

In praise of preprints

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When it's my turn to write for the magazine's Physics Update department, I visit the arXiv.org preprint server. There, I browse the latest papers in the astrophysics of galaxies, medical physics, and fluid dynamics—to name just three of arXiv's categories. My goal: To find an interesting paper that can be adequately summarized in 250–400 words.

Of course, arXiv does more than provide source material for science writers. Since its inception in August 1991, arXiv has served as a public library for papers before their peer review and publication. In the early years, astrophysics, condensed-matter physics, and high-energy physics predominated. In 2017, mathematics (25.6% of all papers) and computer science (21.9%) held the top two spots. High-energy physics (7.8%) slipped to fifth place behind condensed matter (11.7%) and astrophysics (10.7%).¹

I'm not surprised that mathematicians have embraced arXiv. Referees check every equation. Papers can take years to be published. For example, the most cited paper of 2017 in *Journal of the American Mathematical Society*, "Canonical bases for cluster algebras,"² was received by the journal in November 2014 and published in November 2017.

Even in fields with speedier publication, the prompt posting that arXiv affords is an attractive advantage, especially when a topic is hot. In February 2008, Hideo Hosono published his discovery of a new family of iron-based superconductors in the *Journal of the American Chemical Society*. In a news story about it, I wrote: "Within weeks, physicists who'd read the *JACS* paper or who'd heard about it from chemists had started making samples, measuring properties, and posting papers on arXiv. The first band-structure calculations showed that the superconducting phase is two-dimensional, as in the cuprates, and occupies the FeAs planes." (See *PHYSICS TODAY*, May 2008, page 11.)

The quest to find new members of the superconducting family, to reach higher critical temperatures, and to understand the superconductivity was intense. In posting to arXiv, competitive condensed-matter physicists aimed to establish the priority of their results.

Another motivation to post on arXiv is to share ideas with a wide audience. In 1997 Alexei Kitaev posted his 13 000-word

treatise "Fault-tolerant quantum computation by anyons." The paper helped to launch the new field of topological quantum computing. Kitaev didn't submit it to a journal, *Annals of Physics*, until 2002.

ArXiv has been an integral part of the physics landscape for so long that it's worth taking a look back at what the preprint scene was like before it came along. When I was an astronomy grad student in the 1980s, preprints were paper copies bound between card stock and distributed by mail. Some institutions even had branded covers. Given that some of us print out electronic preprints, having them preprinted might seem an advantage, provided only one person at a time wanted to read them.

But the paper preprint system had a serious shortcoming. If your institution wasn't on other institutions' mailing lists, you wouldn't see the preprint. With its free online distribution, arXiv is fairer and more democratic. Anyone with an internet connection can download and upload the latest research.

Preprints continue to evolve. Crossref, the nonprofit that facilitates the interlinking of scholarly research online, has developed a way to assign digital object identifiers, or DOIs, to preprints in such a way that preprints are as fully citable as the final, published versions of record. Last year the National Institutes of Health, the Wellcome Trust, and other big biomedical funders announced they would allow grant applicants to cite preprints. Also last year the American Chemical Society launched its own preprint server, ChemRxiv.

I learned of those and other developments from a blog post on the Scholarly Kitchen by Judy Luther.³ One of her crossheads neatly captures why preprints benefit science and scientists: "Preprint servers put authors in control of when their research is released."

References

1. These and other statistics can be found at <https://arxiv.org/help/stats>.
2. M. Gross, P. Hacking, S. Keel, M. Kontsevich, *J. Am. Math. Soc.* (2017), doi:10.1090/jams/890.
3. J. Luther, "The stars are aligning for preprints," Scholarly Kitchen (18 April 2017).



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