Letters

Weighing the Value of *Physical Review* Citation Statistics

As the number and range of research projects continue to grow, reference citations have come to play more important roles in establishing the relative merits of those projects. Of course, many readers seized on Sidney Redner's study of citation statistics (PHYSICS TODAY, June 2005, page 49) to see "how well" they are doing personally, but many others must have viewed his results as evaluative on a larger scale. Just how significant are citations?

Speaking for my own interests, I could scarcely be unhappy. Among the top 10 "hot" papers on Redner's list (page 51), 6 are in the field of electronic structure calculations, in which I did my 15 years of research long, long ago. The amazing popularity of that field is explicable in many ways. The methods developed by physicists are extremely accurate and have been widely adopted by chemists, who contribute most of the citations. The new methods are transparent, reliable, transferable, and available in user-friendly packages. Physicists can be proud of having taken such fascinating and complex problems and rendered them readily accessible to researchers who have many other responsibilities.

Still, some aspects of the citation game are disappointing. All the top 10 papers are theoretical. Does this mean that experimental physics is dying? No, it just means that citations don't mean so much, and they should not be used to measure impact or importance of a field or as a facile substitute for understanding how science grows and develops. Citations reflect many incidental factors, including the wish to conform to standard practice, and even reflect the convenience of citing a previously cited paper (without reading it). Experimental discoveries, often published in specialized journals, are still by far the most important part of physics, regardless of how many citations a single paper receives in *Physical Review*.

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Of the famous five papers Albert Einstein wrote in 1905, the one deriving $E = mc^2$ is not the most cited. The reason is undoubtedly connected to the fact that $E = mc^2$ is all the reference we use when referring to this relationship. A more recent example will prove my point. Kary Mullis's Nobel Prize paper on polymerase chain reaction may well be the most cited paper of all time. But after a while, authors simply use "PCR method" as shorthand with no reference to the author. Moreover, to the typical citing author, actual use of the PCR method has clearly been of much greater value than the typical reference one cites. Citation theorists have paid insufficient attention to this transmutation of citations to acronyms for the paper. Should they not also be counted?

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Sidney Redner's analysis of citation statistics appears well thought out, but the assumption that the number of *Physical Review* citations to other *Physical Review* papers is even an "approximate proxy of scientific quality" is dubious at best. One nice example is Felix Bloch's 1954 paper showing that sample rotation during a nuclear magnetic resonance measurement can greatly increase the spectral resolution.[1] According to PROLA, the *Physical Review* Online Archive, Bloch's paper has been cited in *PR* a total of six times. However, his result is routinely used for all high-resolution NMR and is the parent for many other developments in the field. I do not think this example is isolated.

Reference

1. F. Bloch, *Phys. Rev.* **94**, 496 (1954).

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Redner replies: I appreciate the letters written about my article. To amplify a comment in the letter by J. C. Phillips, only 3 of the top 100 cited articles as of June 2003 are experimental.[1] From my myopic theorist's perspective, it is also surprising that all these articles are old. Given that physics is an experimental science, the caveats of Phillips and of Bryan Suits are well taken.

The letter by Rustum Roy makes the good point that citations can get transmuted to acronyms or to no citations at all, as in the case of the polymerase chain reaction. More dramatically, the most important scientific advances ultimately get incorporated into the canon; thus we never cite Isaac Newton when writing $F = ma$. It is clear that citations alone are an imperfect measure of the scientific importance of a paper, and one must proceed with caution in developing citation-based productivity measures.

Reference

1. N. Bloembergen et al., *Phys. Rev.* **73**, 679 (1948), #56 in citation rank; E. Wollan, W. Koehler, *Phys. Rev.* **100**, 545 (1955), #66; and E. Hahn, *Phys. Rev.* **80**, 580 (1950), #81.

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Letters and opinions are encouraged and should be sent to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842 or by e-mail to ptletter@aip.org (using your surname as "Subject"). Please include your affiliation, mailing address, and daytime phone number. We reserve the right to edit submissions.

Odes to a Physics Songbag

A wonderful spread of physics-related lyrics from a number of sources, notably Tom Lehrer, appears in the July 2005 issue of PHYSICS TODAY (page 56). Tom's program notes call his one-hour music drama, the *Physical Revue*, the "last class of a mythical course, Physics 11a." It was far from mythical.

The revue was performed during

the last fall-semester meeting of Ed Purcell's course for concentrators in physics. I taught it while Ed was on sabbatical and, appropriately, sang the role of Professor. The counterpoint was sung by Tom, David Robinson, Bob Welker, and Munroe Edmunson as the students. I told the students this would be a preparatory session for the final exam. The song whose lyrics appeared in the PHYSICS TODAY spread was the opening number. The final piece was more faithful to my description of the class that day. It was sung to the music of a scatological Mozart canon, "Oh, du Eselhafter Martin."

Professor
Now, then, are there any questions?
Any problems, any questions?
If there are none, then I am done.
And I can bid you all good day. . . .
Just one more thing, and do not
laugh;
I hope you take the second half.
Physics, Physics, Physics 11b.

Students
Ha, he asks if there are questions.
Holy smoke have I got questions!
I've got a ton, and every one
Would take him half a day to do.
But I don't really want to stay here,
since he's said all he has to
say here.
But it's agreed that I shall need
much more than luck on the
examination. . . .
One thing that makes me laugh:
He hopes I'll take the second half.
Ha ha, ha ha, ha ha, don't make
me laugh.

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As an educator whose motivation and outreach repertoire includes writing and performing songs (see http://www.math.utep.edu/Faculty/lesser/Mathemusician.html), I enjoyed July's "Physics Songbag." Although the examples were inherently enjoyable, readers may not have realized just how widespread and serious such songwriting is.

Educational songs are gaining attention and support. Examples include the *Physics Pholk Songs* CD, partially funded by NSF and available for purchase at http://www.teachersource.com/catalog/index.html, the searchable science song database http://www.science-groove.org/MASSIVE/, and an article in the *Wall Street Journal*.[1]

Using songs in the classroom is fun and community-building, but also has research-backed benefits in helping to motivate students and helping them to recall information. See, for instance, http://www.science-groove.org/SSA/pedagogy.html and http://www.songsforteaching.com/references.htm.

Although many writers of educational songs take their craft quite seriously—there is the Science Songwriters Association—and have released professional recordings, songwriting is too fun and valuable to leave only to "experts." All teachers and students have the ability and should have the opportunity to enhance class learning with a song, jingle, or rap. Comprehensive articles have been written about the use of songs in teaching math and science.[2,3]

References

1. C. Conkey, *Wall Street Journal*, 27 March 2005, p. B1.
2. L. Lesser, *Math. Teach.* **93**, 5 (2000).
3. L. Lesser, *Teaching Statistics* **23**, 3 (2001).

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The whimsical collection of physics songs in the July issue was fun, but it didn't mention astronomy-related music such as Gustav Holst's instrumental "Mars, the Bringer of War." What is more interesting, it didn't mention attempts by modern professional musicians to incorporate scientific themes.

As a fan of rock and heavy metal, not a genre normally associated with physicists and astronomers, I'll throw out a few examples. "High Speed Dirt" by Megadeth imagines what it might be like to be a meteor flashing across the sky and crashing into the Earth—although the singer may also be crashing from something else. Rush was a popular band for many of us undergraduates in the 1980s, as they explored philosophical and scientific themes to go with their technically fantastic music. "Countdown" relays the emotions felt by the band members as they watched a space shuttle launch, with clips of dialog from mission control and the astronauts aboard.

But the best astronomy-related song of all might be Rush's "Cygnus X-1," released soon after the announcement of the object's discovery in the 1970s. A former quasar astronomer, I still use the piece on my exams for stellar astronomy classes because it correctly depicts a black