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‘Sleeping beauty’ papers slumber for decades

Research identifies studies that defy usual citation patterns to enjoy a rich old age.

Daniel Cressey

25 May 2015 Corrected: 26 May 2015

Some scientific studies are popular from the start, garnering multiple citations from other researchers. But others can languish as 'sleeping beauties' for more than a century before awaking to glorious approval, a study finds[1].

Filippo Radicchi, a researcher in complex networks at Indiana University Bloomington, and his colleagues have analysed a set of 22 million scientific papers to identify such beauties — and to find the fairest of them all.

The rate at which papers acquire citations generally declines after an initial period of growth. Previous research shows that the fate of a paper can often be determined based on how many citations it attracts in its first five years.

But some papers lie dormant for years before experiencing a sudden spike in citations as they are discovered and recognized as important. In 2004, bibliometrics expert Anthony van Raan of Leiden University's Centre for Science and Technology Studies in the Netherlands labelled this the ‘sleeping beauty’ phenomenon[2]. Perhaps the most famous example is a 1935 quantum-mechanics paper by Albert Einstein, Boris Podolsky and Nathan Rosen, which rested unloved for decades[3].

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Radicchi and his colleagues came up with the 'beauty coefficient', B, a value based on the number of citations a paper has received and how long after publication it gained them. A paper that accrues citations linearly over time scores 0, but one that languishes for 100 years before rising to fame could score higher than 10,000, the researchers report in the *Proceedings of the National Academy of Sciences*.

Topping the team’s list, with a B value of 11,600, is ‘Concerning adsorption in solutions’, research published in 1906[4] that did not awaken until 2002. The famous Einstein–Podolsky–Rosen paper comes in 14th place, with a B value of 2,258. The longest sleeper in the top 15 is a statistics paper from Karl Pearson, entitled, ‘On lines and planes of closest fit to systems of points in space'. Published in *Philosophical Magazine* in 1901[5], this paper awoke only in 2002.

Top 15 'sleeping beauties'

B value	Title	Authors	Journal	Publication year	Awakening year
11,600	Concerning adsorption in solutions	Freundlich, H.	*Z. Phys. Chem.*	1906	2002

10,769	Preparation of graphitic oxide	Hummers, W. S. & Offeman, R. E.	*J. Am. Chem. Soc.*	1958	2007
5,923	The Scherrer formula for X-ray particle size determination	Patterson, A. L.	*Phys. Rev.*	1939	2004
5,168	Wettability of porous surfaces	Cassie, A. B. D. & Baxter, S.	*Trans. Faraday Soc.*	1944	2002
4,273	A study of the nucleation and growth processes in the synthesis of colloidal gold	Turkevich, J., Stevenson, P. C. & Hillier, J.	*Discuss. Faraday Soc.*	1951	1997
3,978	On lines and planes of closest fit to systems of points in space	Pearson, K.	*Philos. Mag.*	1901	2002
3,892	The tension of metallic films deposited by electrolysis	Stoney, G. G.	*Proc. R Soc. London A*	1909	1989
3,560	CXCVI.–Emulsions	Pickering, S. U.	*J. Chem. Soc., Trans.*	1907	1998
2,962	Resistance of solid surfaces to wetting by water	Wenzel, R. N.	*Ind. Eng. Chem.*	1936	2003
2,736	Probable inference, the law of succession, and statistical inference	Wilson, E. B.	*J. Am. Statist. Assoc.*	1927	1999
2,671	The constitution and fundamental properties of solids and liquids. Part I. Solids	Langmuir, I.	*J. Am. Chem. Soc.*	1916	2003
2,584	Note on an approximation treatment for many-electron systems	Moller, C. & Plesset, M. S.	*Phys. Rev.*	1934	1982
2,573	Relations between the elastic moduli and the plastic properties of polycrystalline pure metals	Pugh, S. F.	*Philos. Mag.*	1954	2005
2,258	Can quantum-mechanical description of physical reality be considered complete?	Einstein, A., Podolsky, B. & Rosen, N.	*Phys. Rev.*	1935	1994
2,184	The dynamics of capillary flow	Washburn, E. W.	*Phys. Rev.*	1921	1995

Source: REF. 1

In many cases, the beauty phenomenon occurs when research finds application in a field outside its own, says Radicchi — such as statistical methods that become useful in biology.

Van Raan says that the “beauty coefficient is certainly an innovative index” that echoes his earlier ‘Grand Sleeping Beauty Equation’, which calculates the number of such papers for a given sleeping time and other variables.

Van Raan is now focusing on issues such as the factors that produce sleeping beauties, and whether the papers are 'one-hit wonders'. If some scientists produce more than one sleeping beauty, that would indicate a well-planned research theme, rather than an unexpected hit.

Rise and shine

For his part, Radicchi says that he is trying to identify the ‘princes’ — the papers that wake up sleeping beauties from their slumbers with an important citation.

Dashun Wang, an information scientist at Pennsylvania State University, University Park, says that the new work is “a very fundamental piece in the field of science of science”. It may eventually help explain why his model to predict the trajectory of a paper from its early citations[6] does not work for around 6.5% of papers. And understanding sleeping beauties, says Wang, will assist the understanding of citation dynamics in general.

“One important conclusion of this paper is that, while the fraction of sleeping beauties may be well within the 6.5% of papers, they are not as rare as we had previously thought,” he says. “These sleeping beauties are now being systematically discovered thanks to the new method proposed in this paper that is rather convincing and does not rely on arbitrary thresholds."

However, Radicchi cautions scientists not to hold out too much hope that their forgotten publications are sleeping beauties, given many papers are never cited: “I expect, if you look at a paper that is 10 years old [and not cited], my guess is it will continue to have zero citations forever.”

Nature doi:10.1038/nature.2015.17615

Corrections

Corrected: This story wrongly placed Dashun Wang at the IBM Thomas J. Watson Research Center — he is now at Pennsylvania State University. The text has been corrected.

References

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One sleeper I have long wished would be awakened is Samuel Bagno's insightful information-theoretic explanation of the necessity for continuing inflation fueled by an average government budgetary deficit: Samual Bagno (1953) "The Communication Model and Economics", IRE Convention Record, 1955 Part 4. As this important, and I think seminal, paper is not readily available, I received permission from IEEE some years ago to post a reproduction on my web site, at "http://www.mmtaylor.net/Economics/Bagno/index.html". Disclaimer: I used this paper heavily in my 1956 B.Eng. essay in 1956, and have watched as government policies -- especially austerity policies such as the 3% deficit limit imposed on Europe by the Maastricht treaty -- seem to have had the expected results.

Barbara H Bowman • 2015-05-28 04:06 PM

"Perhaps the most famous example is a 1935 quantum-mechanics paper by Albert Einstein, Boris Podolsky and Nathan Rosen" Actually, for "most famous," I'd nominate Gregor Mendel's original paper, which was rediscovered 35 years after publication and still forms the basis for our understanding of basic genetics.

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Nature ISSN 0028-0836 EISSN 1476-4687