HOW DO PHYSICISTS PUBLISH PAPERS? THE CASE OF PHYSICAL REVIEW E

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Walk to a mathematician and ask about their most frustrating publishing story. You may as well sit down — the answer might take a while. Even if they don't know you (or maybe *especially* if they don't know you), they will just unload a litany of the most horrifying stories that would make you question the sanity of people staying in this profession.

Then ask them why do they persevere and keep submitting and resubmitting their papers given that the `arXiv` is a perfectly fine way to disseminate their work. You will hear the usual fruit salad of practical matters: job applications, CVs, graduate students, grants, Deans, promotions, etc. Nobody even thinks that their publishing efforts are to increase their readership, verify the arguments, improve their presentation style, etc., ostensibly the purpose of mathematical journals.

The adversarial relationship and countless bad experiences make it is easy to lose sight of the big picture. In many ways we are privileged in math to have relatively few predatory and what I call parasitic for-profit publishers. In fact, other than a few new online journals, relatively little has changed in the past two decades. For better or worse, things are very different in physics, where the community was forced to adapt faster and arguably better in response to changes in the publishing landscape.

The following is a story of the *Physical Review E* (PRE), its inner working, culture and challenges. I make some suggestions reflecting my personal views at the end, and try to avoid natural compare-and-contrast with math publishing. The discussion is shortened and granulated for the sake of brevity.[1]

My background. I am a Mathematics Professor at UCLA, specializing primarily in combinatorics. Over the past 35 years, I published over 150 papers in over 60 different journals across many areas of mathematics and theoretical computer science. Over the past 10 years I have written extensively about math publishing on my blog. Until last year, I had no first hand knowledge of physics journals.

Why am I writing about this? I chose to write about the PRE because I published my own paper there and enjoyed the experience. To learn more about the journal, I spoke to a number of people affiliated with the PRE in different capacities, from the management to members of Editorial Board, to frequent authors and reviewers. I learned of both achievements and ongoing challenges, some of which ring very familiar. I will emphasize the differences between PRE and math journals, but will not aim to discuss other physics journals beyond numerical data.[2]

PRE's place in the physics journals' universe. It is one of 5 similarly named "area journals": PRA, PRB, etc. More generally, it is one of 18 journals of the American Physical

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[1] In this article, I have not included discussions and comparisons with the AMS and other professional math societies. I will assume the readers are sufficiently familiar with the mathematical publishing to fill the gaps and make their own judgement. If not, read a polemical version of this article on my blog: igorpak.wordpress.com

[2] In general, the experience in different physics journal can differ much more than in different math journals.

Society (APS). Other journals include *Physical Review Letters*[3], *Physical Review X*[4], *Reviews of Modern Physics*[5], and a number of more specialized journals. Other major physics publishers include the Institute of Physics (IOP, a UK physics society with 85 titles), Springer including its flagship division Nature Portfolio, Elsevier including its *Physica* series, and to a lesser extent *Science*, various SIAM journals and MDPI titles.

Journal structure. The PRE editorial structure is rather complicated. Most of the editorial work is done by an assortment of Associate Editors, some of whom are employed full time by the APS (all of them physics PhD's), and some are faculty in physics or adjacent fields from around the world, typically full time employed at research universities. Such Associate Editors receive a 2 year renewable contract and sometimes work with the APS for many years. Both professional and part time editors do a lot of work handling papers, rejecting some papers outright, inviting referees, etc.

The leadership of PRE is currently in flux, but until recently included Managing Editor, a full time APS employee responsible for running the journal (such as overseeing the work of associate editors), and a university based Lead Editor overseeing the research direction. There is also an "Editorial Board", which is really a board of appeals (more on this later), where people serve a 3 year term without pay, giving occasional advice to associate editors and lending their credibility to the journal.

Submissions. Typically, the papers are assumed to have been published on the `arXiv`, and PRE encourages submissions consisting of `arXiv` numbers and nothing else. There are sharp word count limits for "letters" (short communications) and "articles".[6]

Desk rejections. At PRE, about 15-20% of all papers are rejected within days after the initial screening by the managing or associate editors who then assign the remaining papers according to the research area. Some associate editors are reluctant to do this at all, and favor at least one report supplemented by the initial judgement. This percentage is a little lower than at the (more selective) PRL where it is reported to be 20-25%.[7]

Review process. Associate editors send papers to referees with the goal of obtaining two reports. The papers tend to be much shorter and more readable by the general scientific audience compared with the average math paper, and good style is emphasized as a goal. The reviewers are given only three weeks to write the report, but that time can be extended upon request.

Typically, editors aim to finish the first round in three months, so the paper can be published in under six months. Only few papers lag beyond six months. The reason is often an extreme difficulty in finding referees. Asking 4-8 potential referees is normal, but on rare occasions the numbers can be as high as 10-20.

While at PRL outright rejections are common even if all reviews are positive (just insufficiently so), at PRE the editors rarely reject the papers after reports and give the authors an opportunity to resubmit. The goal is to reach a final decision after 2-3 rounds.

[3]PRL is APS's flagship journal which published only very short papers.

[4]PRX is another APS's leading journal, online only, gold open access, publishes longer articles.

[5]APS's highest cited journal which publishes survey articles.

[6]This structure and naming evolved over time. In previous decades, PRE had "brief reports" and "rapid communications" which led to current "letters".

[7]Before 2004, this percentage was even lower at the PRL, but the APS did some rather interesting research on the issue and concluded that such papers consume a lot of resources and rarely survive the review process. See *Physical Review Letters Evaluation Committee Report*, October 2004, tinyurl.com/mu37dwzc.

Rate of success. In total, PRE receives about 3,500-4,000 submissions a year, of which about 55-60% get accepted, an astonishingly high percentage when compared to even second tier math journals.[8] The number of submissions has been slowly decreasing in recent years, perhaps reflecting many new publications venues.

It is worth putting these numbers in perspective by comparing them with other journals. PRE and PRL publish about 1,800 and 2,100 papers per year, respectively. Other APS journals publish even more: PRD publishes about 4,000, and PRB close to 5,000 papers a year. But, for example, *Jour. AMS* publishes about 25, *Mathematika* about 50, *Proc. LMS* about 60, *Forum Math. Sigma* in the range of 60-120, *Bull. LMS* in the range of 100-150, *Trans. AMS* about 250, *Adv. Math.* about 350, *IMRN* in the range of 300-500, and *Proc. AMS* about 450 papers per year. These are boutique numbers compared to the APS editorial machine.[9]

Transparency. In contrast with PRE and other physics journals, math journals are notoriously secretive about their submission statistics, so we are unable to make apples-to-apples comparisons with acceptance rate and average wait time for desk rejection, and for acceptance.[10] Even *MDPI Mathematics* which used to boast about its 60% rejection rate stopped disclosing this information. As an exception, we could find an 11% acceptance rate at *Amer. Math. Monthly*, but they also have 1 day (!) average wait between submission and desk rejection, and 28 days on average between submission and final peer review decision. This makes the journal an outlier in every respect. For example, *Adv. Math.* seems unashamed of its average 379 days (!) wait between submission and acceptance.

Publication. When a paper is accepted, it is sent to production which APS outsources. There are two quick rounds of approval of LaTeX versions compiled in the house style and proofread by a professional. It then gets published online with a unique identifier, usually within 2-3 weeks from the date of acceptance. Old fashioned volumes and numbers do exist, but of no consequence as they are functions of the publication date. There is zero backlog. Strictly speaking there is still a print version of the PRE delivered to about 30 libraries worldwide that are unconcerned with deforestation and willing to pay the premium, but really nobody wants to read these paper versions.[11]

Appeals. When a paper is finally rejected, the authors have the right to appeal the decision. The paper is sent to a member of the Editorial Board closest to the area. The editor reads both the paper and the referee reports, then writes their own report, which they sign and send to the authors. More often than not the decision is confirmed, but reversals do happen. Since what's "important" is ultimately subjective, this serves an important check on Associate Editors and helps keep peace in the community. Numerically, only about 3-5% of rejected papers are sent for an appeal, about 2-3 papers per Editorial Board member each year.

Editorial system. The APS has its own editorial system which handles the submissions, and has an unprecedented level of efficiency and transparency compared to that of math journals I am familiar with. The authors can see a complete log of dates of communications with (anonymized) referees, the actions of editors, etc. The editors work as a team, jointly handling all incoming email and submission/resubmission traffic. Routine tasks like forwarding the revision to the first

[8]For comparison, PRL is an even bigger operation which handles over twice as many papers. I estimate that PRL accepts roughly 20-25% of submissions, probably the lowest rate of all APS journals.

[9]One argument why so few papers get published in these journals is that math papers can be much longer than a typical physics paper. This argument does not translate well into the digital age. Nor does that apply to *Bull. LMS* or *Proc. AMS*, of course. We mention in passing that while great length is unavoidable sometimes, mathematicians tend to forget that brevity is a feature, not a bug.

[10]Please leak to us if you have access to hard numbers!

[11]Some graduate students I know are unaware even which building houses our math library at UCLA.

round referees are handled by whoever is first available, but editorial decisions (accept/reject, choices of referees), are made by the assigned Associate Editor. If the Associate Editor has a week long backlog or is expecting some inactivity, his queue is redistributed between other editors.

Relations between the journals. Many PRE papers arrive first to PRL where they are quickly rejected. The editorial system allows editors from one journal see all actions and reports in all other APS journals. If the rejected PRL paper fits the scope of PRE and there are reports suggesting PRE might be suitable, PRE editors try to invite such papers. This speeds up the process and simplifies life for everyone involved. For longer papers, PRE editors also browse rejections from PRX, etc. From time to time, business-oriented managers at the APS raise the possibility of creating a lower tier journal where they would publish many papers rejected from PRA–PRE, but the approach of maintaining standards keeps winning for now.

Survey articles. The APS publishes *Reviews of Modern Physics*, which is fully dedicated to survey articles. The Associate Editors solicit such articles and incentivize the authors by paying them about $1,500 for completion within a year, but only $750 is the project took longer. The articles vary in length and scope, from about 15 to about 70 pages.[12] There are also independent submissions which very rarely get accepted as the journal aims to maintain its reputation and relevance. Among all APS publications, this journal is best cited by a wide margin.[13]

At PRE, the editors recently started to solicit "perspectives" – forward looking articles suggesting important questions and directions. They publish about 5 such articles a year, hoping to bring the number up to about 10.

Profiled articles. In 2014, following the approach of popular magazines, PRE started making "Editors' Suggestions". These are a small number of articles the editors chose to highlight, both formally and on the website. They are viewed as minor research award that can be listed on CVs by the authors.

Outstanding referee award. The APS instituted this award in 2008, to encourage quick and thorough refereeing. This is a lifetime award and comes with a diploma size plaque which can be hang on the wall. More importantly, it can be submitted to your Department Chair and your friendly Dean as a community validation of your otherwise anonymous efforts. Each year, there are a total of about 150 awardees selected across all APS journals, of which about 10 are from PRE. This selection is taken very seriously. The nominations are done by Associate Editors and then discussed at the editorial meetings.

Community relations. In much of physics, the `arXiv` is a preferred publication venue since the field tends to develop at rapid pace. In some areas, a publication in *Nature* or *Science* is the key to success, especially for a junior researcher, so the authors are often willing to endure various associated indignities and if successful pay for the privilege.[14] However, in many theoretical and non-headline worthy areas, these journals are not an option, which is where the PRE and other APS journals come in.

[12]The APS articles use tiny font and double columns, so these pages numbers would more than double in the standard math journal style.

[13]We note that there are very few math journals dedicated to surveys, despite a substantial need for expository work. Besides *Proc. ICM* and *Séminaire Bourbaki* series, we single out *Bull. AMS*, *EMS Surveys* and *Russian Math Surveys*. A few journals publish surveys occasionally, e.g., *Bull. LMS* publishes about 2 surveys per year.

[14]In particular, `arXiv` posting is impossible for copyright reasons.

Speaking broadly, the PRE operates as an electronic news source which provides service to the community in the friendliest way possible. It validates the significance of papers needed for job related purposes, helps the authors to improve the style, does not bite newcomers, and does not second guess their experimental finding (there are other venues which do that). It provides a quick turn around and rarely rejects even moderately good papers.

When I asked both the editors and authors how they feel about PRE, I heard a lot of warmth, the type of feeling I never heard from anyone towards math journals.[15] There is a feeling of community when the editors tell me that they often publish their papers in PRE, when the authors want to become editors, etc. In contrast, I heard a lot of vitriol towards *Nature* and *Science*,[16] and an outright disdain towards MDPI physics journals.[17]

Some suggestions. In my opinion, most math publishers are behind the curve in innovation and community relations. It would be a bit of a reach to ask them for major changes, but here are some ideas that seem more approachable:

- stop wasting paper and fully move to electronic publishing,
- do not limit total numbers of published pages; aim for as many good papers as you can get,
- improve your electronic editorial system to make it more transparent,
- help editors work as a team, and incentivize them financially,
- set up new math journals fully dedicated to survey articles, both solicited and contributed,
- create the appeal procedures, select featured articles, and institute awards for best referees,
- publish as much editorial statistics as possible (acceptance percentage, average wait, etc.)

Many math journals and publishers have already moved into electronic publishing, but most have not. Some of these items have an obvious obstacle — they cost money. I can write a separate article about the economics of this, but it all comes down to "it takes money to make money". The second item is the most controversial perhaps, as it is likely to lead to lower standards. I get it — some journals would rather be "excellent but evil" than "very good and friendly". The last three items are low-hanging fruit that can be implemented without difficulty.

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[15]Personally, I was rather partial to the storied JCTA where I would publish my best combinatorics papers. In 2020, the editorial board resigned en masse and formed *Combin. Theory*. I am afraid my feeling did not transfer to CT, nor stay with JCTA which continues to publish. It just evaporated.

[16]In physics, considerations of *impact factors* and visibility within the community are of paramount importance. This is why physicists would still prefer *Nature* and *Science* over PRE and PRL. The vitriol is largely a reflection on the journals' attitude: their interest in sensationalism rather that fundamental contributions to science, their search for perfect pictures to illustrate press releases, and even enormous per page charges. Back in the 1880s, J.J. Sylvester published a handful of short math articles in the *Nature*; those days are clearly not coming back.

[17]The disdain is largely related to the parasitic nature of this for profit publisher who seem to care little for actual science, see my blog post wp.me/p211iQ-C9. Note however, that when I polled the authors of *Mathematics*, a flagship MDPI journal, most authors expressed a high level of satisfaction with MDPI. In fact, the majority emailed me that would consider submitting again, ibid.