., . . .*) insist on a media embargo until the publication day. Thus, you'll be unable to sell the story to *Daily Star, National Enquirer* or *Bild*. It is tough being an academic. . . .
- Once your paper has been processed, possibly reset, possibly copy-edited, you'll receive galley proofs, together with a stern email telling you to correct them and return within a couple of days. If you've sent a clean source file in the house style, life is easy: just read quickly, answer few queries and return the lot. However, if the paper has been reset (probably introducing fresh errors) you'll have your work cut out.
- Update your CV and publications' list.

And then, few months later, you'll open a fresh, nice-smelling volume (or, more probably, a website) and here is your paper smiling at you, and you'll realise that

Happiness is a warm paper!

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HAPPINESS IS



... writing (good) papers.