

Universality, reputation and dynamics of scientific impact

Santo Fortunato



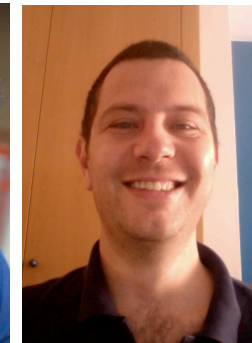
Aalto University

Acknowledgements

Francesco Becattini Arnab Chatterjee Claudio Castellano Kimmo Kaski Marija Mitrović Fabio Pammolli



Raj K. Pan Pietro Parolo Orion Penner Alex Petersen Filippo Radicchi Massimo Riccaboni Gene Stanley



Citation distributions

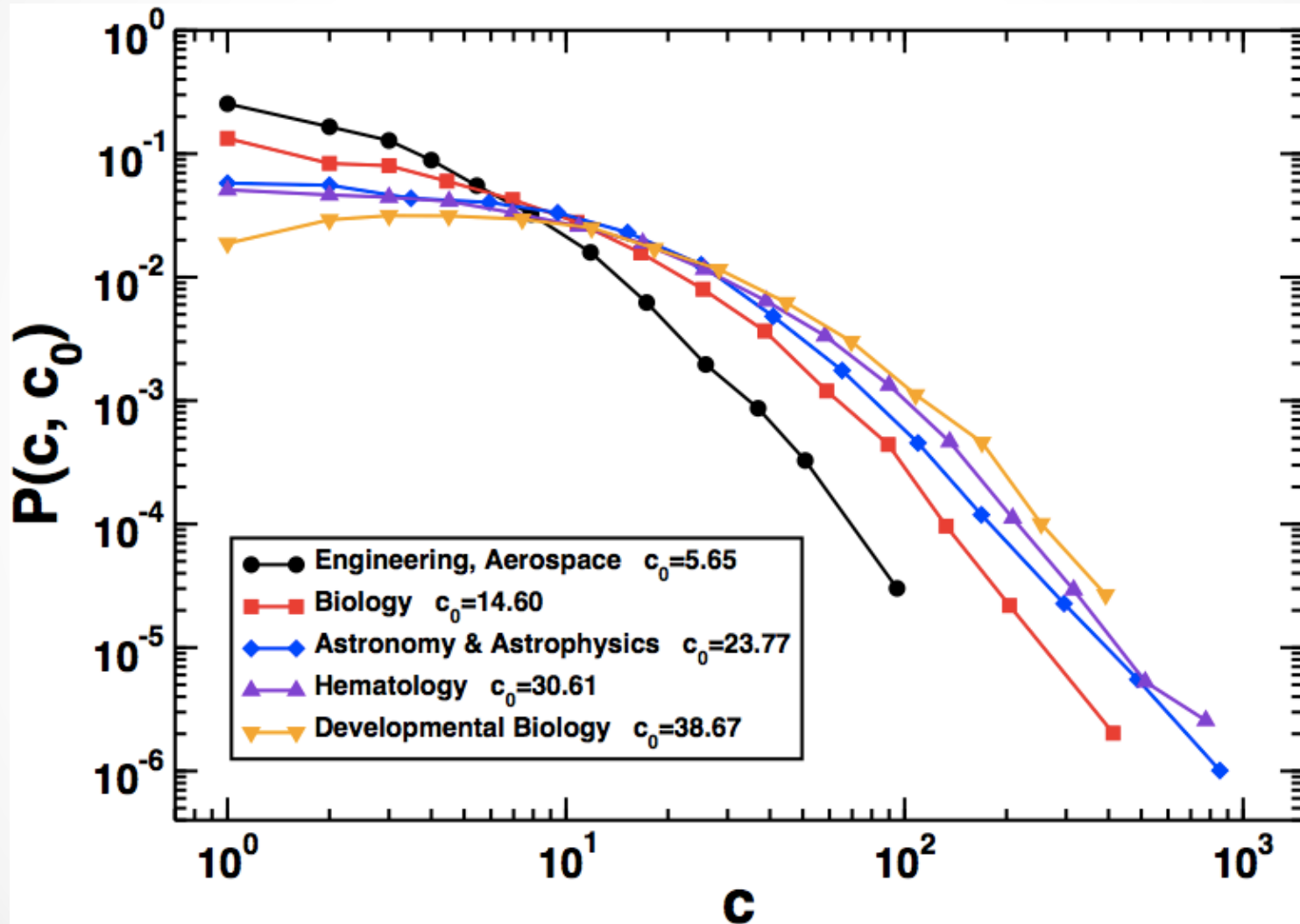
WEB OF KNOWLEDGESM



Index	Subject category	Year	N_p	c_0	c_{max}	σ^2	χ^2/df
1	Agricultural economics and policy	1999	266	6.88	42	1.0 (1)	0.007
2	Allergy	1999	1,530	17.39	271	1.4 (2)	0.012
3	Anesthesiology	1999	3,472	13.25	282	1.8 (2)	0.009
4	Astronomy and astrophysics	1999	7,399	23.77	1,028	1.1 (1)	0.003
5	Biology	1999	3,400	14.6	413	1.3 (1)	0.004
6	Computer science, cybernetics	1999	704	8.49	100	1.3 (1)	0.004
7	Developmental biology	1999	2,982	38.67	520	1.3 (3)	0.002
8	Engineering, aerospace	1999	1,070	5.65	95	1.4 (1)	0.003
9	Hematology	1990	4,423	41.05	1,424	1.5 (1)	0.002
10	Hematology	1999	6,920	30.61	966	1.3 (1)	0.004
11	Hematology	2004	8,695	15.66	1,014	1.3 (1)	0.003
12	Mathematics	1999	8,440	5.97	191	1.3 (4)	0.001
13	Microbiology	1999	9,761	21.54	803	1.0 (1)	0.005
14	Neuroimaging	1990	444	25.26	518	1.1 (1)	0.004
15	Neuroimaging	1999	1,073	23.16	463	1.4 (1)	0.003
16	Neuroimaging	2004	1,395	12.68	132	1.1 (1)	0.005
17	Physics, nuclear	1990	3,670	13.75	387	1.4 (1)	0.001
18	Physics, nuclear	1999	3,965	10.92	434	1.4 (4)	0.001
19	Physics, nuclear	2004	4,164	6.94	218	1.4 (1)	0.001
20	Tropical medicine	1999	1,038	12.35	126	1.1 (1)	0.017

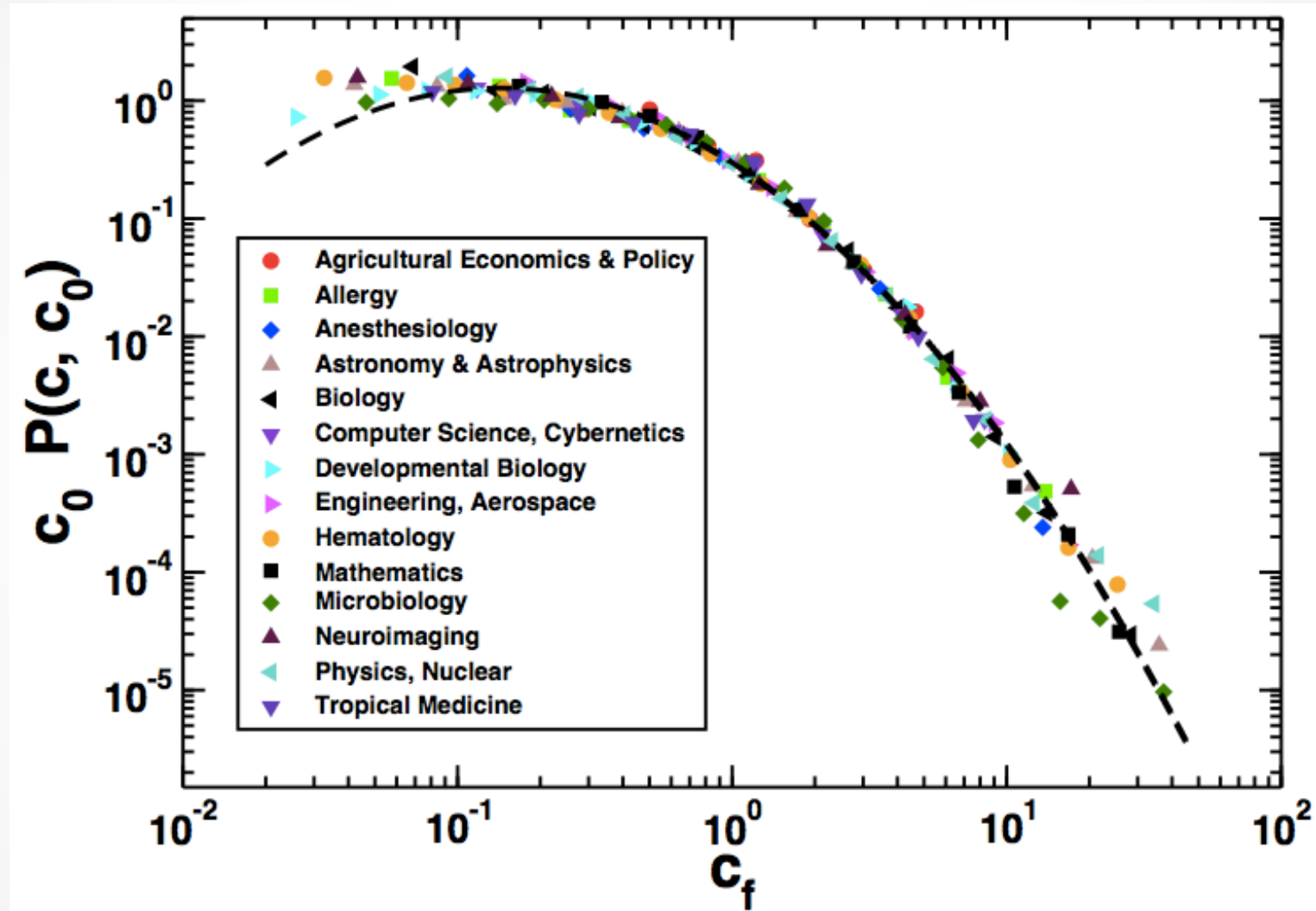
Papers classified in 172 scientific disciplines (from Acoustics to Zoology)

Distribution of cites



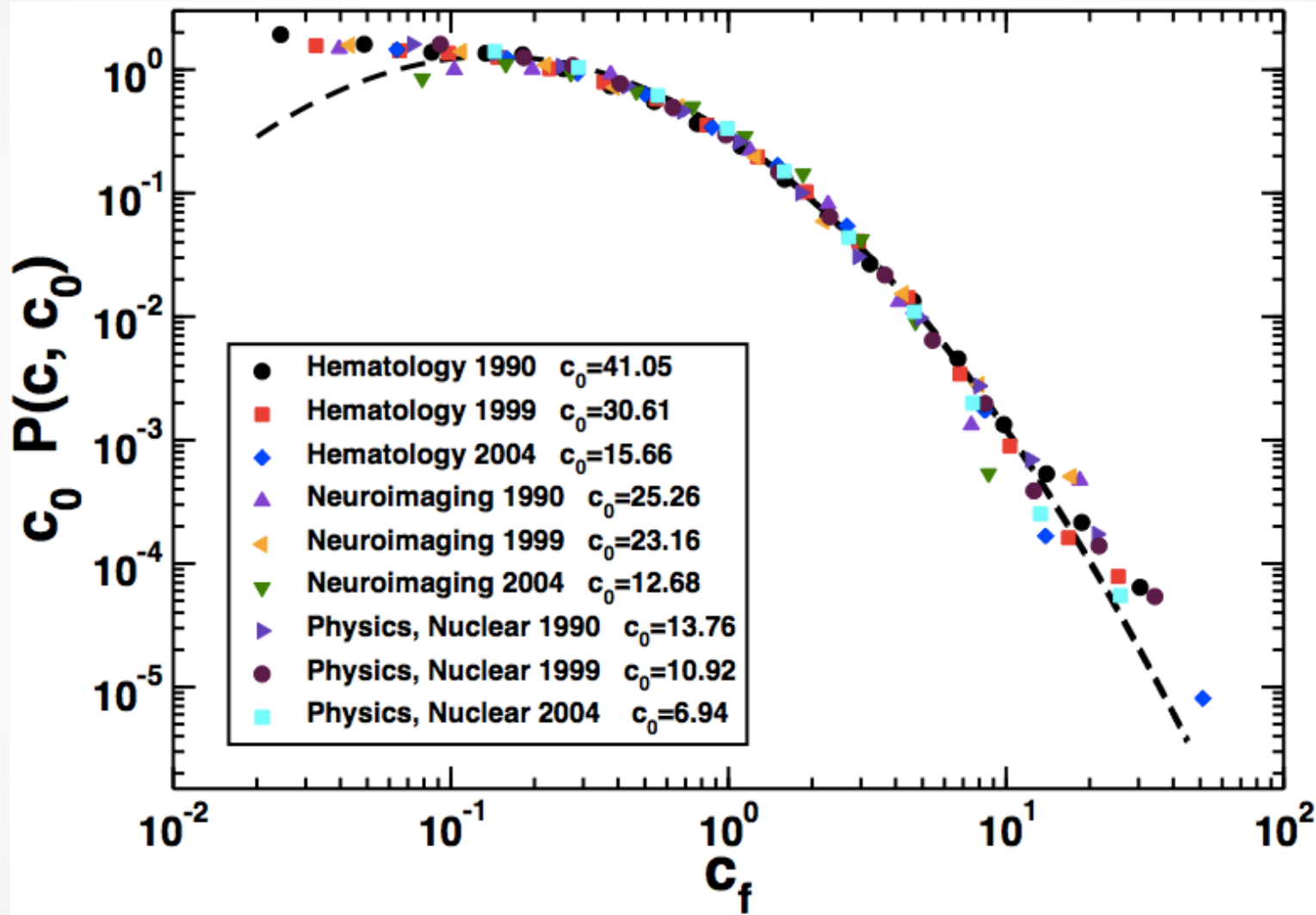
Field dependence (Thomson-Reuters category)!

Could c_0 be the reason of the discrepancy?

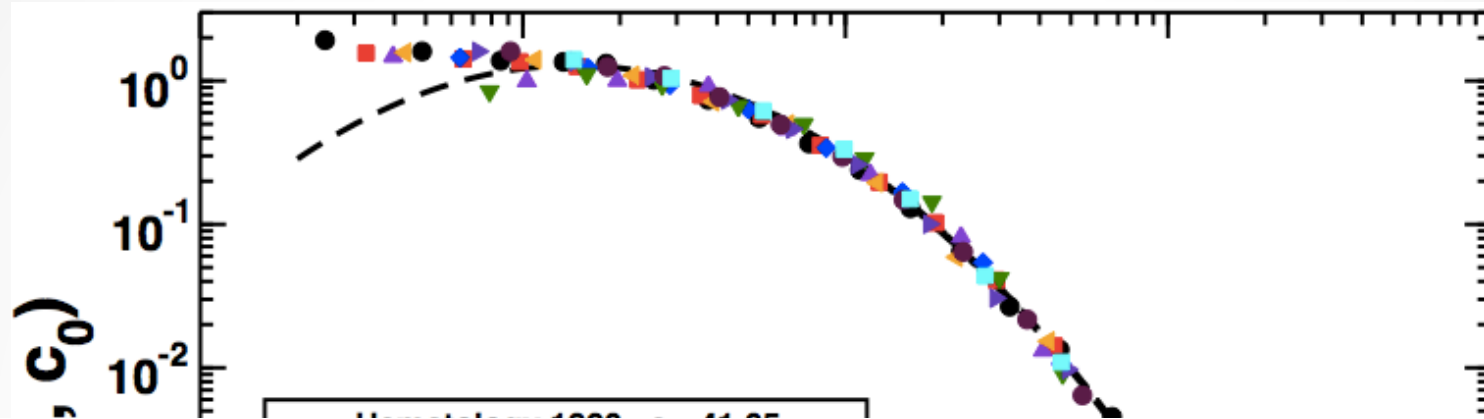


F. Radicchi, S.F. and C. Castellano,
Proc. Natl. Acad. Sci. USA 105, 17268-17272 (2008)

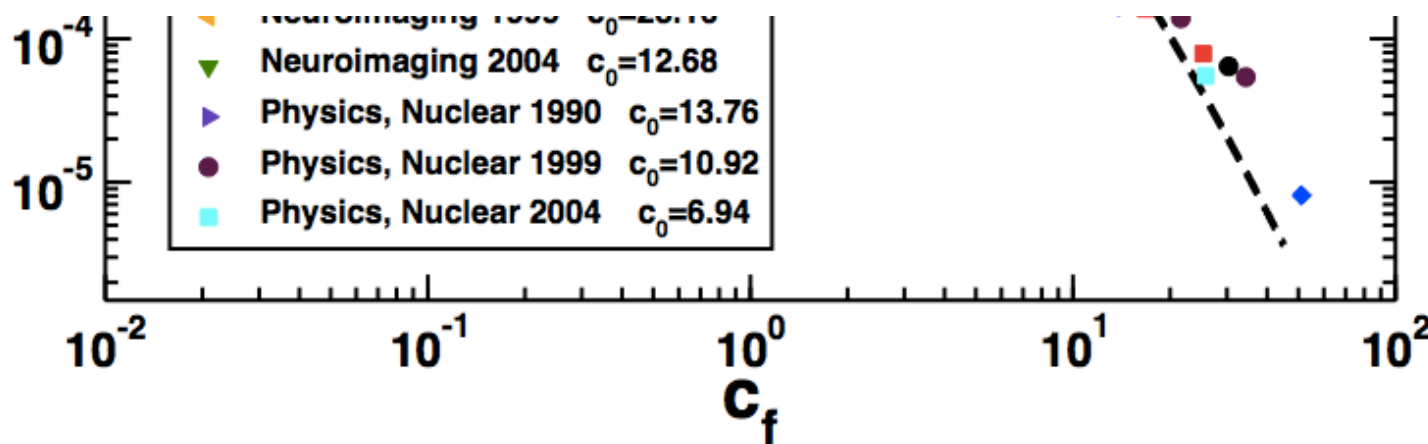
The universal distribution is **stable** in time!



The universal distribution is **stable** in time!



Normalized indicators?



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Published online 20 October 2008 | Nature | doi:10.1038/news.2008.1169

News

Is physics better than biology?

Citation statistics now comparable across disciplines.

Philip Ball

Is the physics department at your university performing better than the biology department?

Answering such questions objectively has been hard, because citation statistics and other bibliometric indicators can't be directly compared across disciplines. But now a team in Italy has found a way to do just that.

Claudio Castellano at the Sapienza University of



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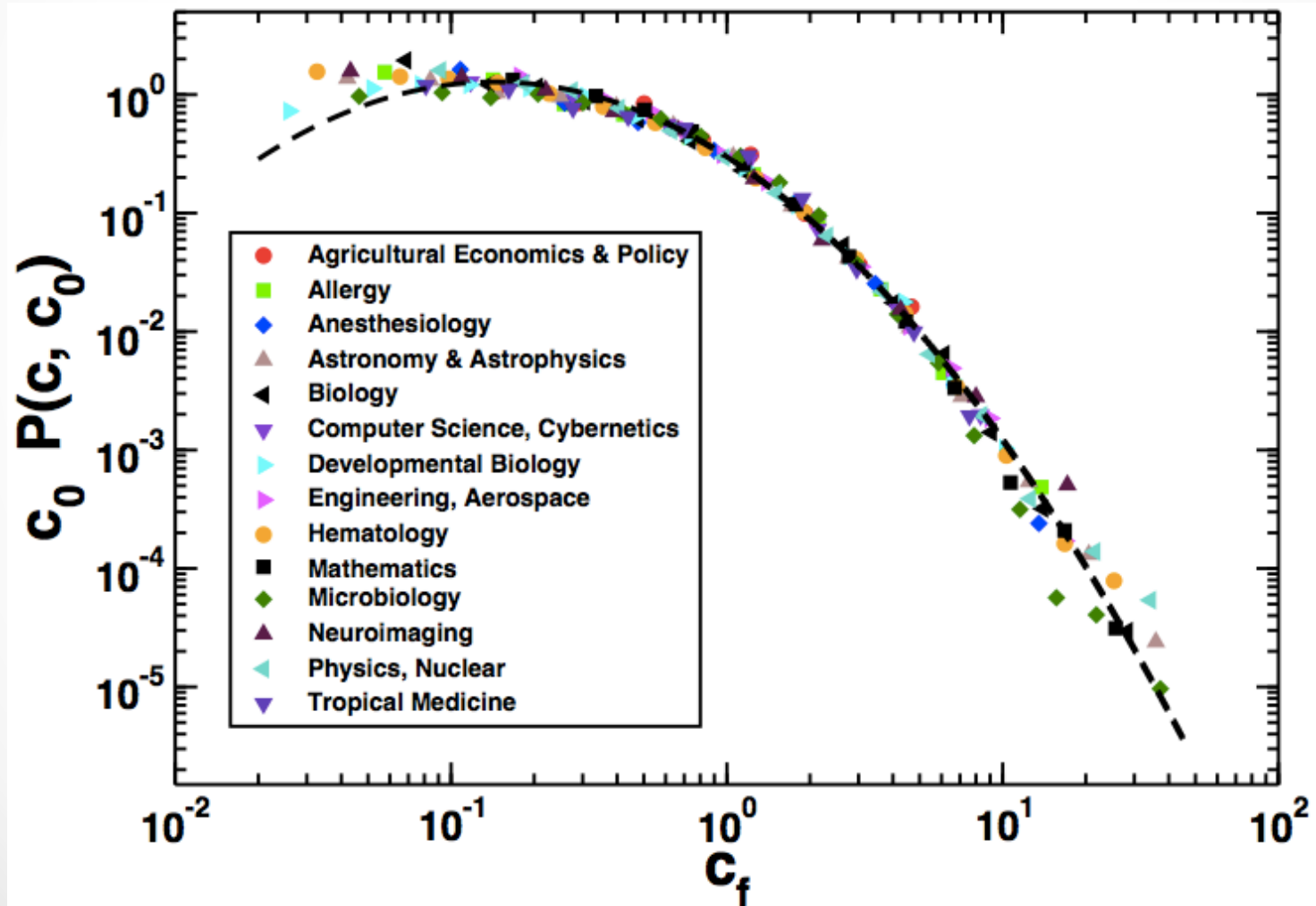
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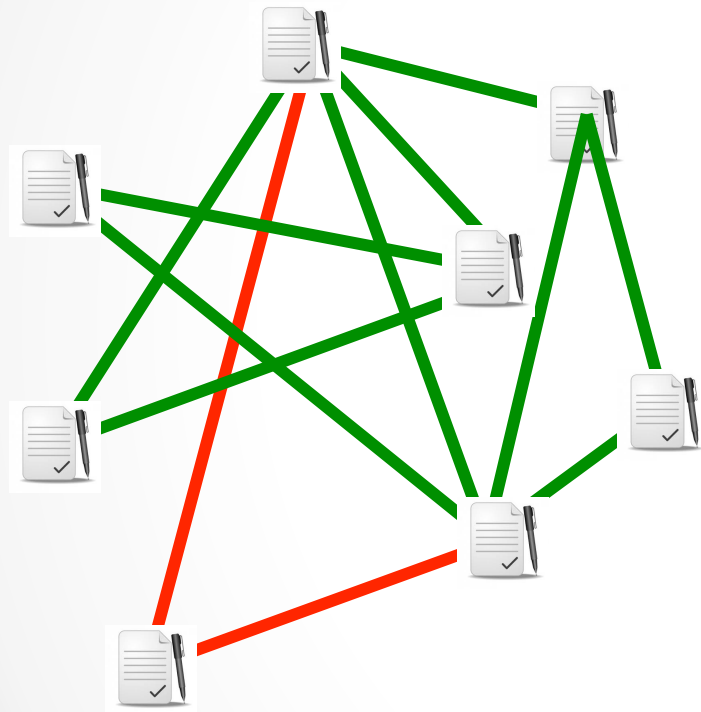
Fitting the universal distribution

Fat-tailed distribution (power law, lognormal)



Preferential attachment?

De Solla Price (1976), Barabási & Albert (1999)



Principle: probability for a new paper A to cite an older paper B is proportional to (a power of) the number of citations of B (“rich gets richer”)

$$\Pi(A \rightarrow B) \propto [c_B]^\pi$$

Problem: the rate of citation accumulation grows with time!

Our data

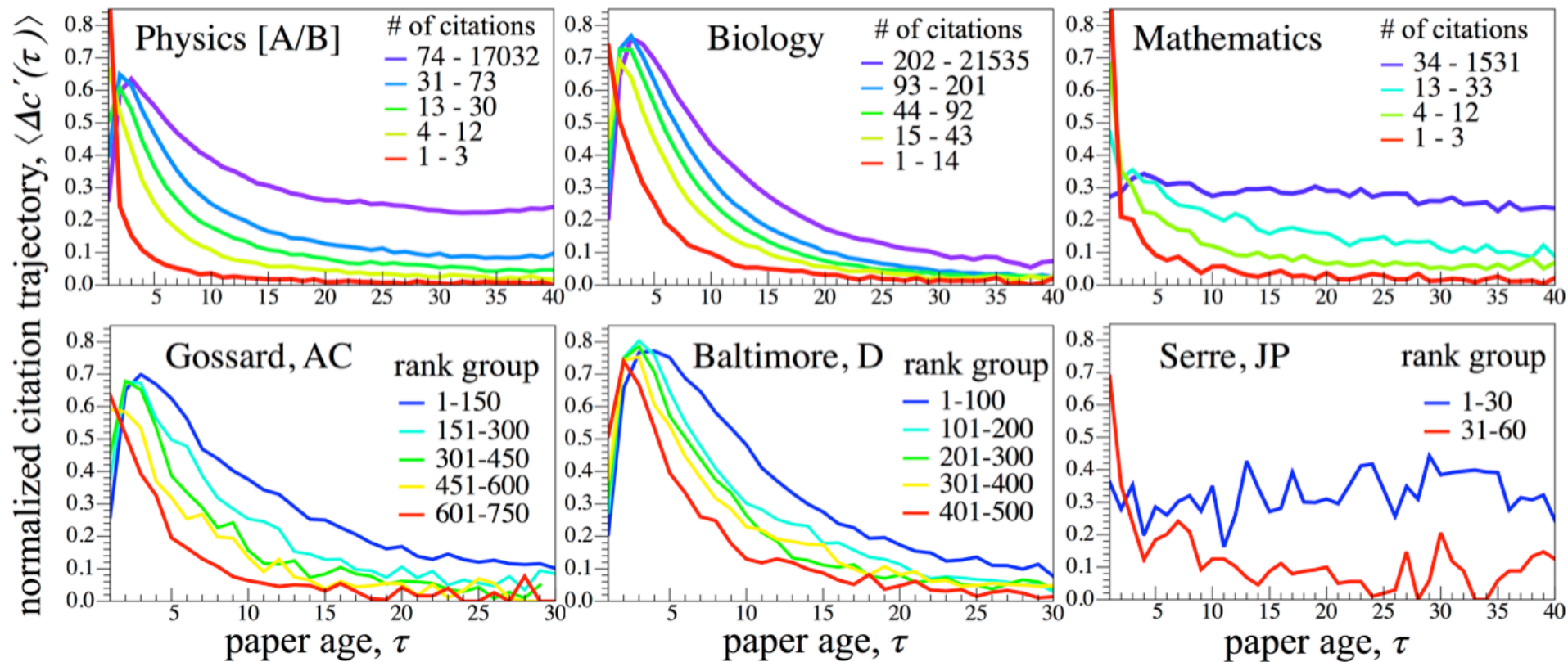
- A. Prolific authors of *Physical Review Letters* (PRL) (1958-2008)
- B. Highly productive physicists
- C. Young assistant professors from US Top 50 physics and astronomy departments
- D. Prolific authors of *Cell*
- E. Prolific authors of *Annals of Mathematics*

Summary

1. 300 physicists
2. 100 biologists
3. 50 mathematicians

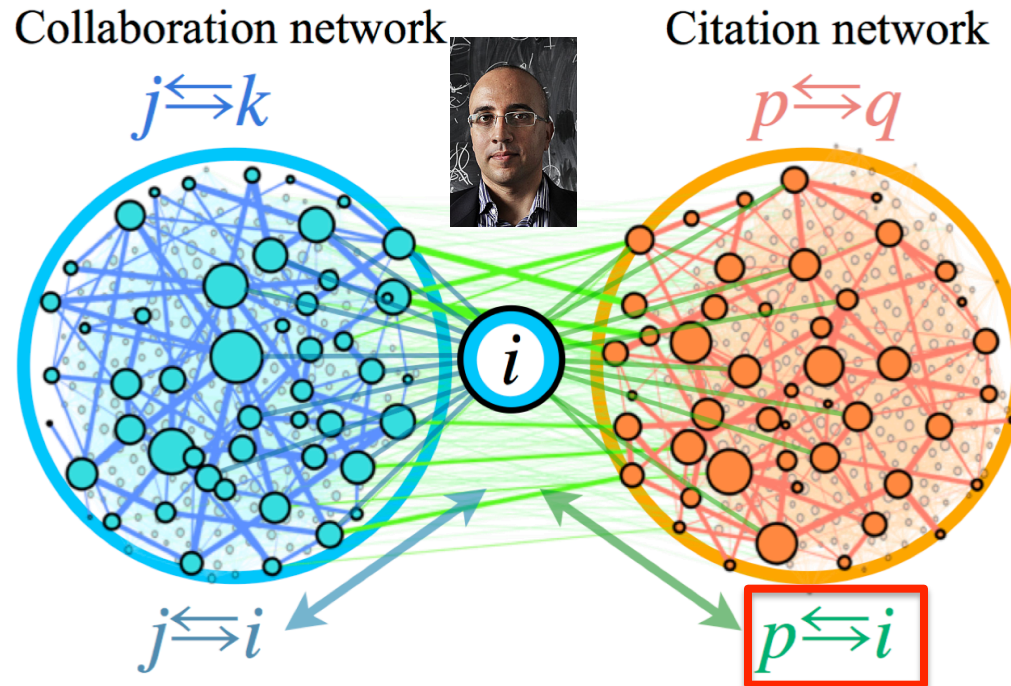
**A. M. Petersen, S. F., R. K. Pan, K. Kaski, O. Penner, A. Rungi,
M. Riccaboni, H. E. Stanley, F. Pammolli,
Proc. Natl. Acad. Sci. USA 111, 15316-15321 (2014)**

Citation life-cycle



- Citation peak before publication age $\tau \approx 5$ years
- Slower decay for highly cited papers
- Long life for papers in math

The role of reputation ...



Question: what is the role of author's reputation on citation dynamics?

A. M. Petersen, S. F., R. K. Pan, K. Kaski, O. Penner, A. Rungi,
M. Riccaboni, H. E. Stanley, F. Pammolli,
Proc. Natl. Acad. Sci. USA 111, 15316-15321 (2014)

Reputation variable

Measure of reputation of author i at time t : total number of citation $C_i(t)$, from the beginning of i 's career until year t

Issues:

1. It does not account for quality: high values of $C_i(t)$ can be achieved with many low-impact papers
2. Effect of reputation of coauthors?
3. It can only grow in time, while reputation may also decrease (misconduct, fraud)

**A. M. Petersen, S. F., R. K. Pan, K. Kaski, O. Penner, A. Rungi,
M. Riccaboni, H. E. Stanley, F. Pammolli,
Proc. Natl. Acad. Sci. USA 111, 15316-15321 (2014)**

Other variables

t = Career age, number of years since first publication

τ = Paper age, number of years since first citation

$c_{i,p}(t)$ = Citations of paper p and author i until time t

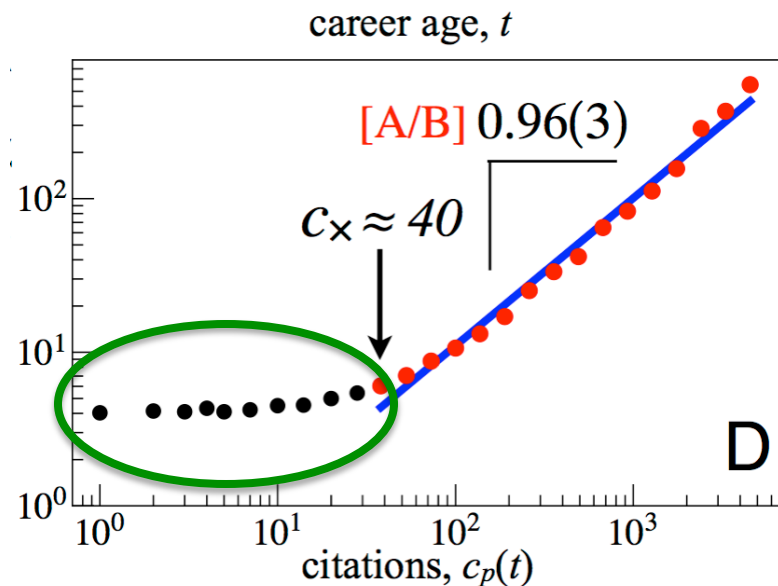
$\Delta c_{i,p}(t)$ = Citations received by paper p of author i in year t

**A. M. Petersen, S. F., R. K. Pan, K. Kaski, O. Penner, A. Rungi,
M. Riccaboni, H. E. Stanley, F. Pammolli,
Proc. Natl. Acad. Sci. USA 111, 15316-15321 (2014)**

The reputation model

$$\Delta c_{i,p}(t+1) \text{ vs } c_{i,p}(t) ?$$

Preferential attachment?



For $c_p(t)$ lower than a threshold c_x the number of cites exceeds that predicted by preferential attachment: why?

The reputation model

Regression model

$$\begin{aligned}\Delta c_{i,p}(t+1) &\equiv \eta \times \Pi_p(t) \times A_\rho(\tau) \times R_i(t) = \\ &= \eta [c_p(t)]^\pi \exp(-\tau_p/\bar{\tau}) [C_i(t)]^\rho\end{aligned}$$

noise

preferential
attachment

life cycle

reputation

Main result: reputation term important before threshold c_x and irrelevant above c_x

The reputation model

Citations are initially boosted by author reputation up to a *tipping point* c_x above which the citation rate is sustained mostly by publication reputation

For two scientists such that $C_1(t) = 10 C_2(t)$:

$$\Delta c_1(t) / \Delta c_2(t) \approx 1.66 \quad (c < c_x)$$

66 % increase for each 10-fold increase in $C_i(t)$!



Being a big name in science brings benefits

A study that links scientists' reputations with their citations triggers online talk.

Chris Woolston

12 November 2014

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Scientists develop reputations that often work to their advantage. A study suggests that the presence of a well-known scientist on a list of authors can drive citations of the paper, regardless of the merits of the research — especially soon after its publication. The report rapidly started an online discussion. “How scientists too



Based on data from
[Altmetric.com](#). Altmetric is

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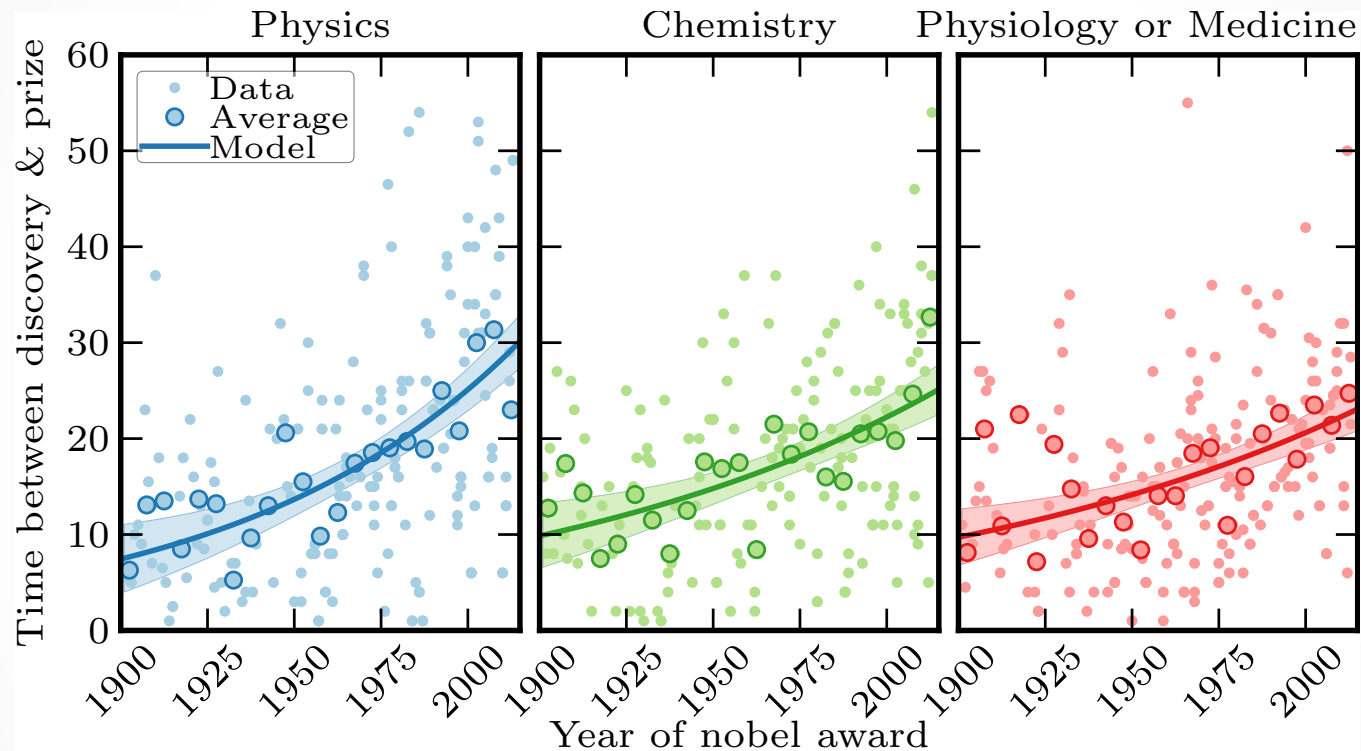
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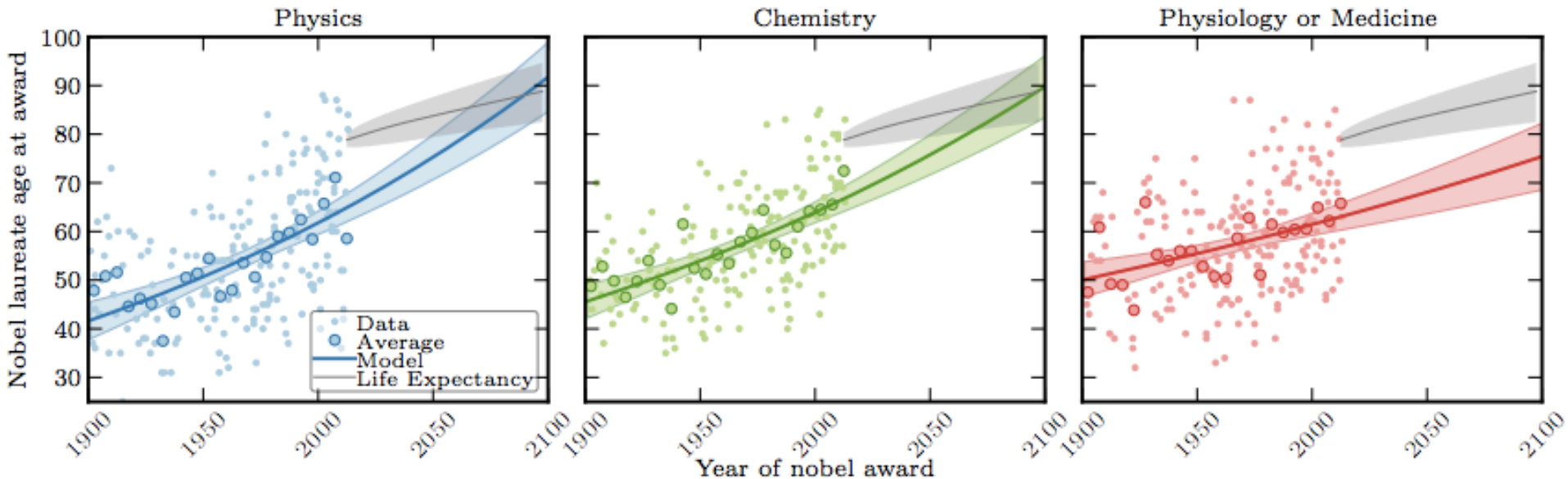
5.

The Nobel Prize Delay



F. Becattini, A. Chatterjee, S. F, M. Mitrović, R. K. Pan, P. Della Briotta Parolo, Nature 508, 186 (2014)
<http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.2012>

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<http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.2012>

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NATURE | CORRESPONDENCE



Prizes: Growing time lag threatens Nobels

Santo Fortunato

Nature **508**, 186 (10 April 2014) | doi:10.1038/508186a

Published online 09 April 2014

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The time lag between reporting a scientific discovery worthy of a Nobel prize and the awarding of the medal has increased, with waits of more than 20 years becoming common. If this trend continues, some candidates might not live long enough to attend their Nobel ceremonies.

Before 1940, Nobels were awarded...

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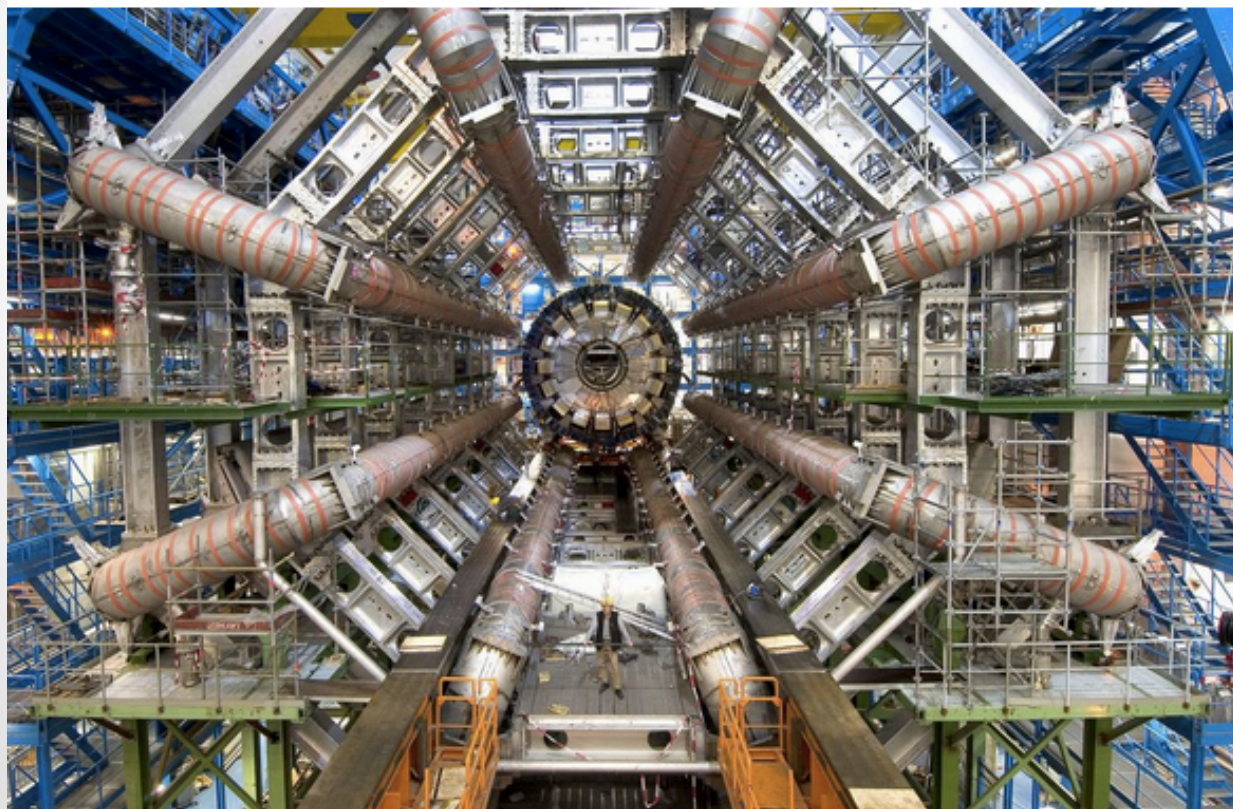
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Opinion: Science Is Running Out of Things to Discover

The advancing age when Nobelists receive their prizes could suggest fewer breakthroughs are waiting to happen.



The Large Hadron Collider at the European Organization for Nuclear Research (CERN) in

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Dying for a Nobel? Winners snag prizes at older ages

Traci Watson, Special for USA TODAY 1:10 p.m. EDT April 9, 2014

Study finds that there's a growing time lag between discoveries and awarding of Nobel prizes for those findings.



(Photo: Bullit Marquez, AP)

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The Nobel Prize is supposed to be the ultimate mark of scientific achievement. Now it has become a mark of something else: endurance.

New research shows that the time lag between a notable scientific discovery and the Nobel Prize for that discovery has escalated sharply over the past

century. Before 1940, roughly 10% to 15% of physics or chemistry laureates had endured a wait of more than 20 years between their discovery and the prize. But since 1985, 50% to 60% of laureates have waited that long. The lag time has also risen, though not as steeply, for winners of the Nobel for physiology or medicine.

If the trend continues, the gap between discovery and award will become so long that by the end of the century, many worthy scientists will die before they make the trip to Stockholm to receive their Nobels, says study co-author Santo Fortunato of Aalto

verizon

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Nobelpreise: Forscher müssen immer länger auf Ehrung warten





REUTERS

Peter Higgs: Fast ein halbes Jahrhundert lag zwischen seiner Idee und dem Nobelpreis im Jahr 2013

Bis wissenschaftliche Arbeiten mit einem Nobelpreis ausgezeichnet werden, vergeht immer mehr Zeit. Viele Forscher erhalten den Preis einige Jahrzehnte später - oder können gar nicht mehr geehrt werden, weil sie vorher sterben.

Les lauréats des Nobel sont de plus en plus âgés

🏠 > ACTUALITE > SCIENCES & ENVIRONNEMENT Par  Marielle Court | Mis à jour le 08/10/2014 à 18:24 | Publié le 08/10/2014 à 17:27

PARTAGER 
IMPRIMER 

Si la valeur n'attend pas le nombre des années, le prix **Nobel** se montre plus patient. D'après une étude menée par Santo Fortunato, statisticien à l'université Aalto (Finlande), les scientifiques obtiennent la prestigieuse récompense de plus en plus tard après la parution des travaux qui les ont distingués. S'ils décrochaient la récompense, en moyenne, moins de dix ans après leur découverte au début du XXe siècle, ils doivent aujourd'hui attendre plus de 20 ans pour recevoir le prix de physiologie ou de médecine, 25 ans pour celui de chimie et 30 ans en physique, expliquait-il dans *Physics Today*, en mai dernier.

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Forskare kan hinna gå ur tiden

10 april



När teorin om Higgspartikeln väl var bekräftad tog det inte lång tid innan Peter Higgs fick ta emot sitt Nobelpris i fysik. Men grunden till teorin lades 50 år tidigare. Foto: Frank Augstein

Tiden mellan upptäckt och Nobelpris har ökat markant på senare år. Fysikern Santo Fortunato varnar nu för att om utvecklingen fortsätter kommer framtida pristagare inte hinna belönas under sin livstid.

DEVELOPING

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Scientists sound alarm over long wait for Nobel prize

AFP

By Peter Harmsen | AFP – Sun, Oct 5, 2014



Take-home messages

Normalized indicators?



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