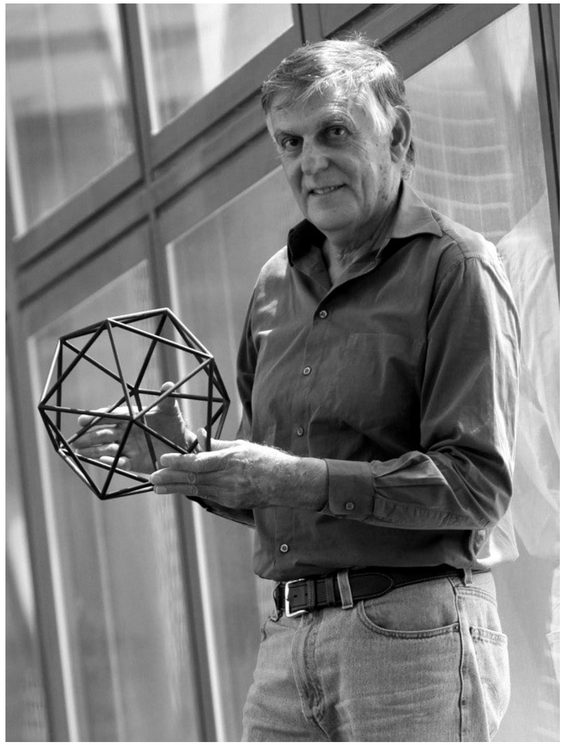
Physics, Interdisciplinarity, and the Chaperone Effect

Roberta Sinatra

@robysinatra

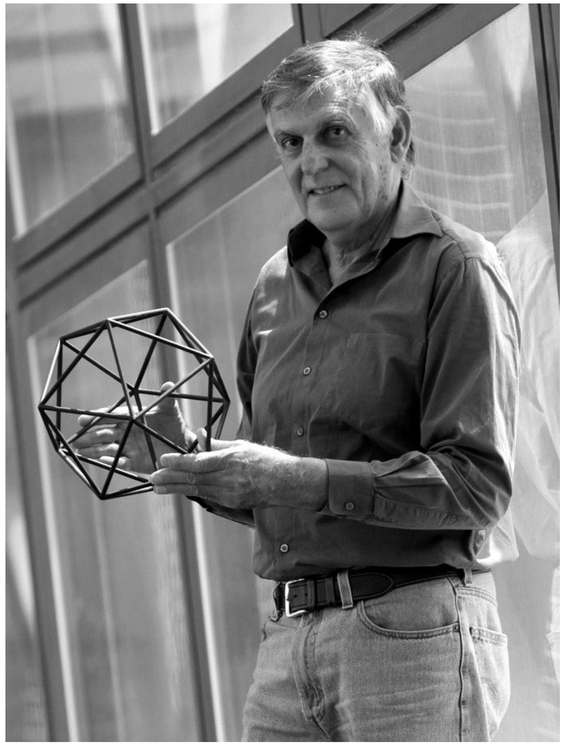
Dan Shechtman

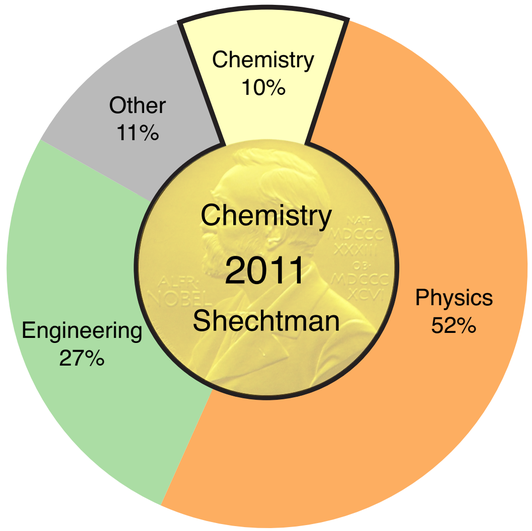


Material scientist
Nobel prize in chemistry

Shechtman et al., PRL 53, 1951 (1984)

Dan Shechtman

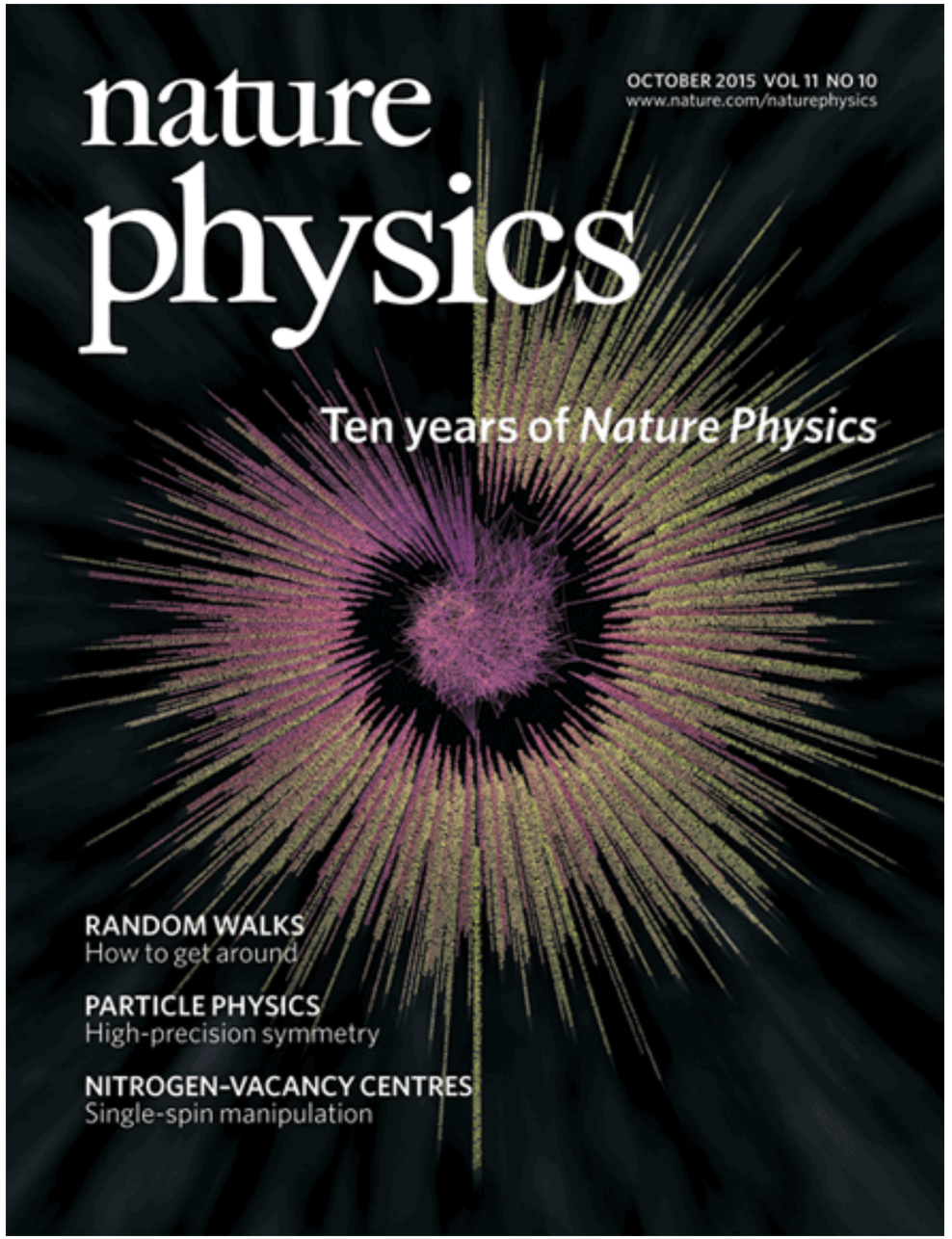




Material scientist
Nobel prize in chemistry
Cited by physicists (6x)

Shechtman et al., PRL 53, 1951 (1984)

What is physics?



What is physics?

What is physics?

Physics is what physicists do.

- Sam Edwards

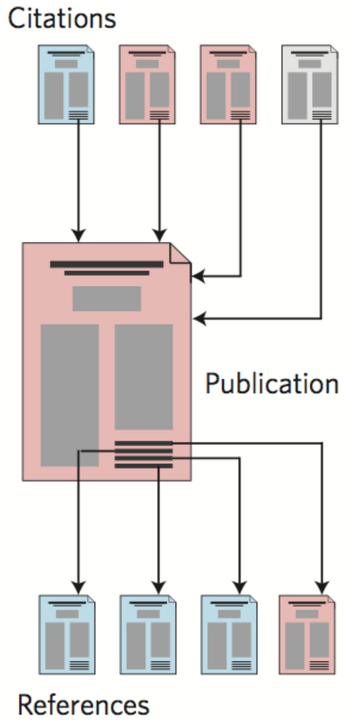
What is [field]?

[field] is what [people in the field] do.

Basic units of science: publication and citation

WEB OF KNOWLEDGE℠

THOMSON REUTERS

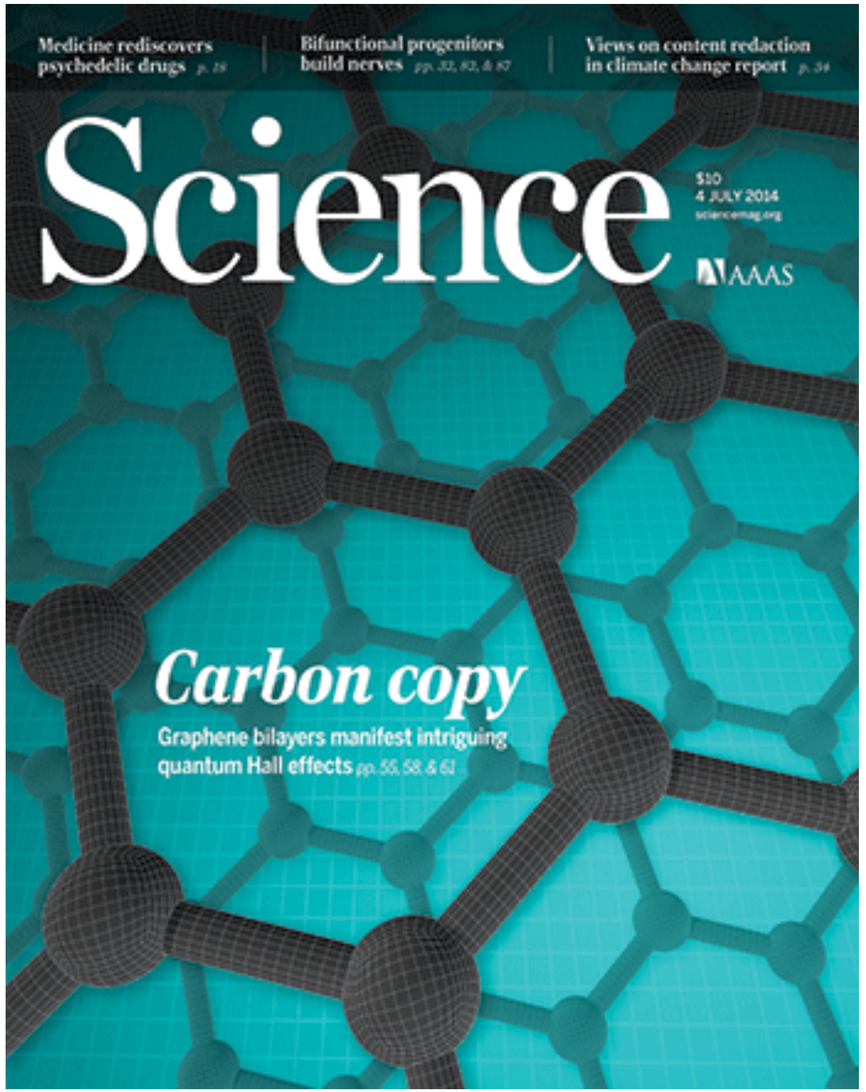


- 40M papers from 23,000 journals
- 113 years
- 500M citations

Journal classification:
WoS, Scimago, Wikipedia

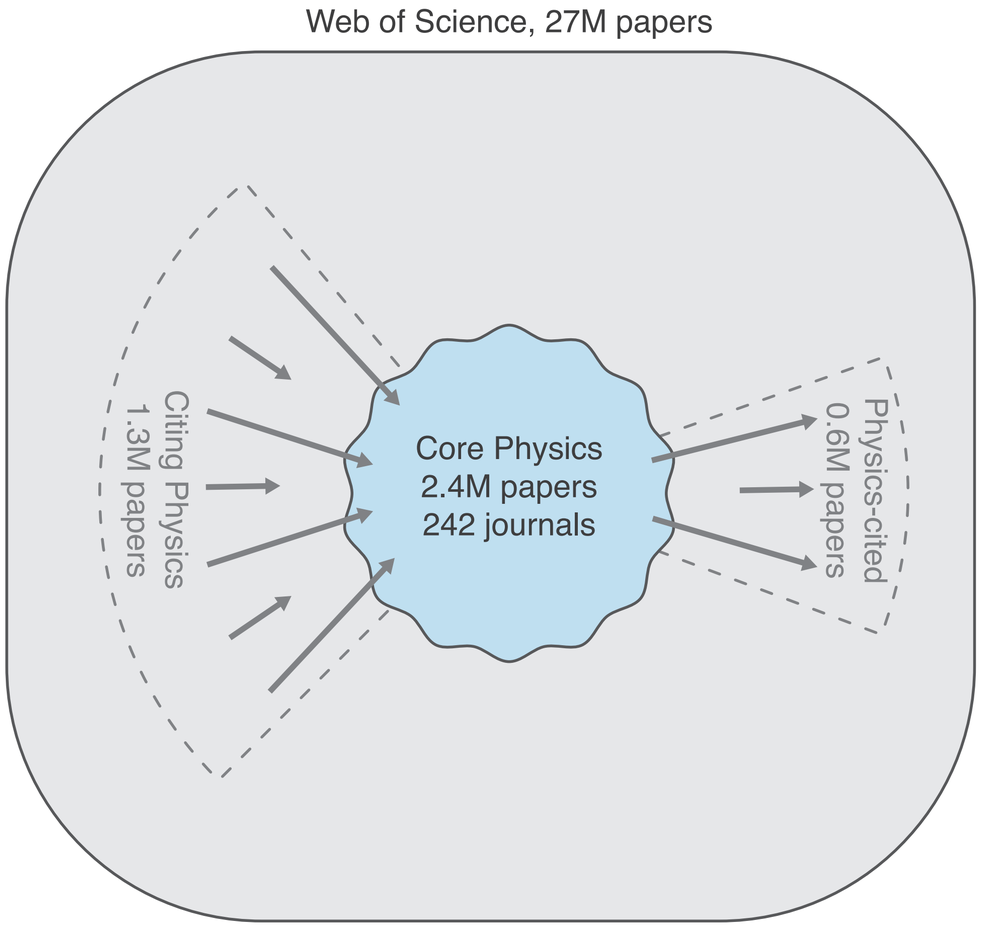
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

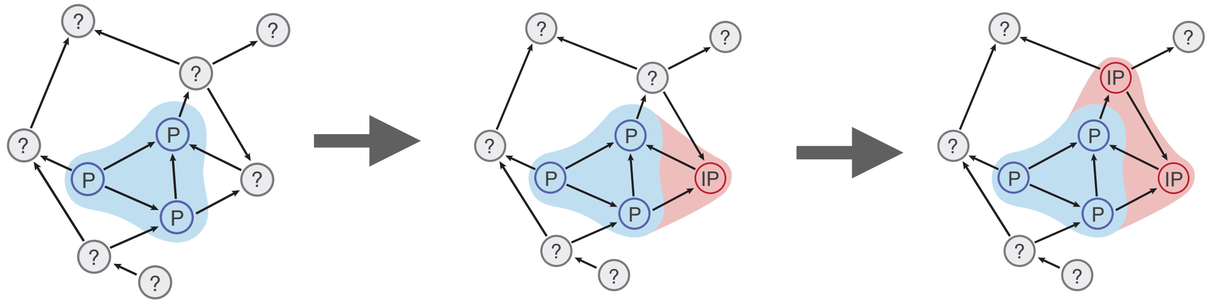
Physics is not published in physics journals only



Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

How to detect physics papers

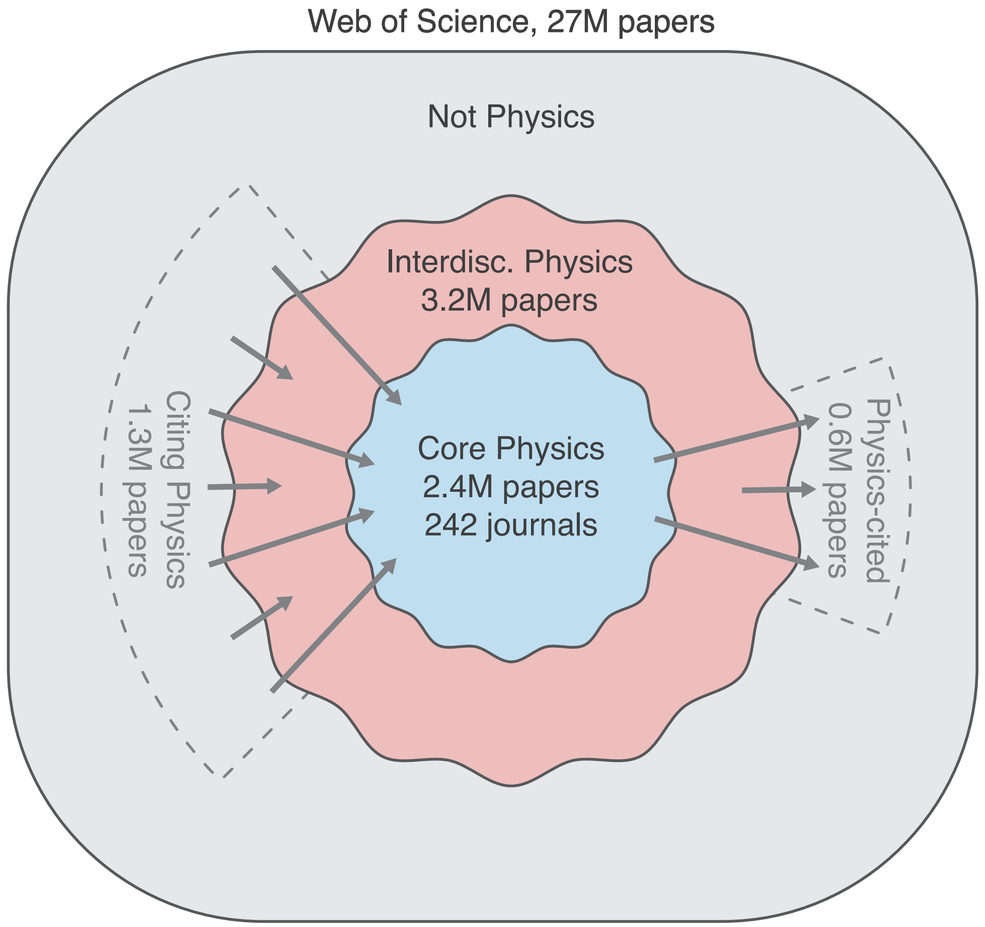


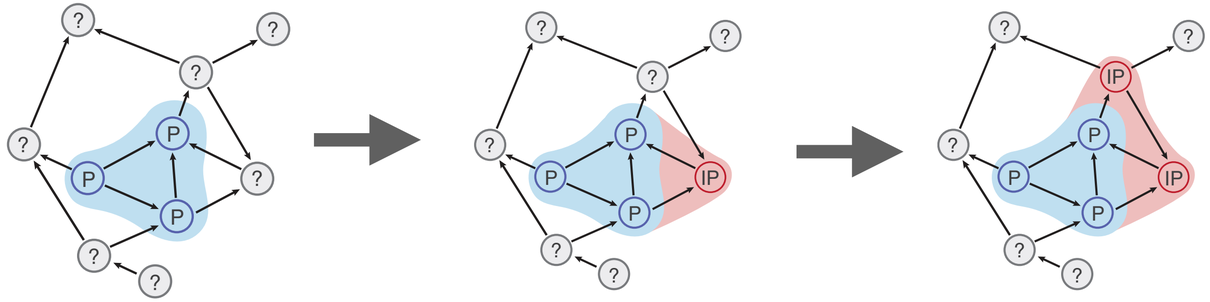


Physics is what is citing and cited by core physics
(in a statistical significant way)

Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

How to detect physics papers





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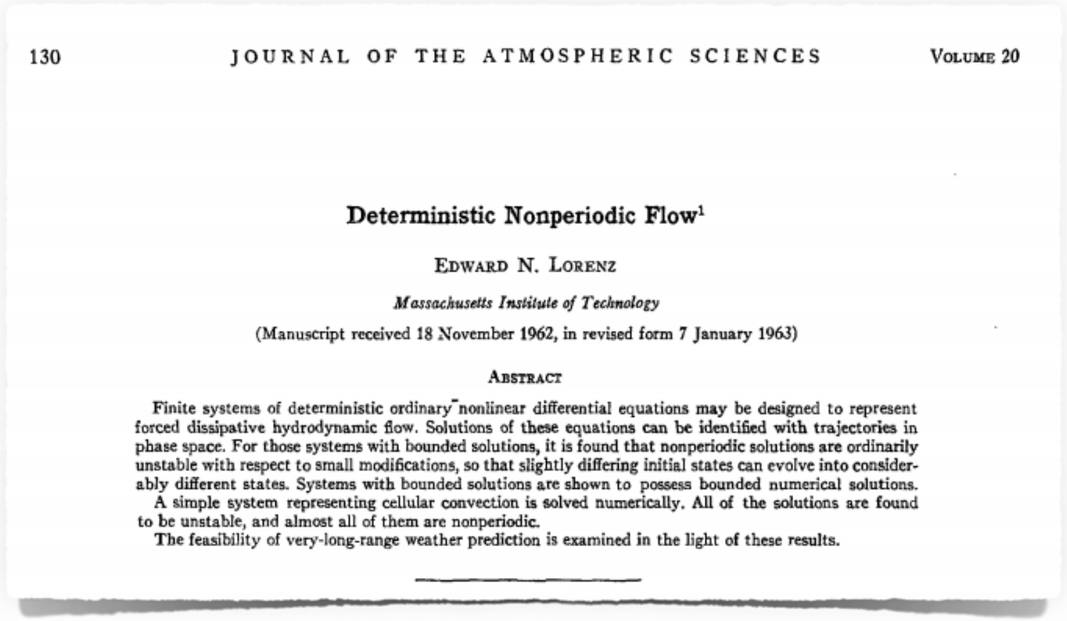


130 JOURNAL OF THE ATMOSPHERIC SCIENCES VOLUME 20

Deterministic Nonperiodic Flow[1]

EDWARD N. LORENZ

Massachusetts Institute of Technology

(Manuscript received 18 November 1962, in revised form 7 January 1963)

ABSTRACT

Finite systems of deterministic ordinary nonlinear differential equations may be designed to represent forced dissipative hydrodynamic flow. Solutions of these equations can be identified with trajectories in phase space. For those systems with bounded solutions, it is found that nonperiodic solutions are ordinarily unstable with respect to small modifications, so that slightly differing initial states can evolve into considerably different states. Systems with bounded solutions are shown to possess bounded numerical solutions.

A simple system representing cellular convection is solved numerically. All of the solutions are found to be unstable, and almost all of them are nonperiodic.

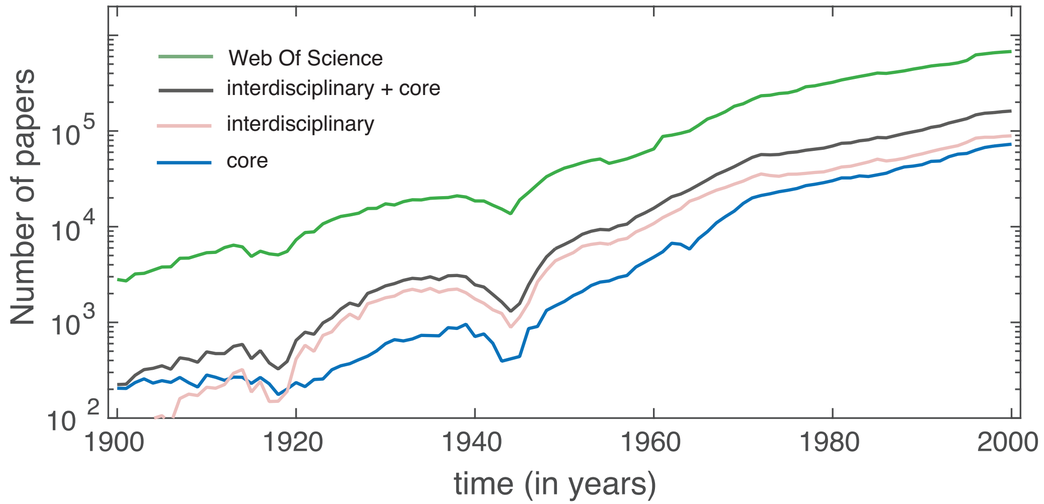
The feasibility of very-long-range weather prediction is examined in the light of these results.

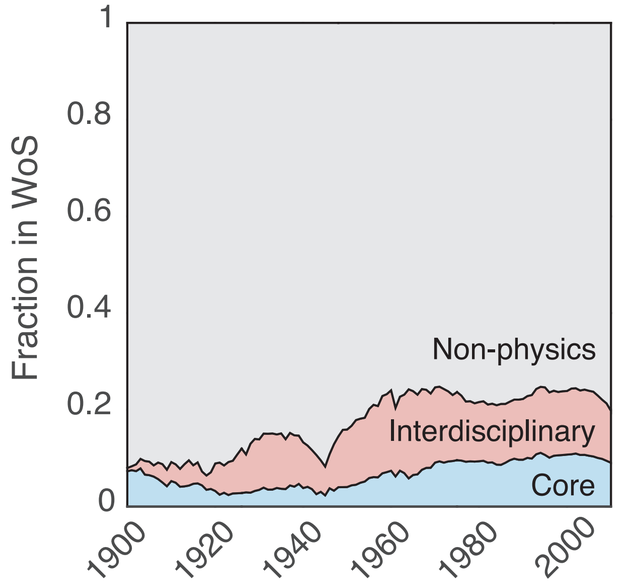
5,131 citations:

1,945 from core physics (5x)

1,711 come from interdisciplinary physics (2.4x)

How is physics evolving?

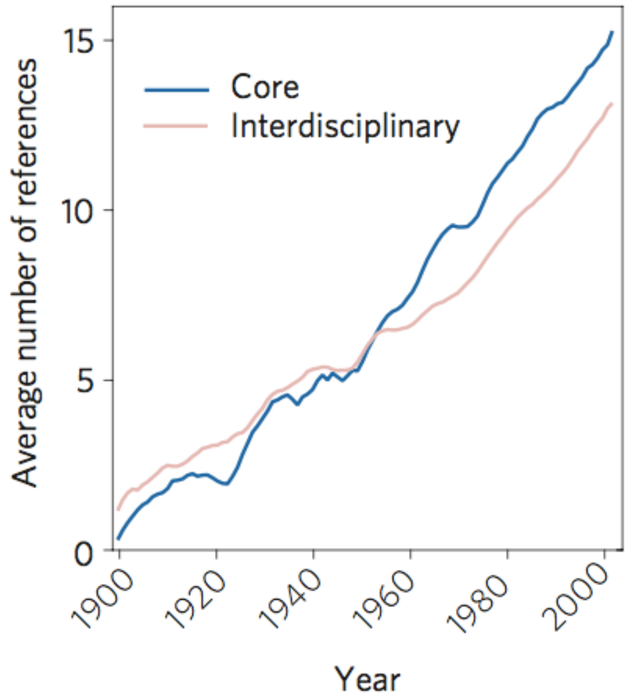




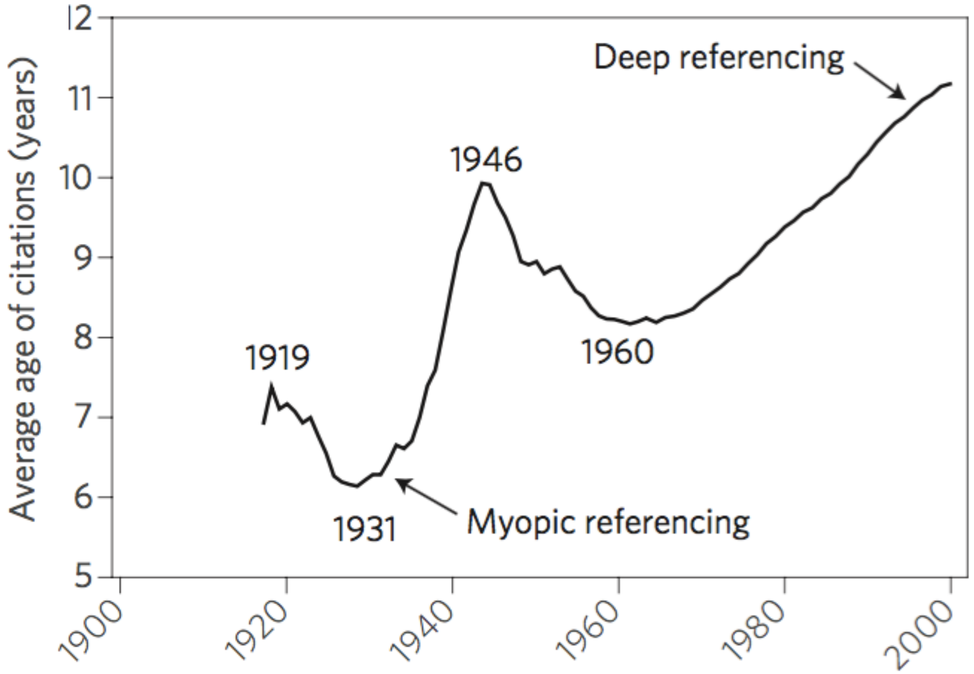
Number of physics papers grows exponentially,
now at the same speed as the entire WoS literature

Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

How is physics citing?



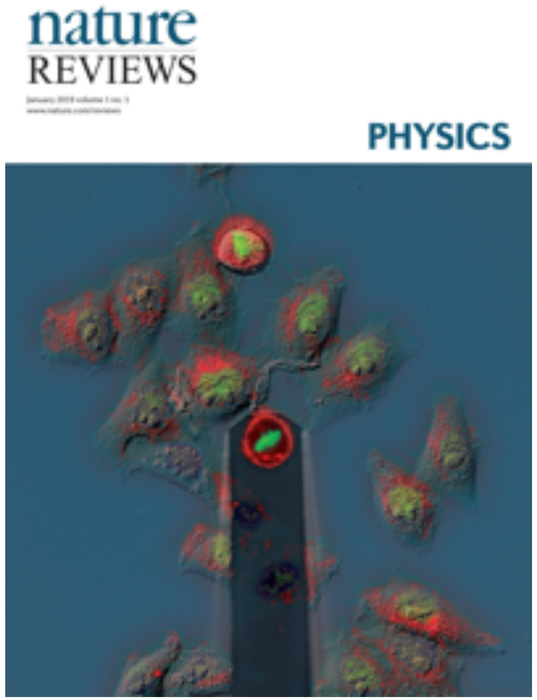
Growth of number of references



Age of citations

Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

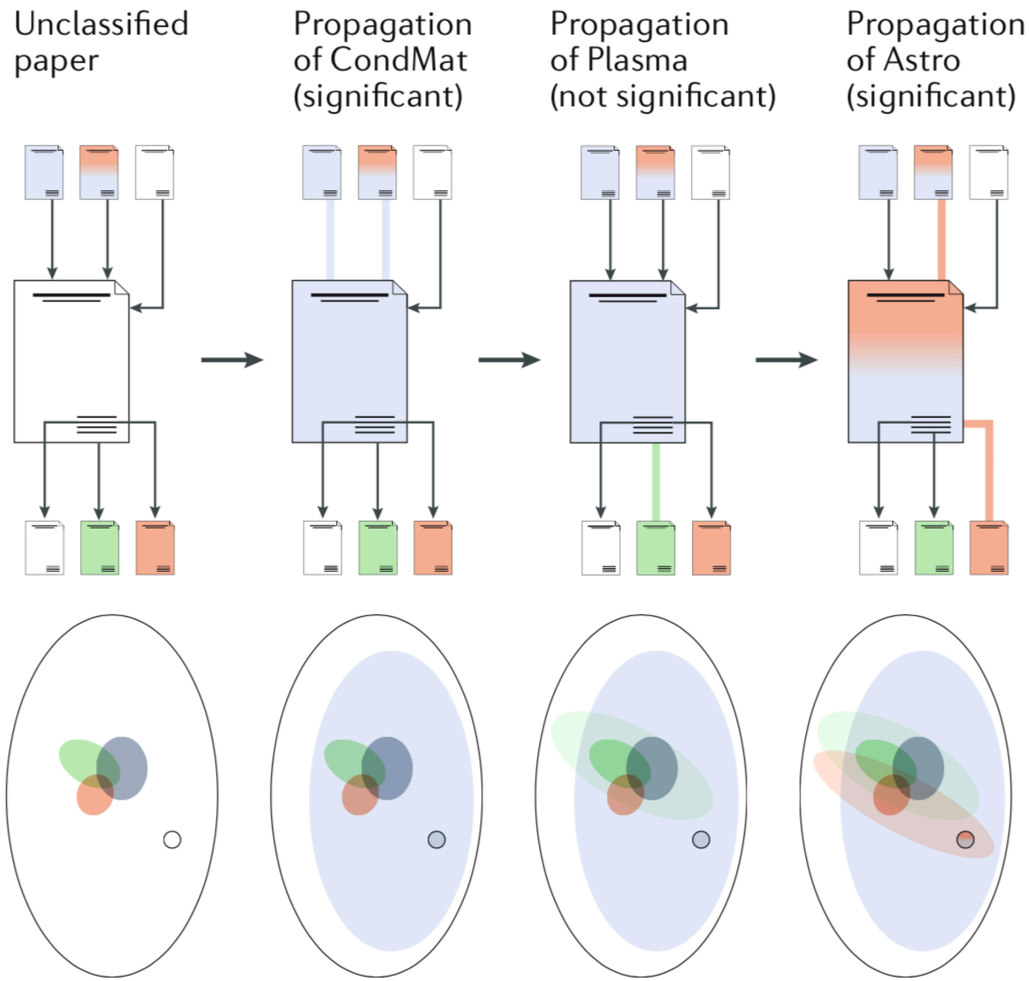
Taking census of Physics



How many physicists
are out there?
In which fields?

Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)

We propagated PACS to identify paper subfields



APS: 400k → WoS: 1.1 Mio papers

Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)

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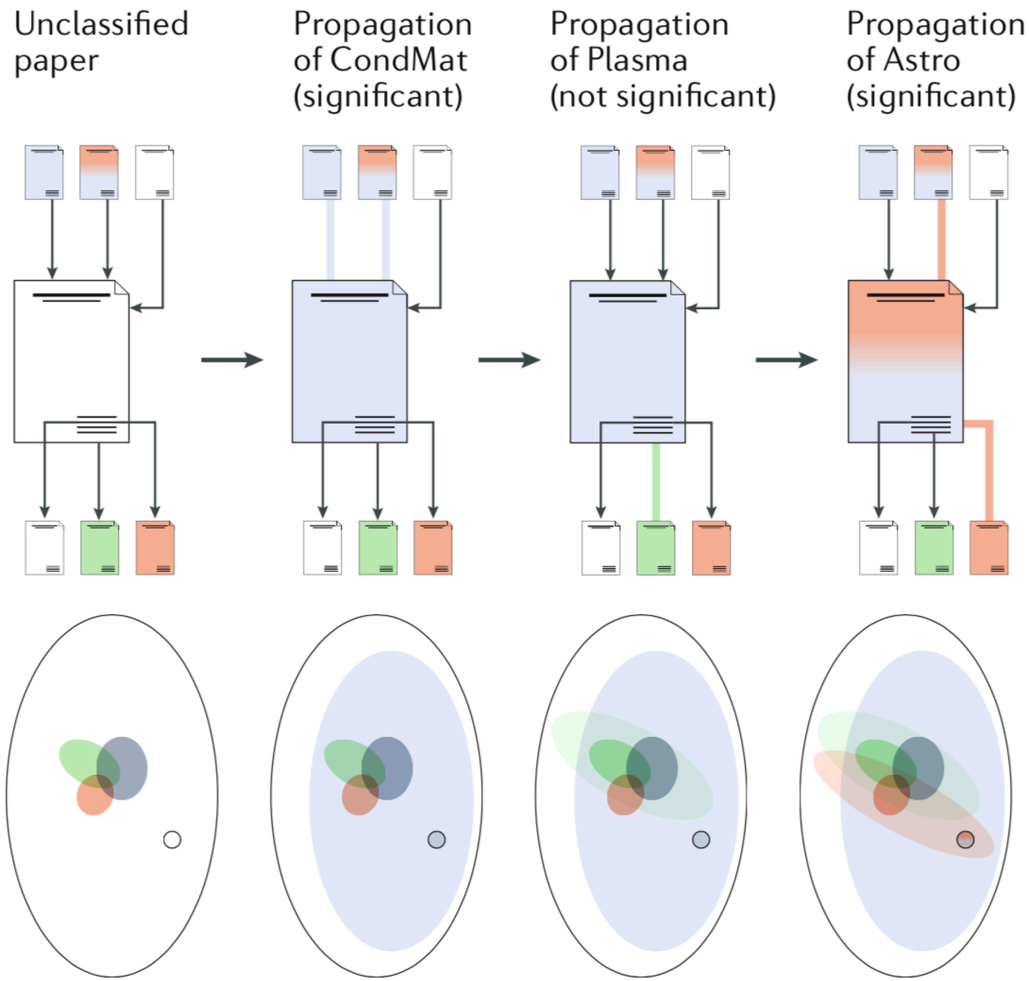
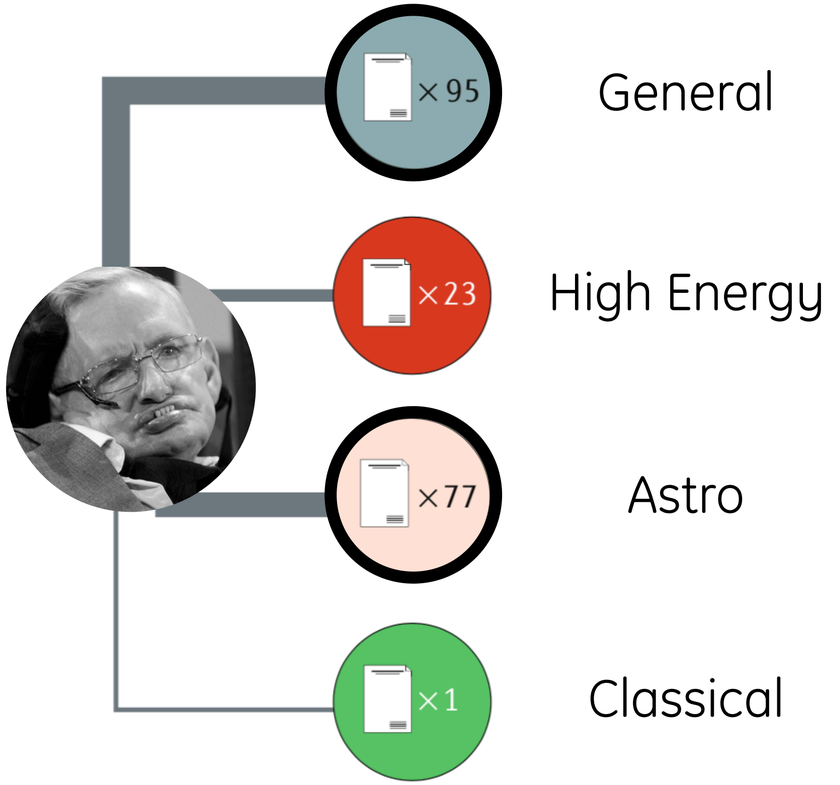


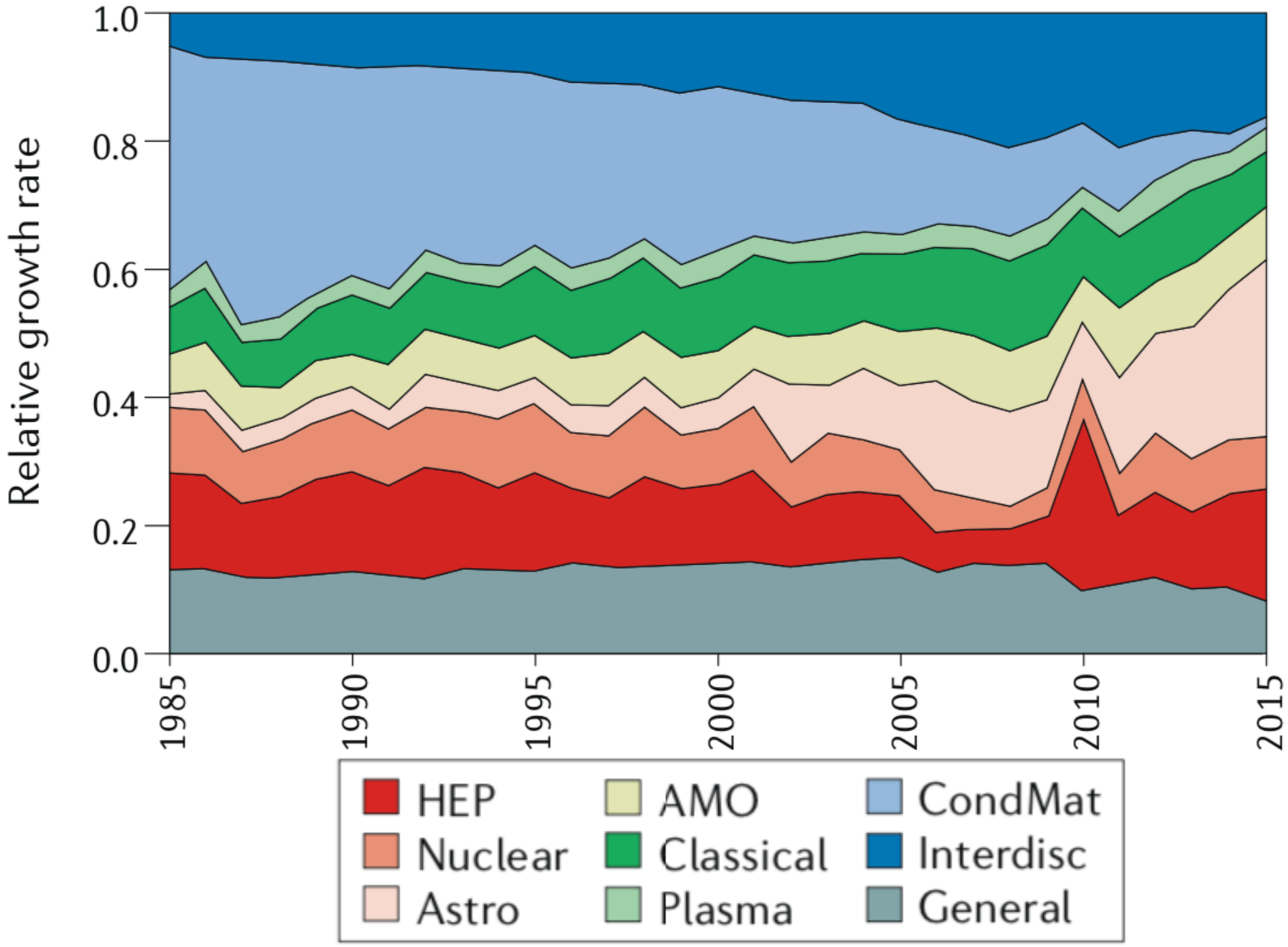


APS: 400k → WoS: 1.1 Mio papers

140,000 physicists

Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)

Some fields grow, some fields shrink considerably



Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)

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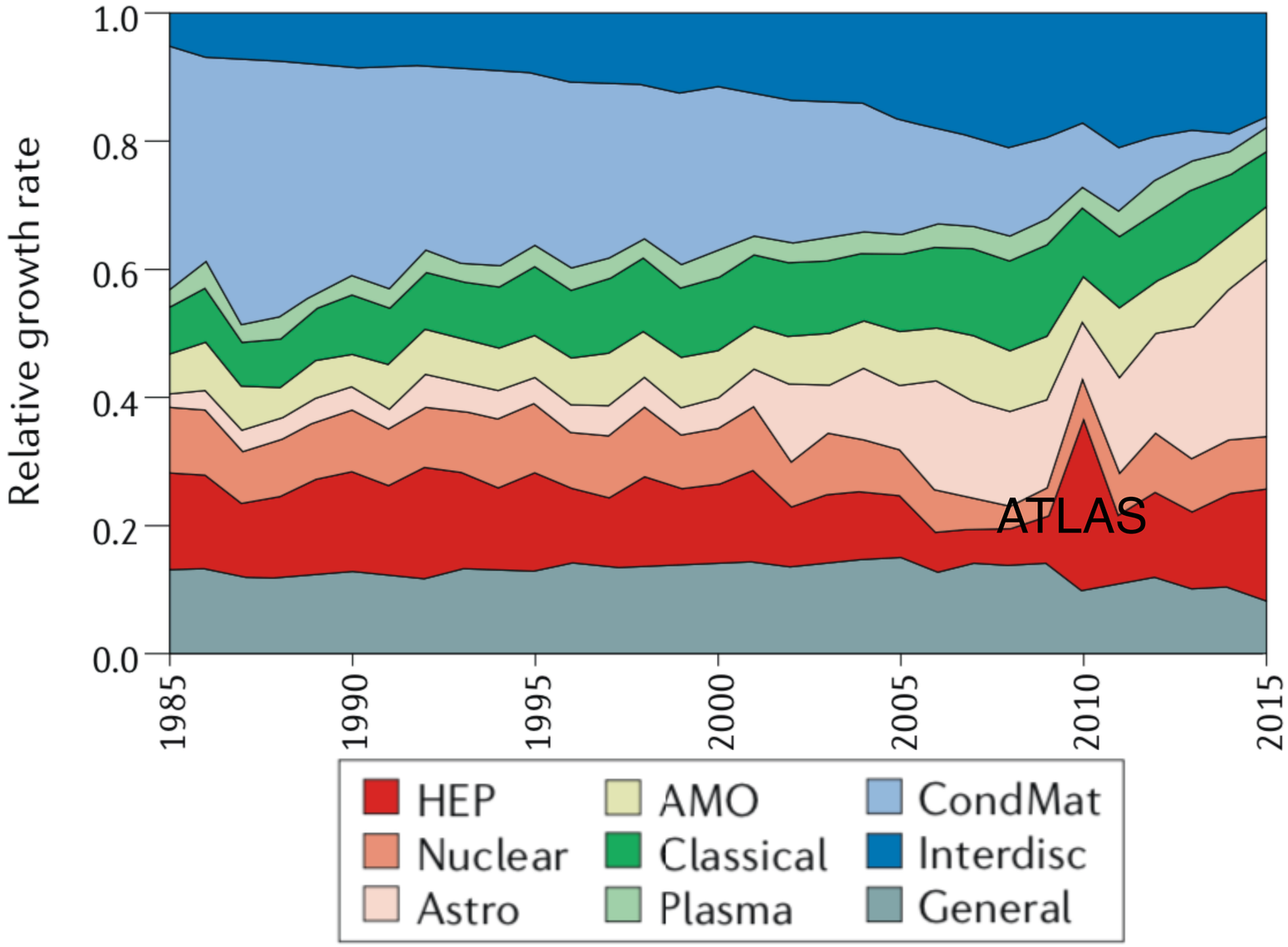

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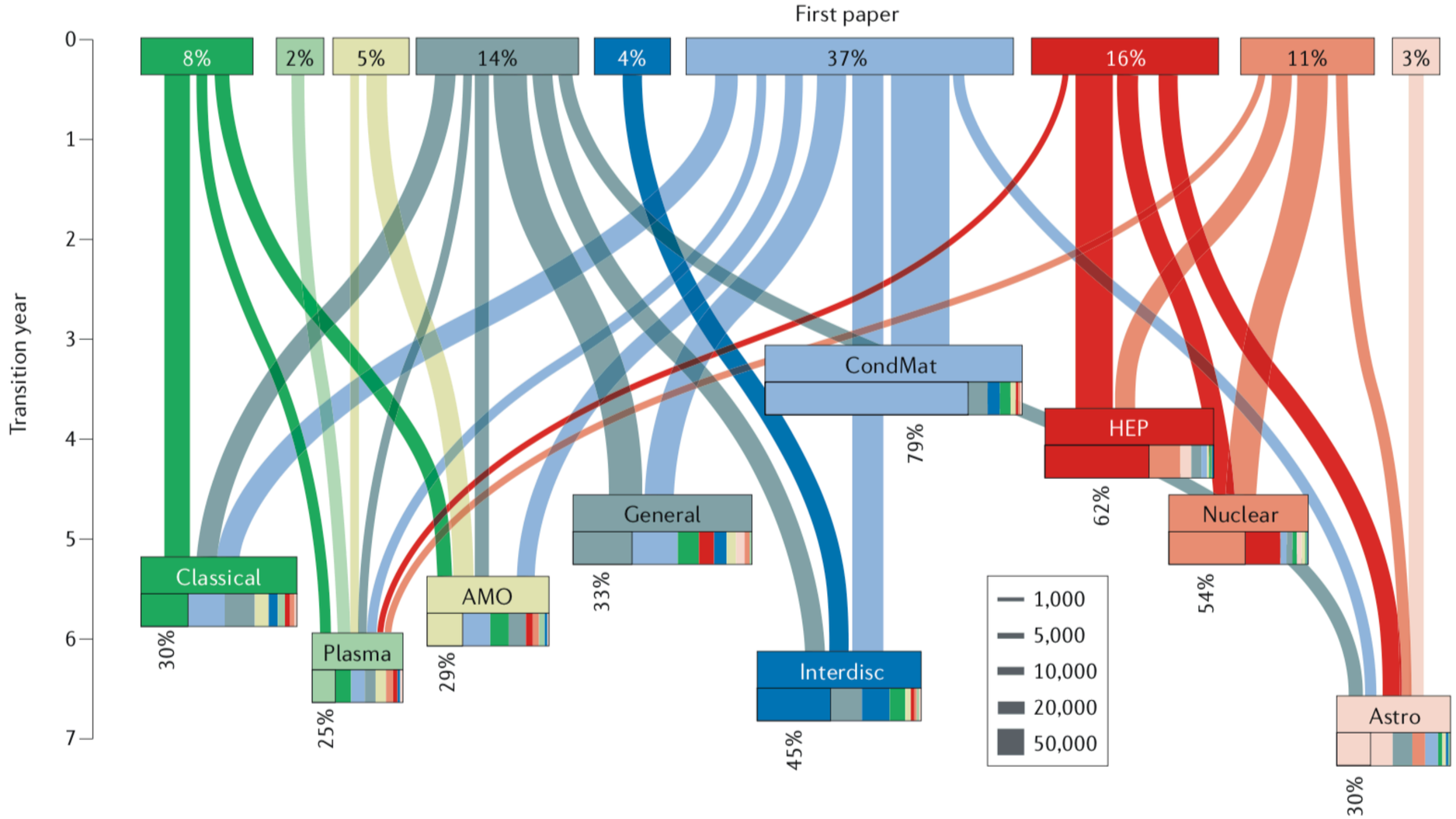

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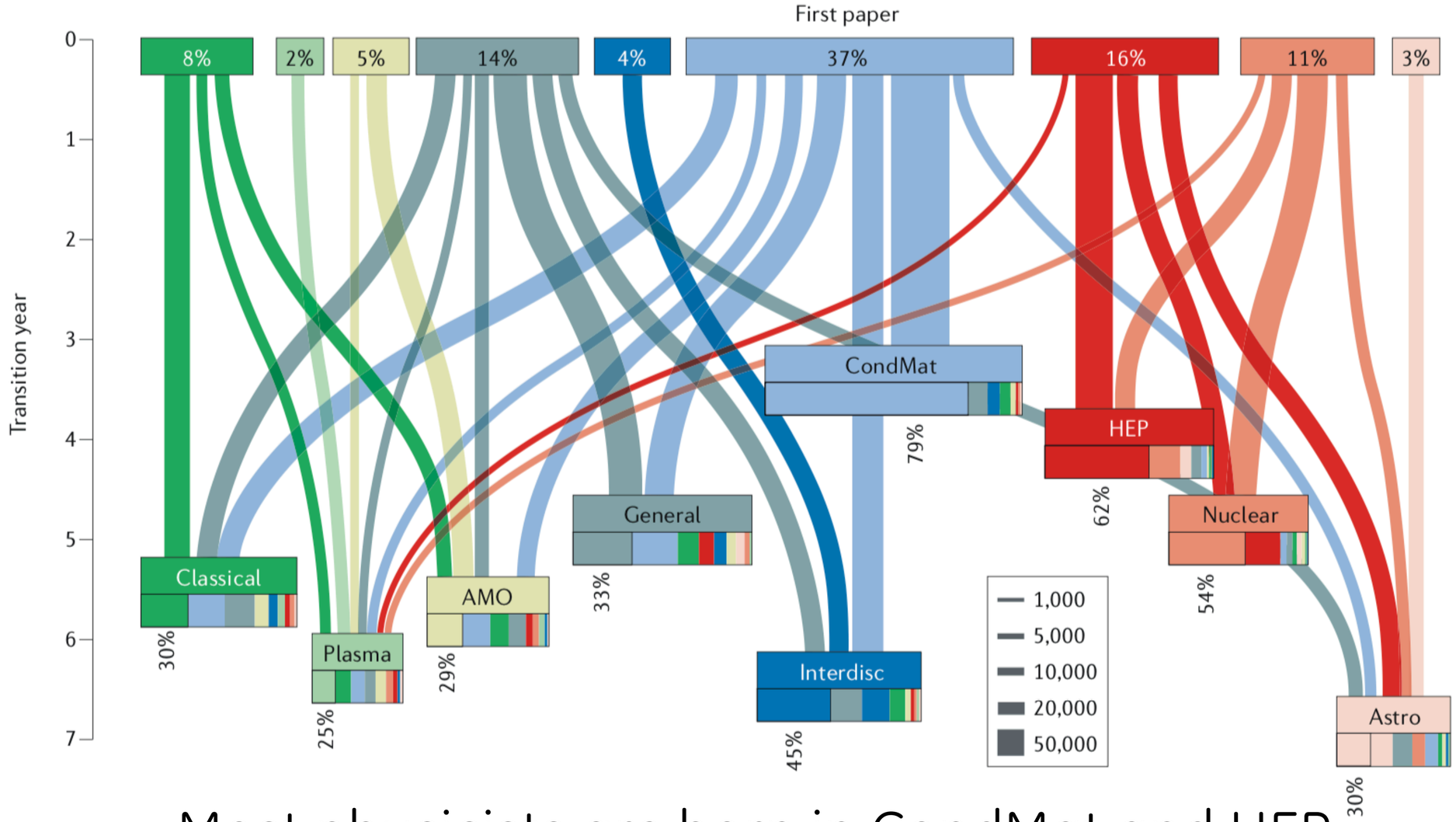
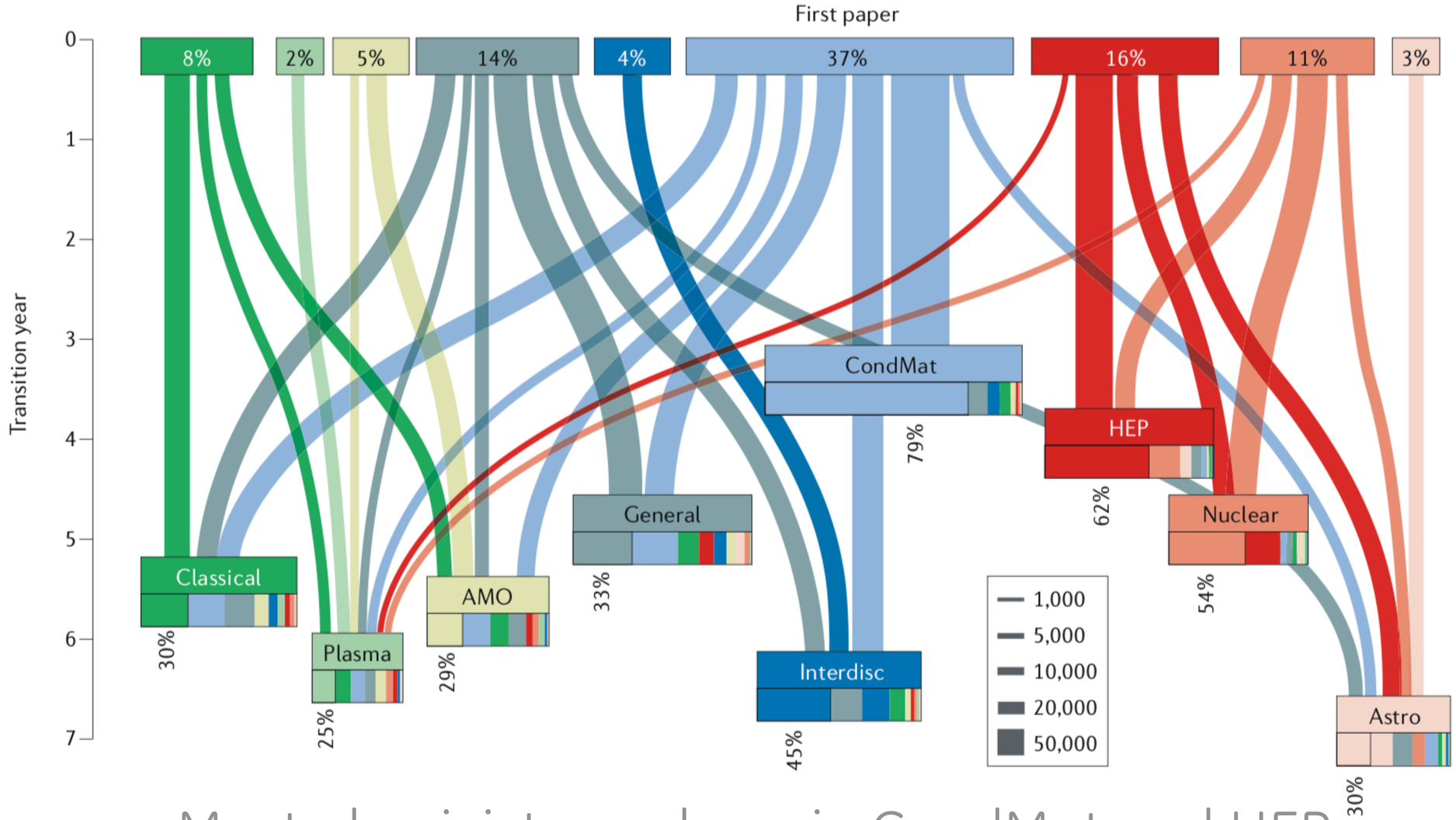


Most physicists are born in CondMat and HEP

Transitions to Interdisc and Astro takes longest

Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)



Most physicists are born in CondMat and HEP

CondMat => Inter, HEP => Astro, Many => Plasma

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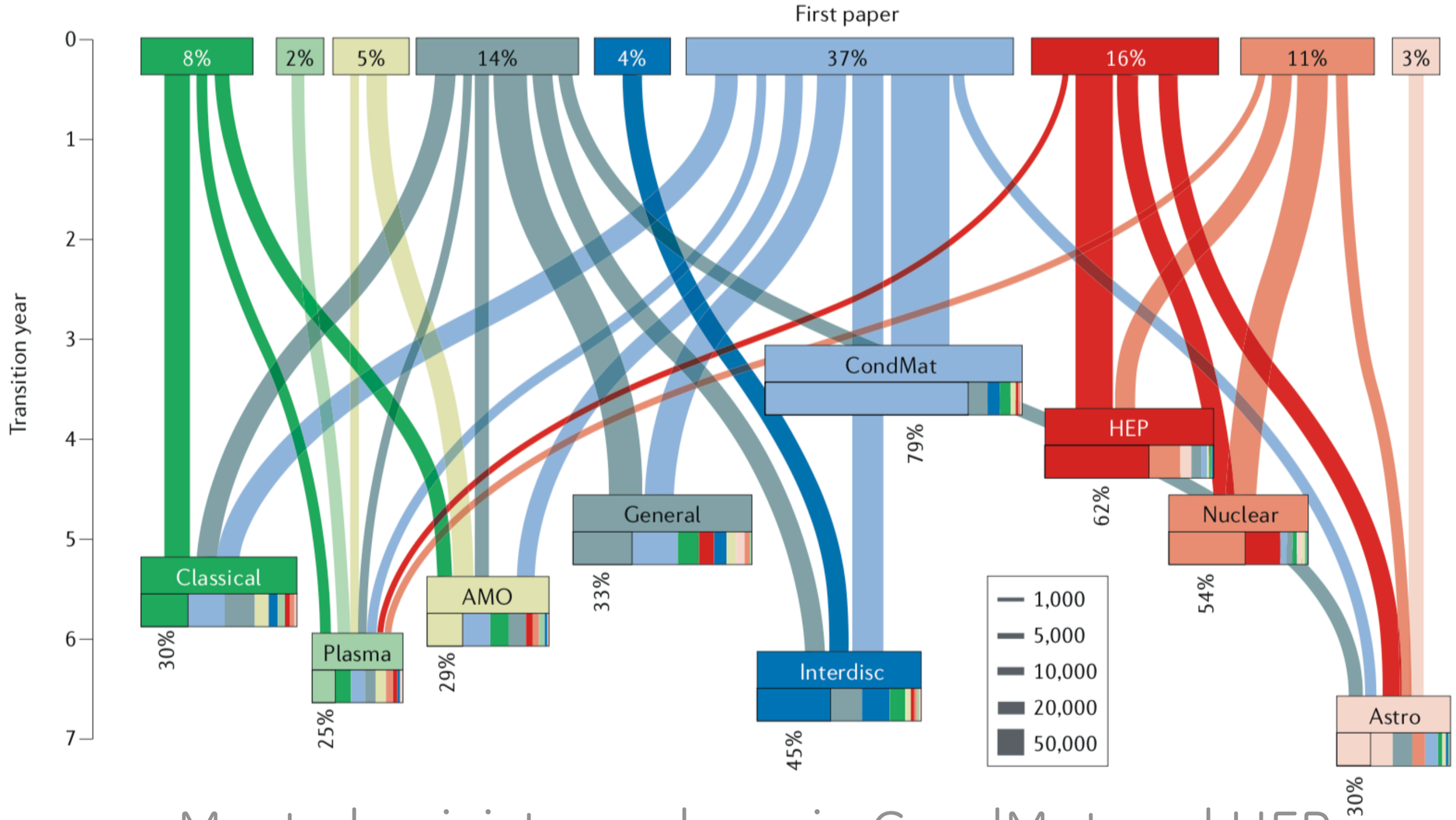
Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)



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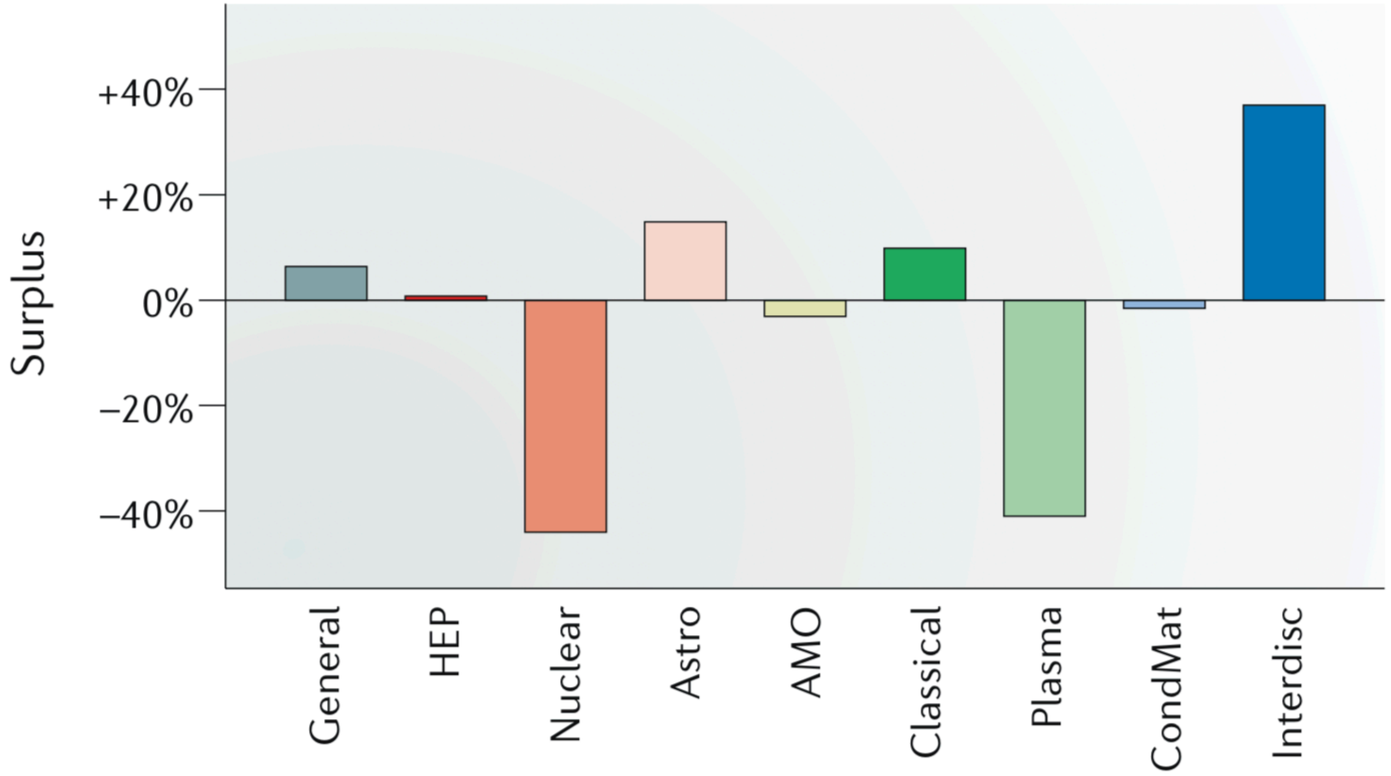
Subfield impact: Interdisc generates the highest number of high-impact papers compared with its size

Top 1% papers for citations



Battiston, Musciotto,, Wang, Barabási, Szell, Sinatra, Nature Reviews Physics, 1, (2019)

We can use these methods in:

- Committees
- Grants solicitation/classification
- Scope of journals and paper reviews
- Fellowships

Let the data decide!

Interdisciplinarity is important

Interdisciplinary research is important

Why interdisciplinary research matters

Scientists must work together to save the world. A special issue asks how they can scale disciplinary walls.

16 September 2015 | Corrected: 17 September 2015

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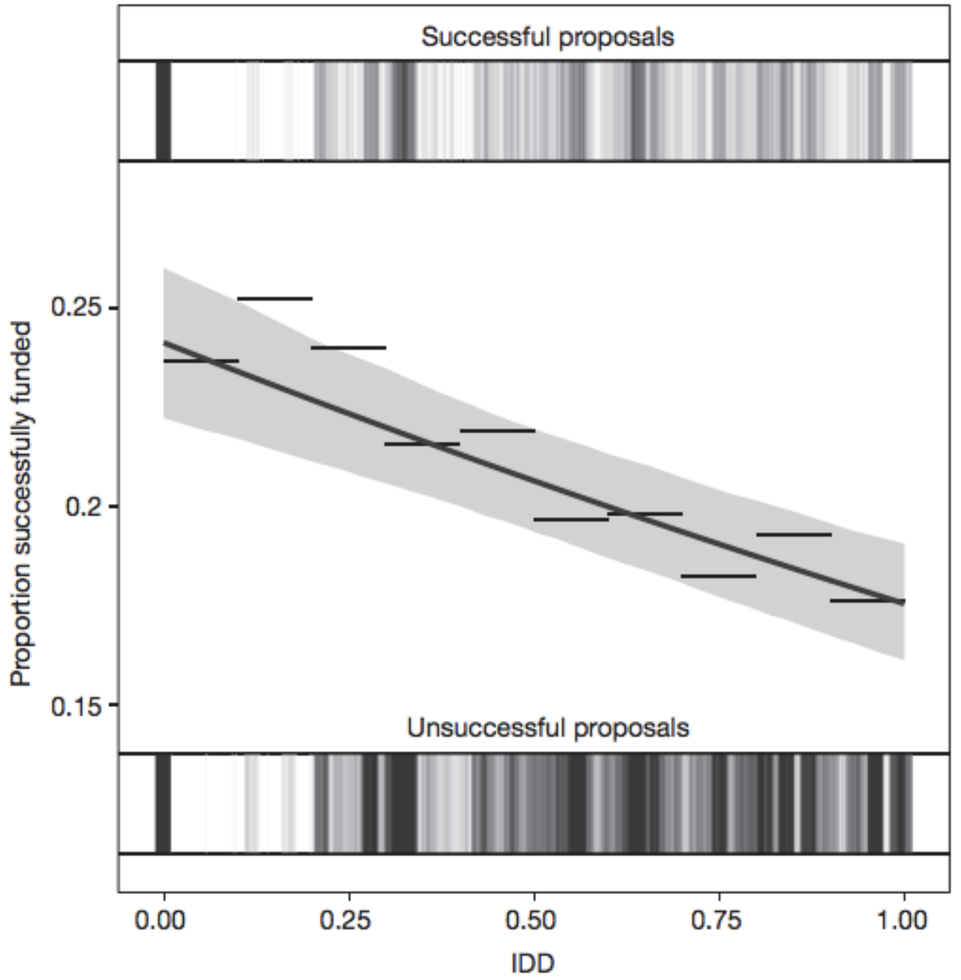
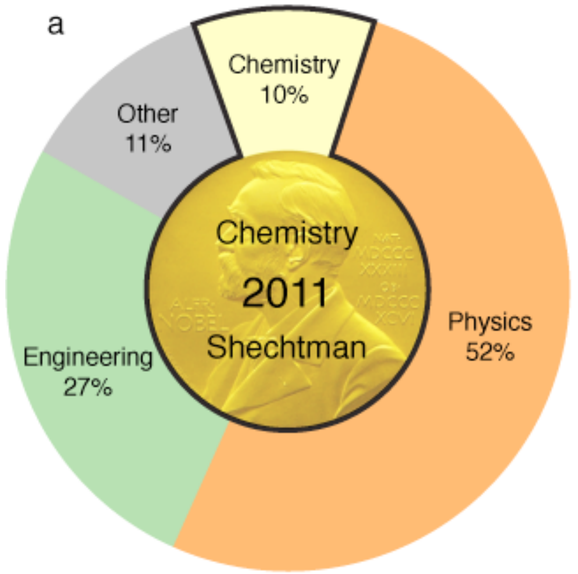
Interdisciplinary research is important but discriminated

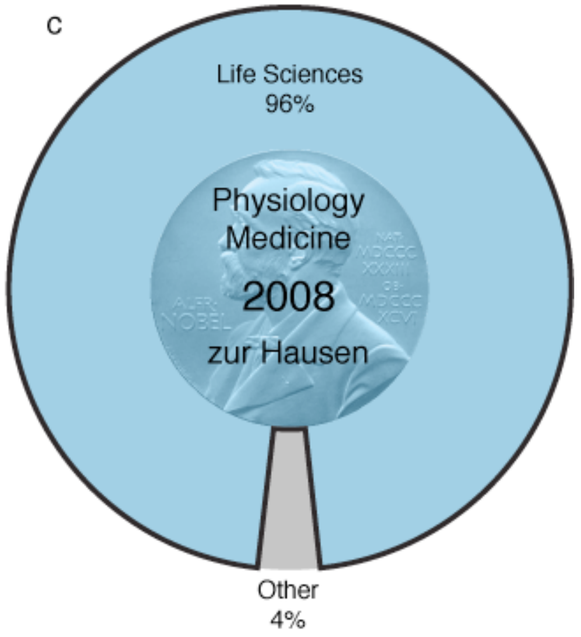


Bromham et al., Nature 534, 684-687 (2016)

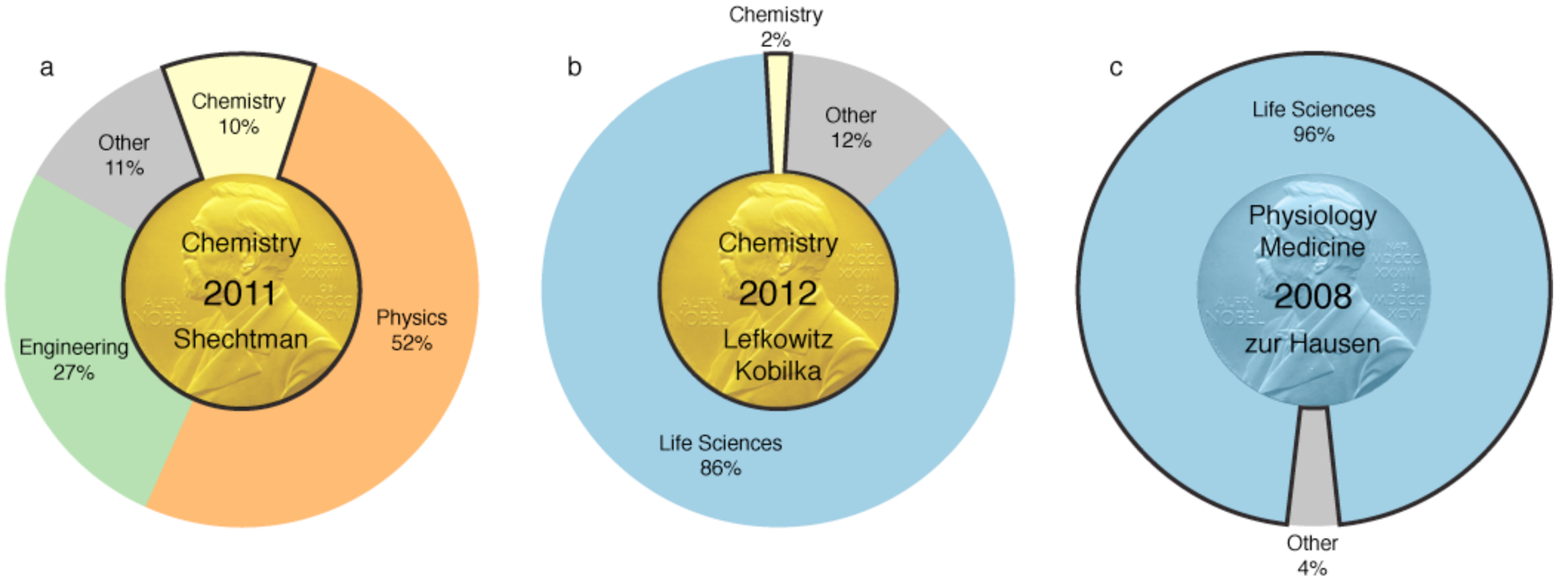
Interdisciplinary research is important but discriminated

What about awards?





Michael Szell, Yifang Ma, Roberta Sinatra, under review (2018)



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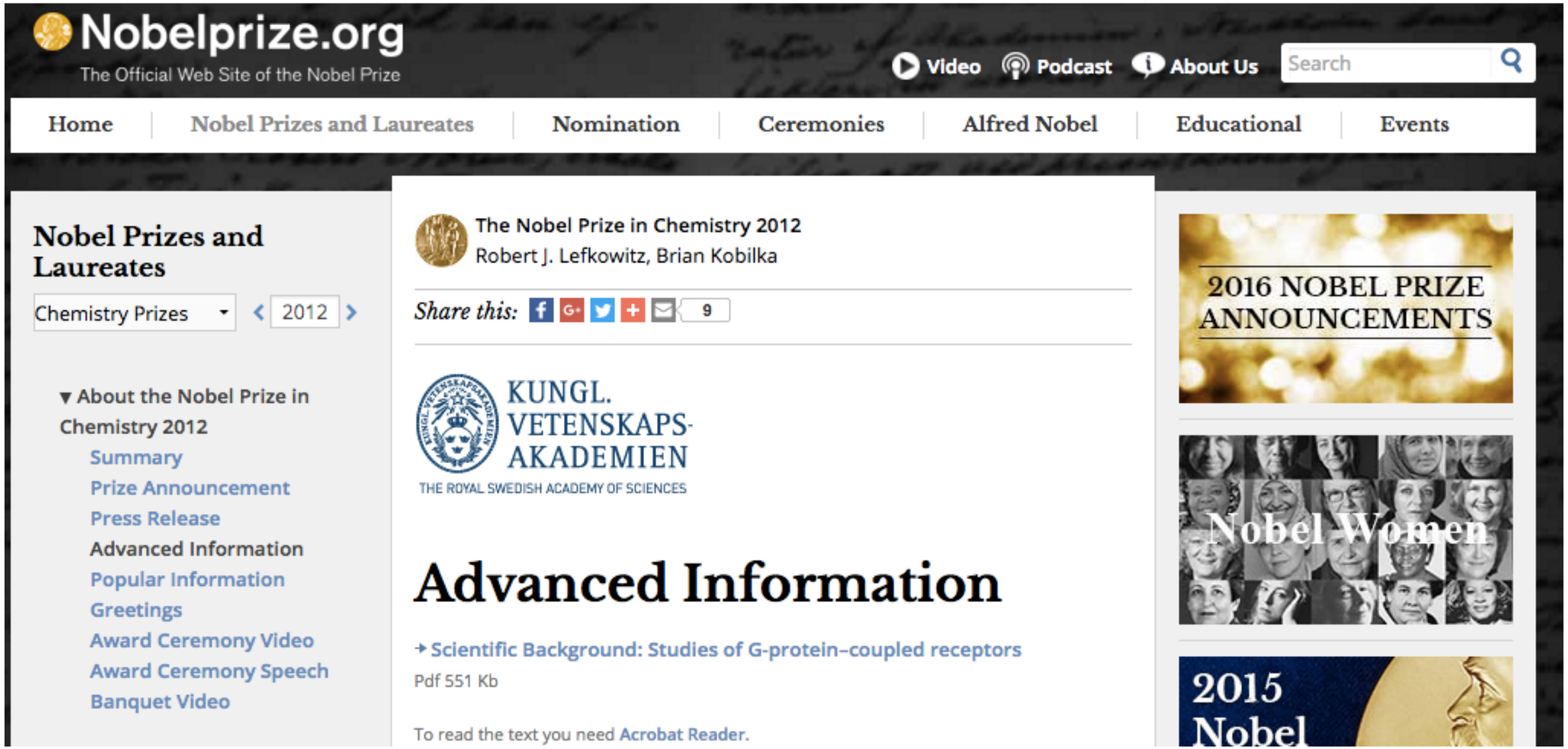
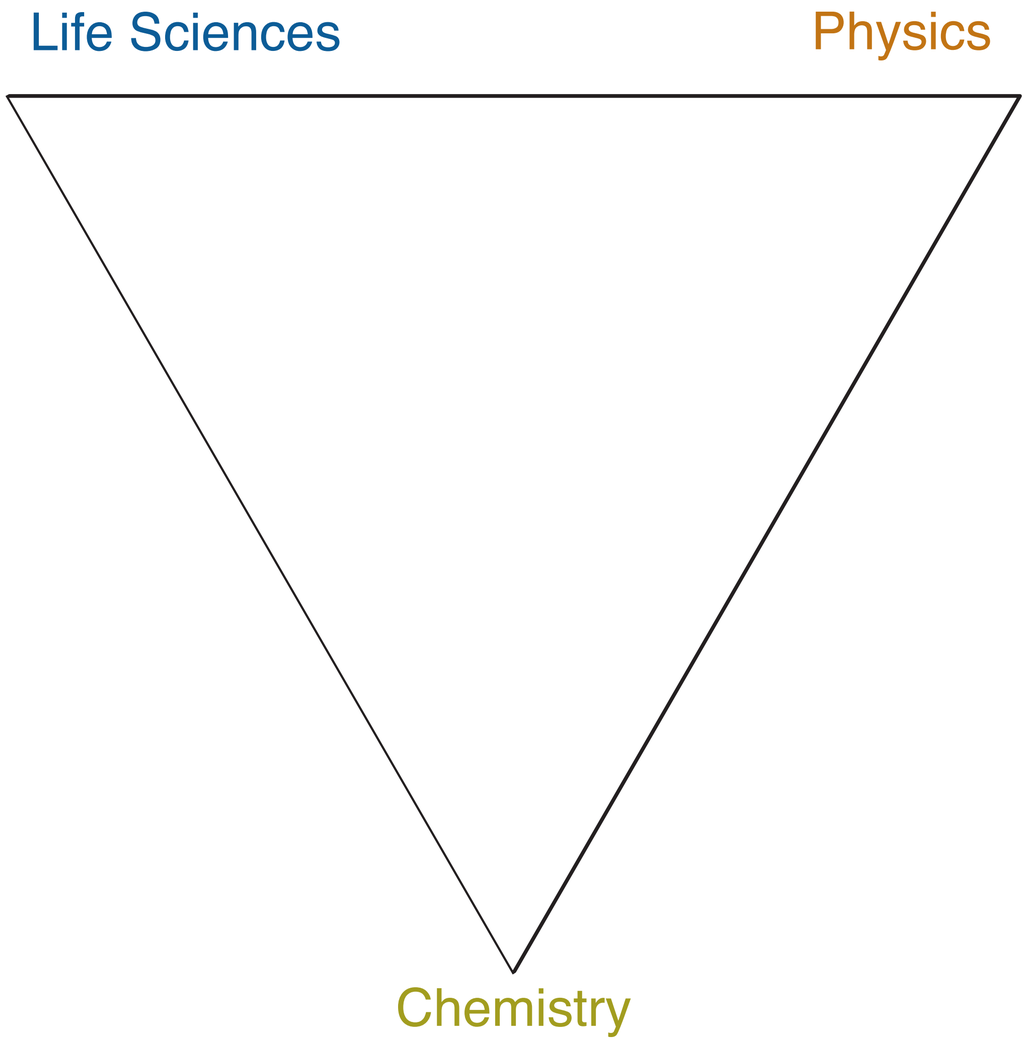
Data acquisition from nobelprize.org



Issues

- Before 1995, key papers unclear
- No citation data for too recent papers
- Sleeping beauties

Visualizing interdisciplinary impact



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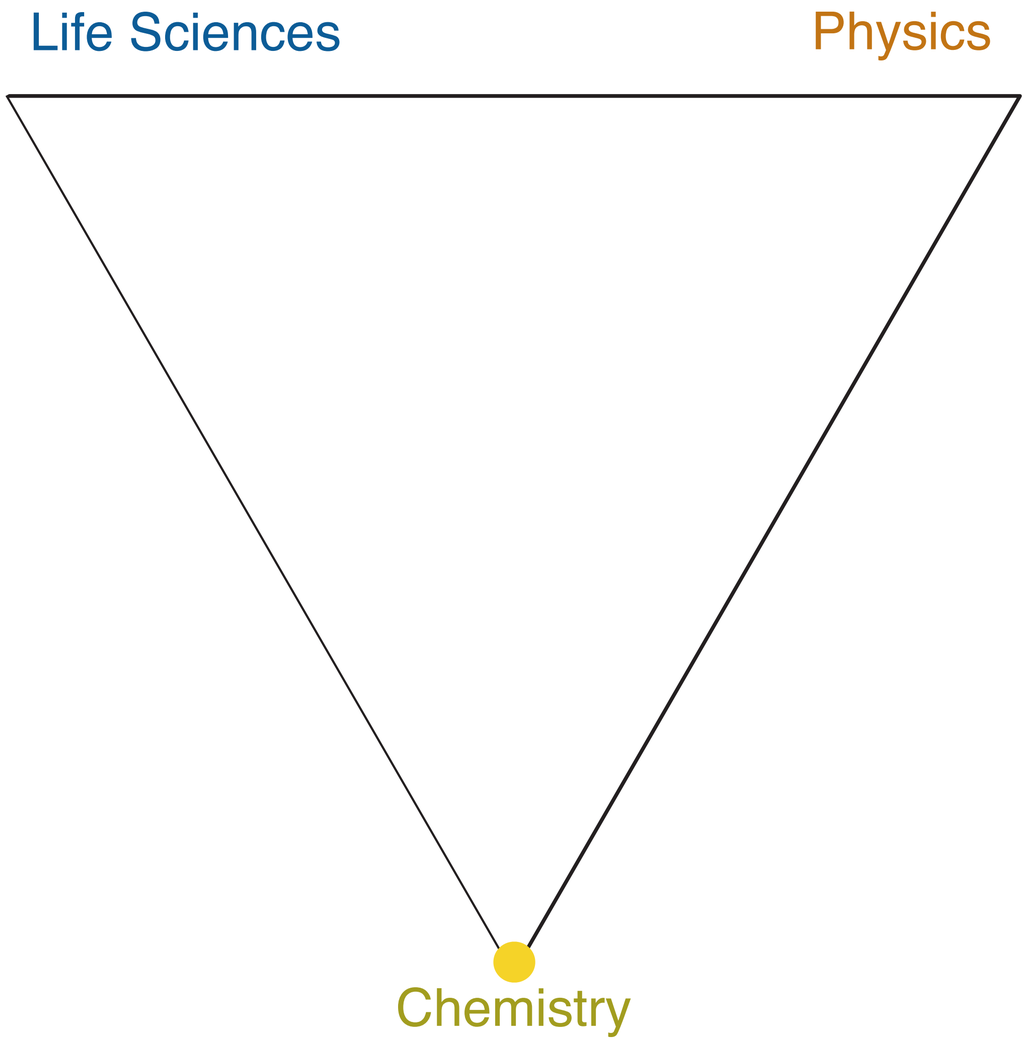

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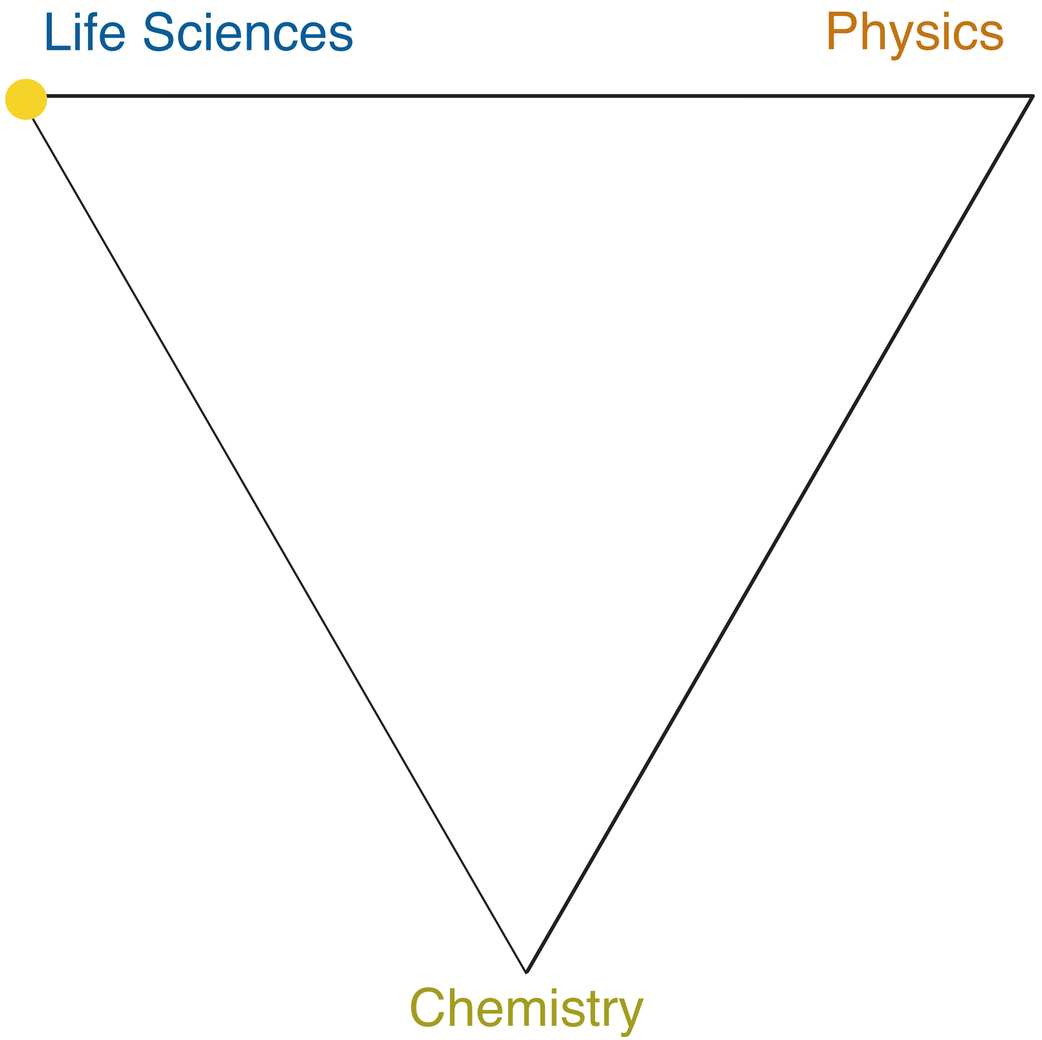

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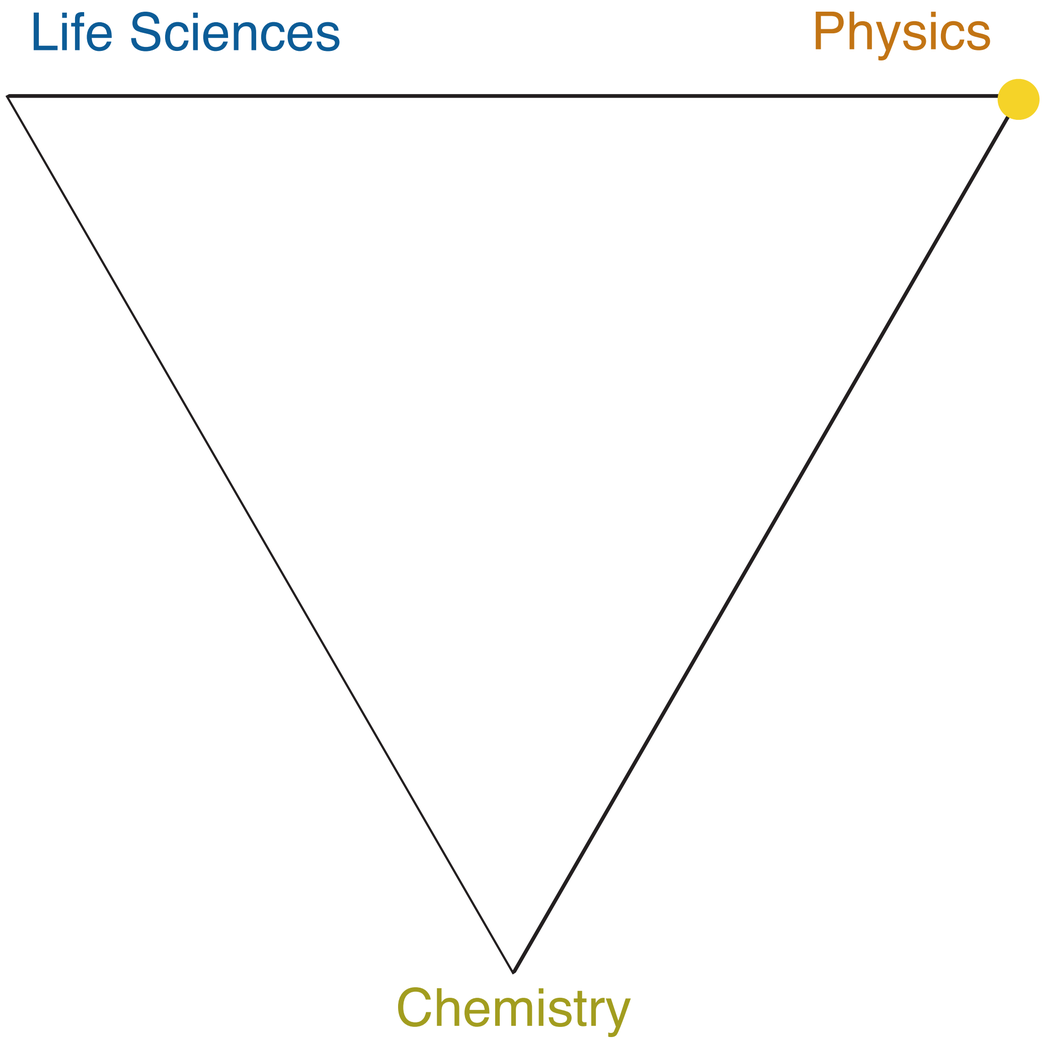

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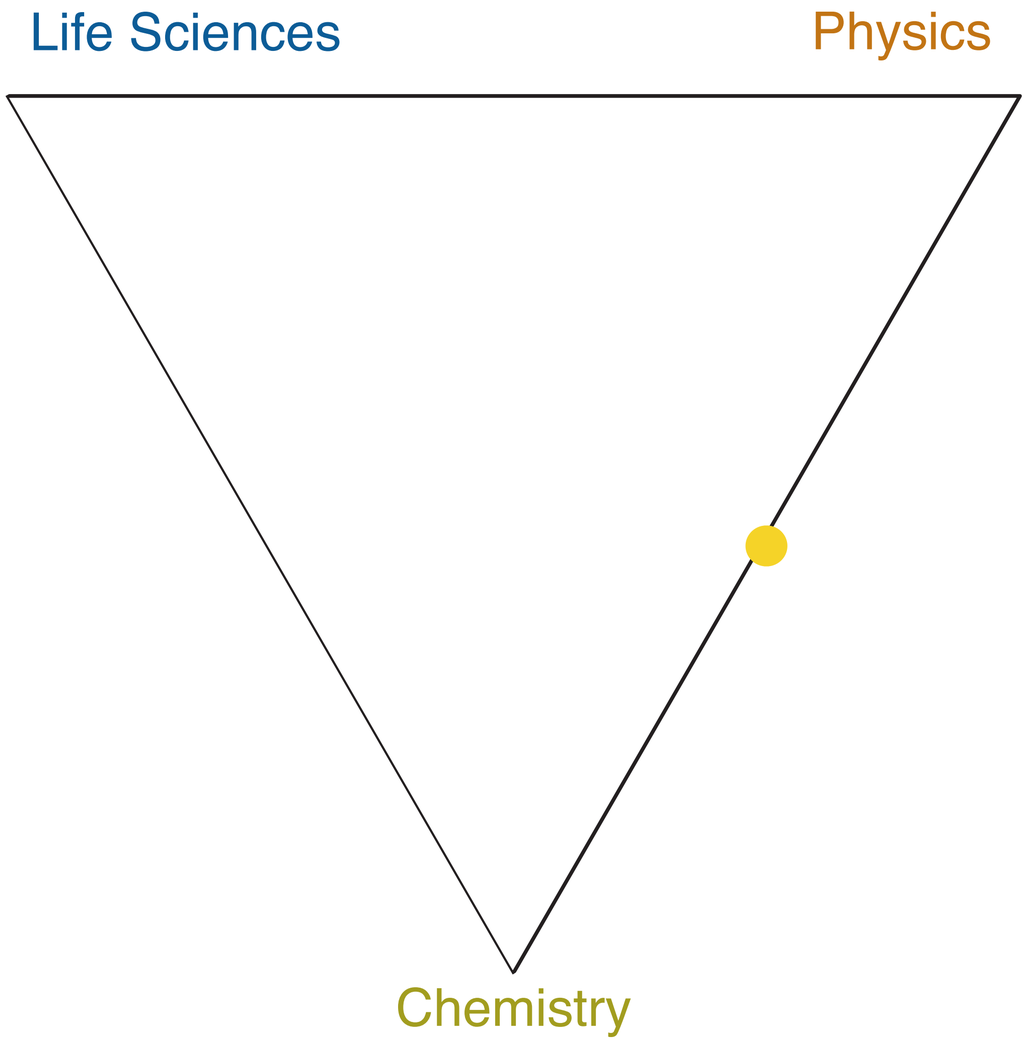

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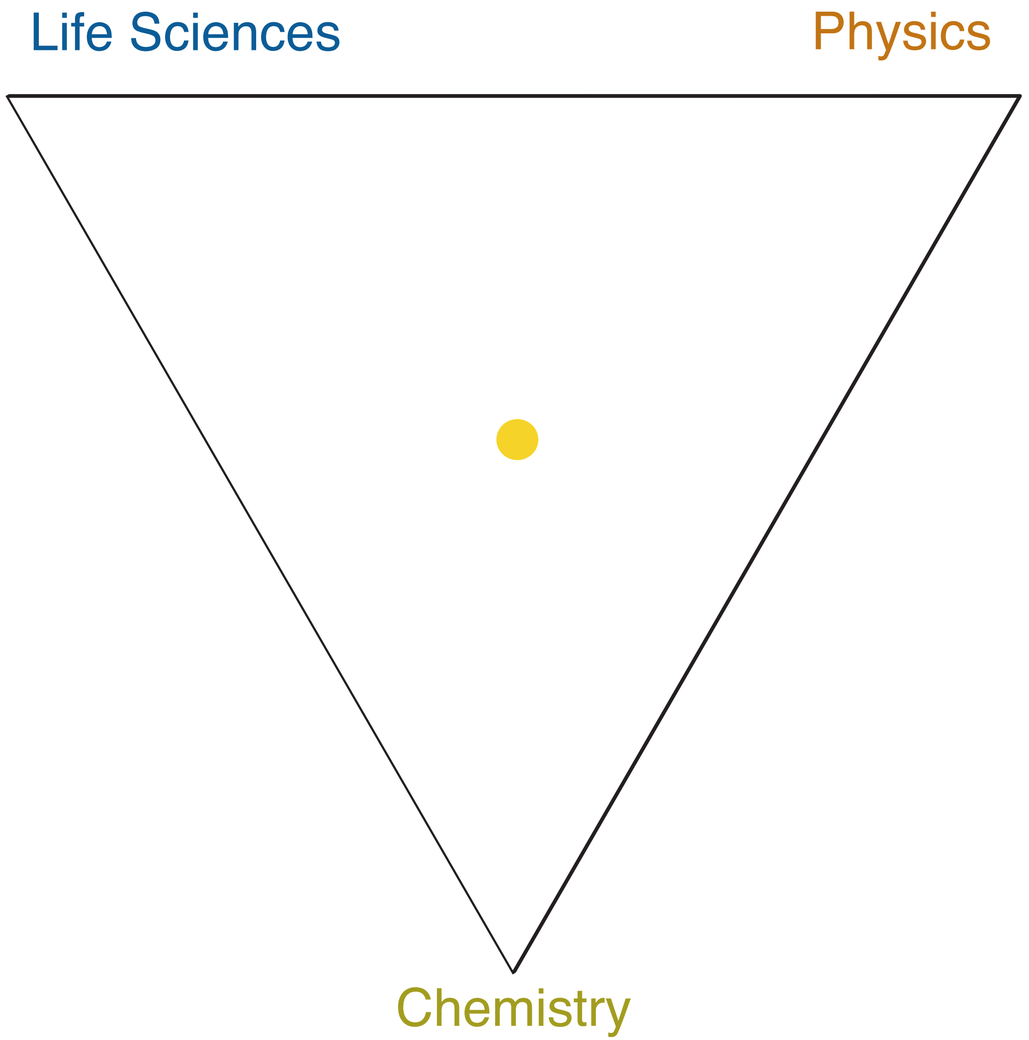

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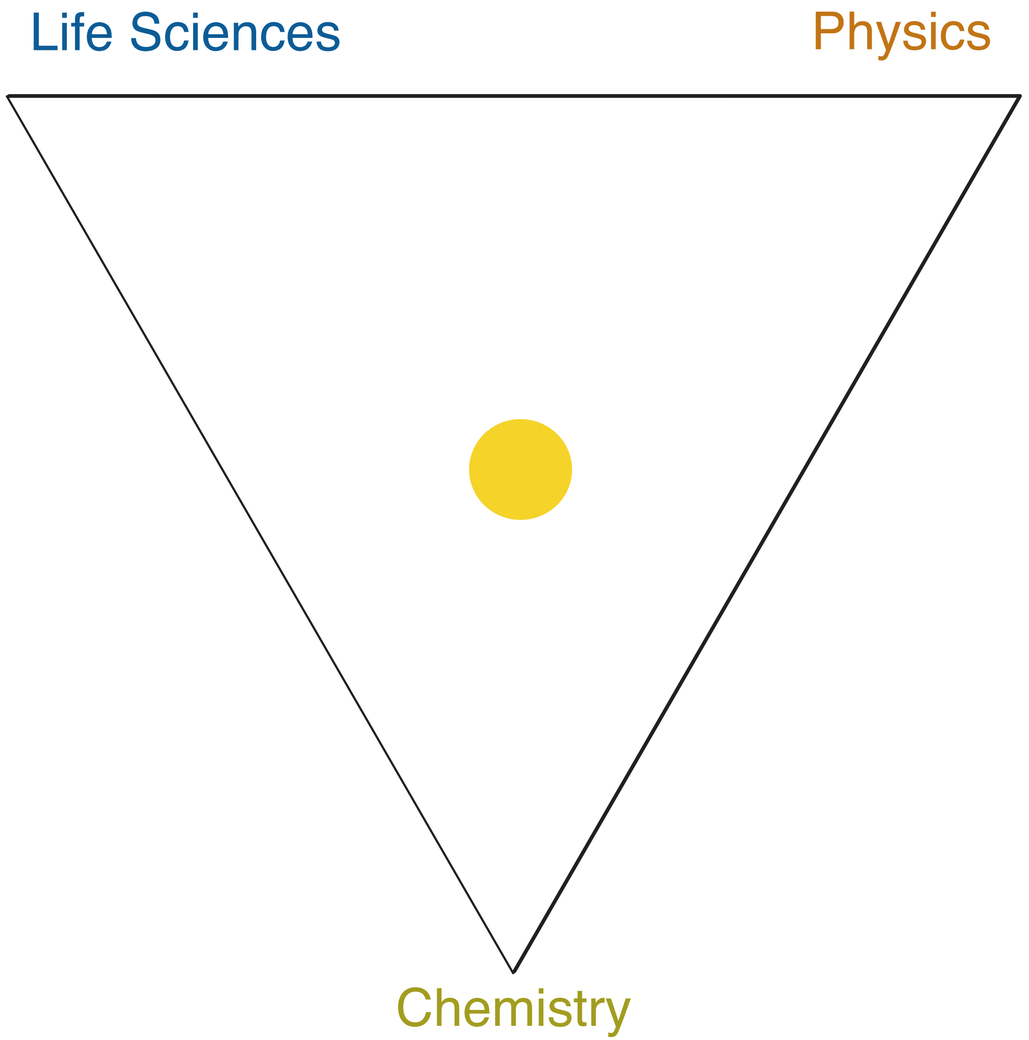

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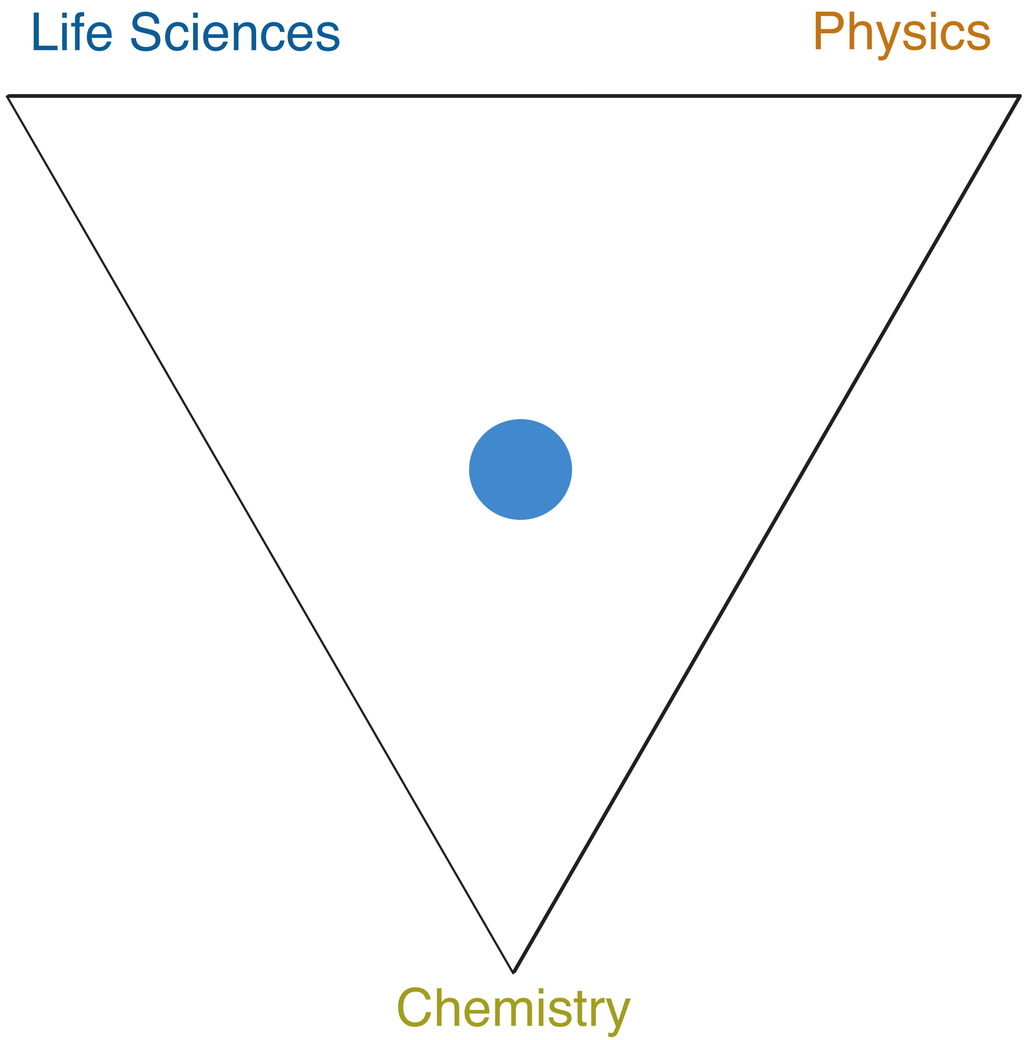
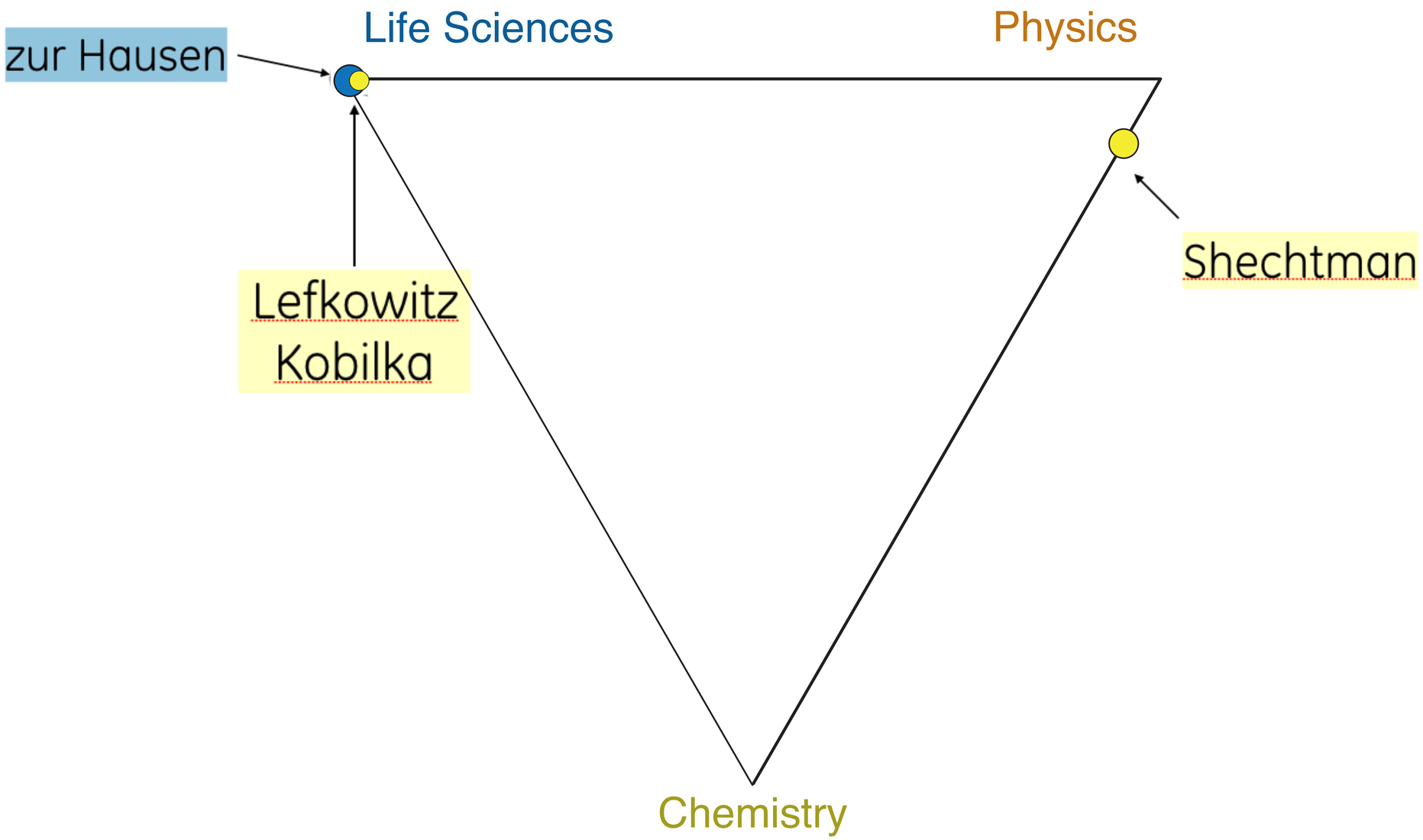


Visualizing the interdisciplinary impact of Nobel prizes



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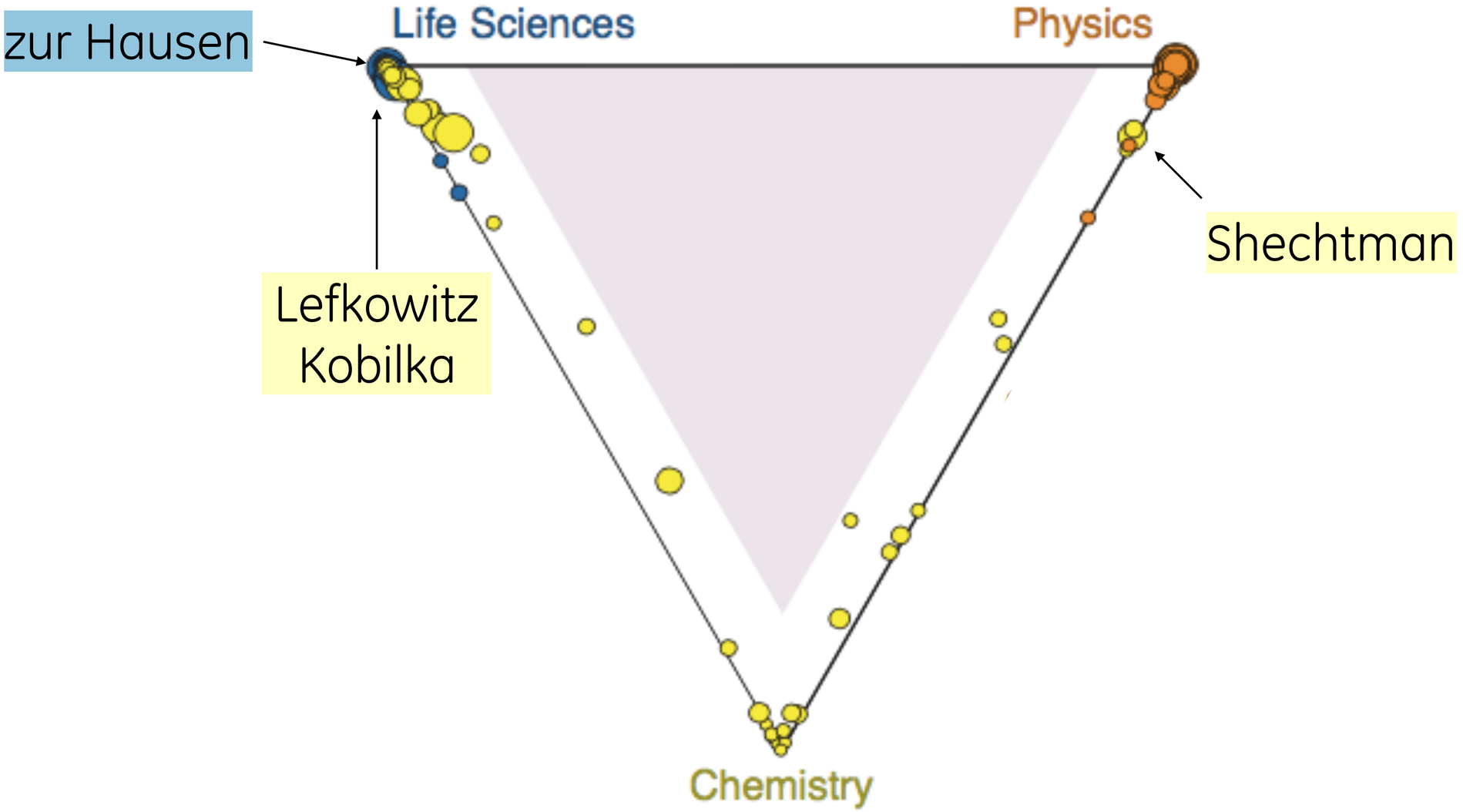
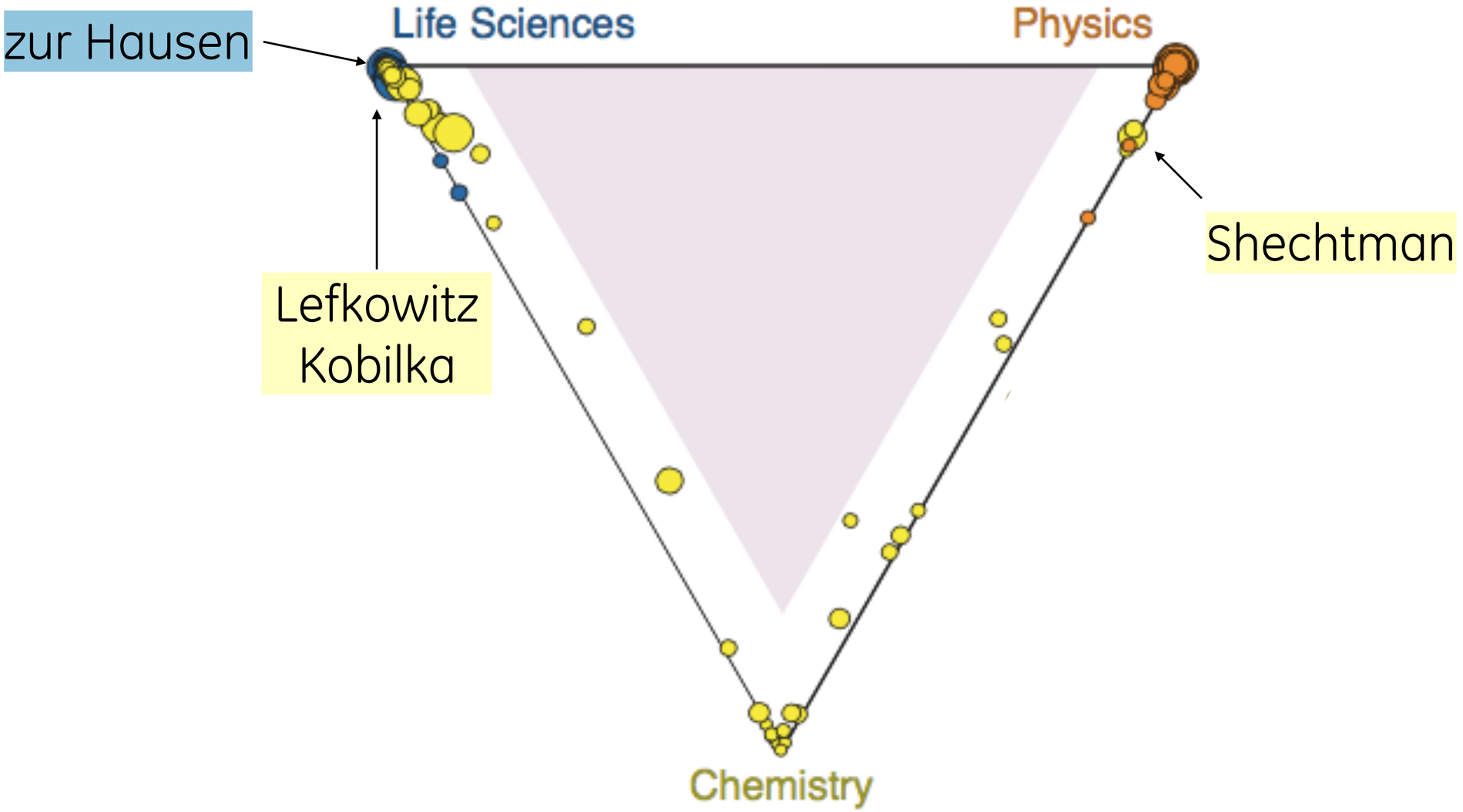


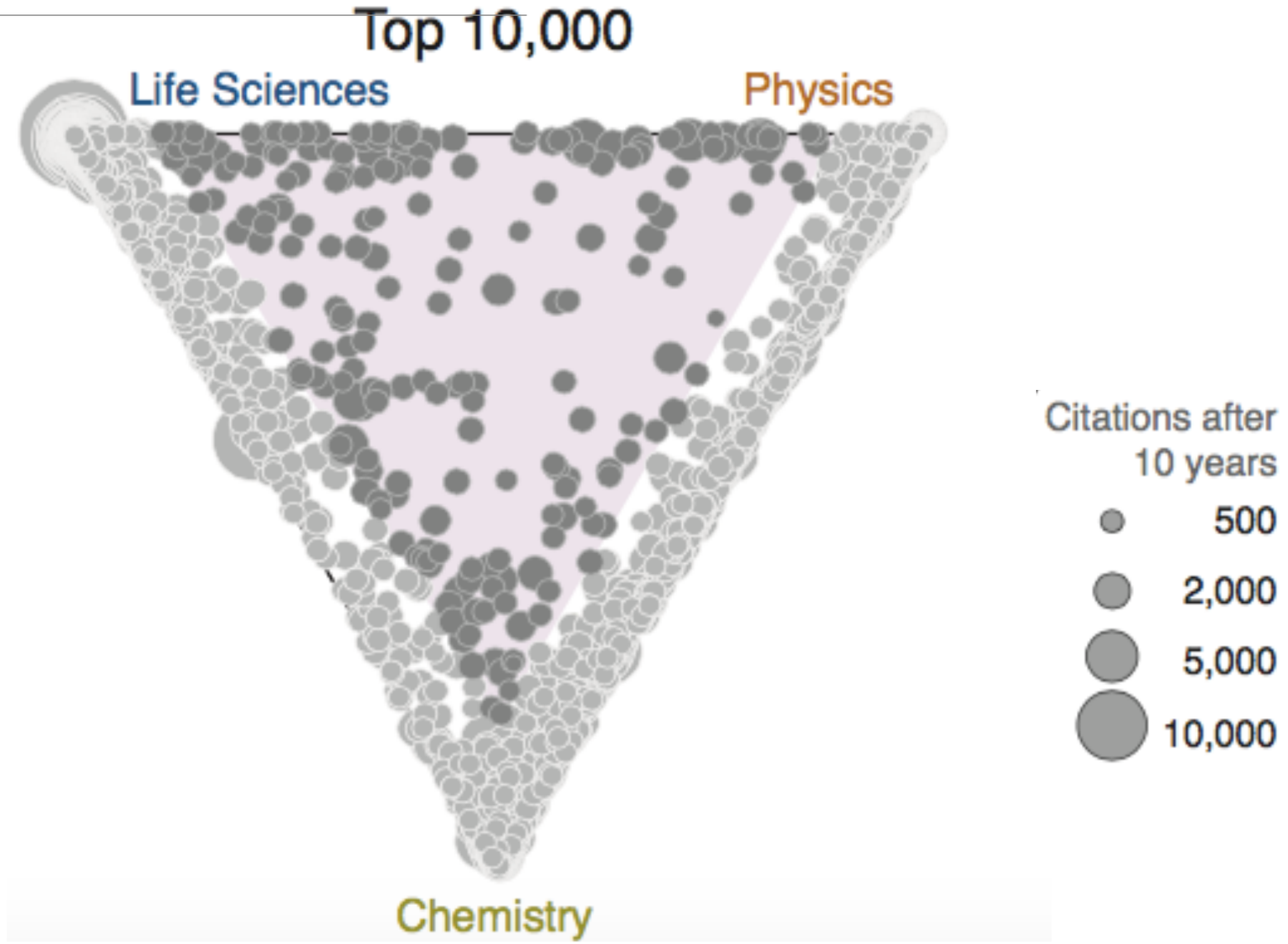
Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

Visualizing the interdisciplinary impact of Nobel prizes



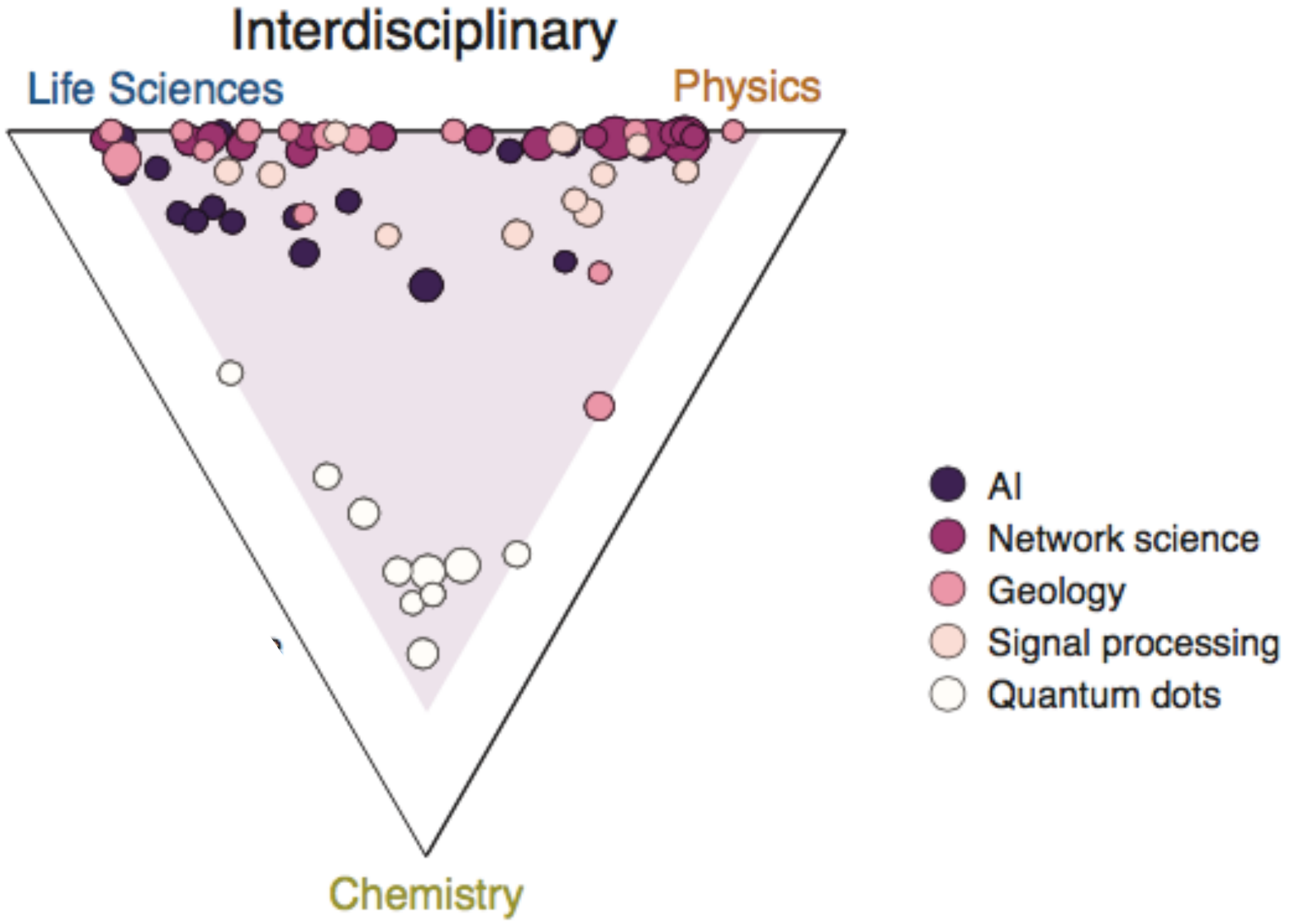
Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

Visualizing the interdisciplinary impact of high impact papers



Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

Displaying high interdisciplinary papers



Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

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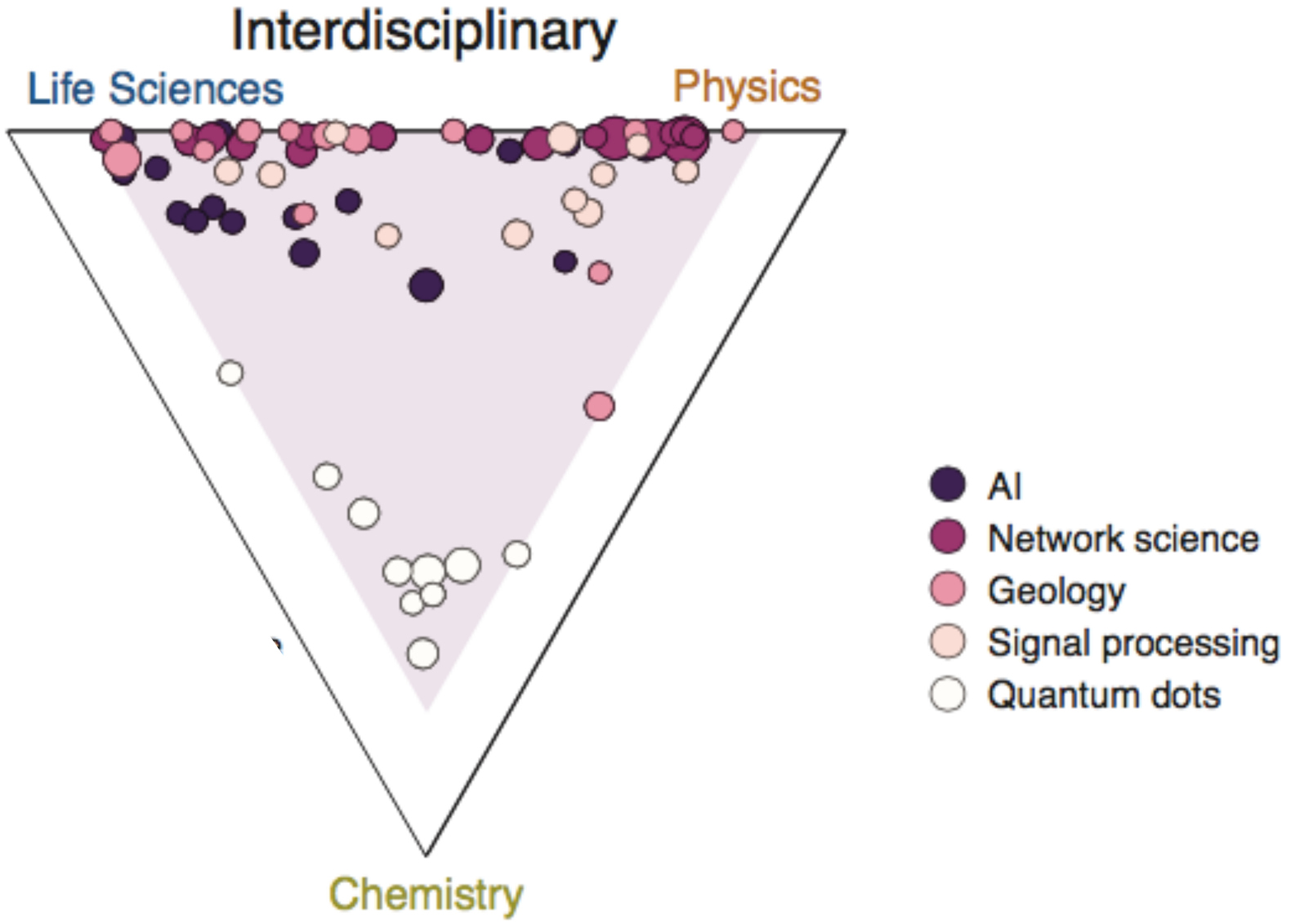
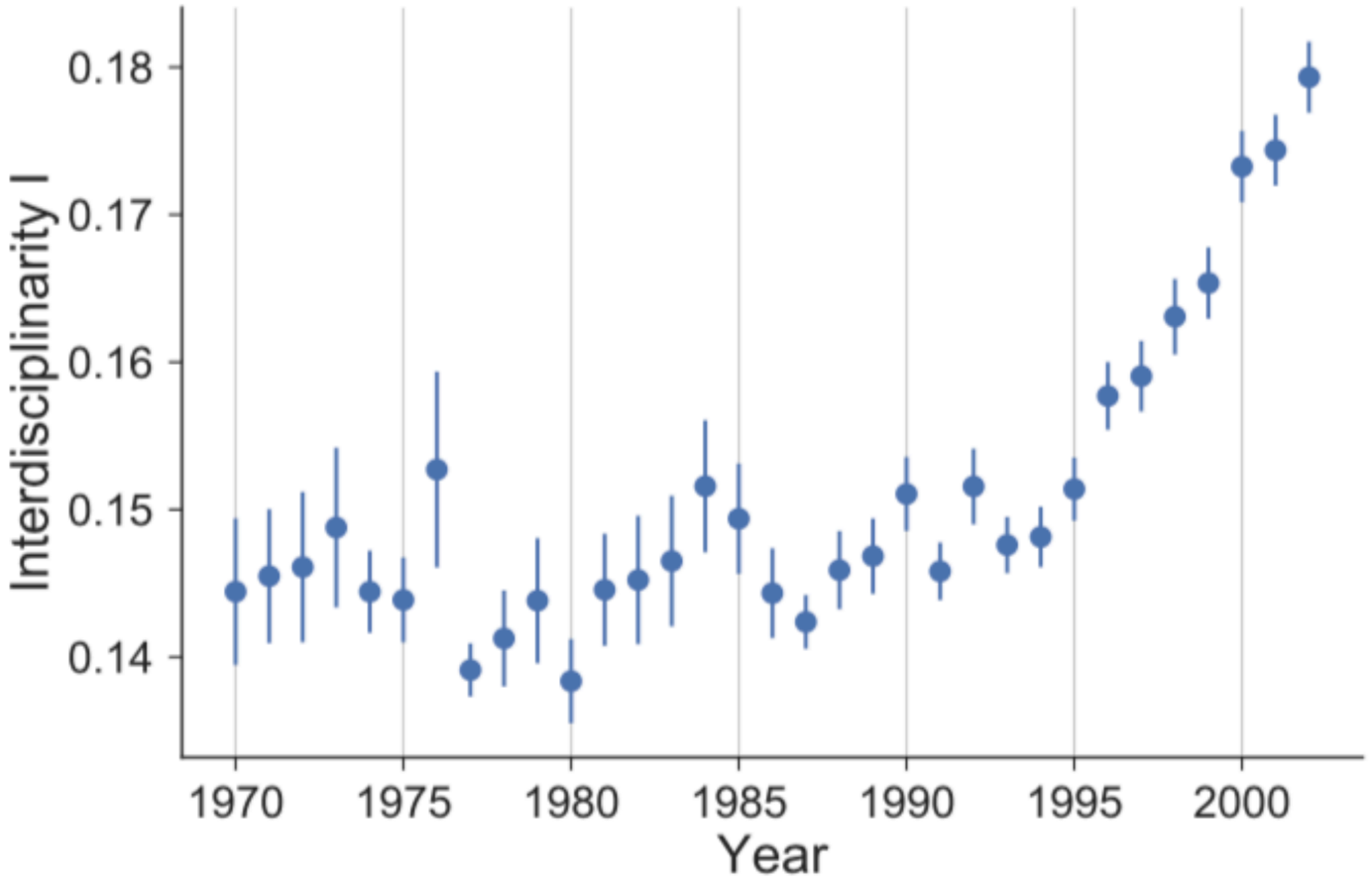


Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

Interdisciplinarity is happening, despite many biases



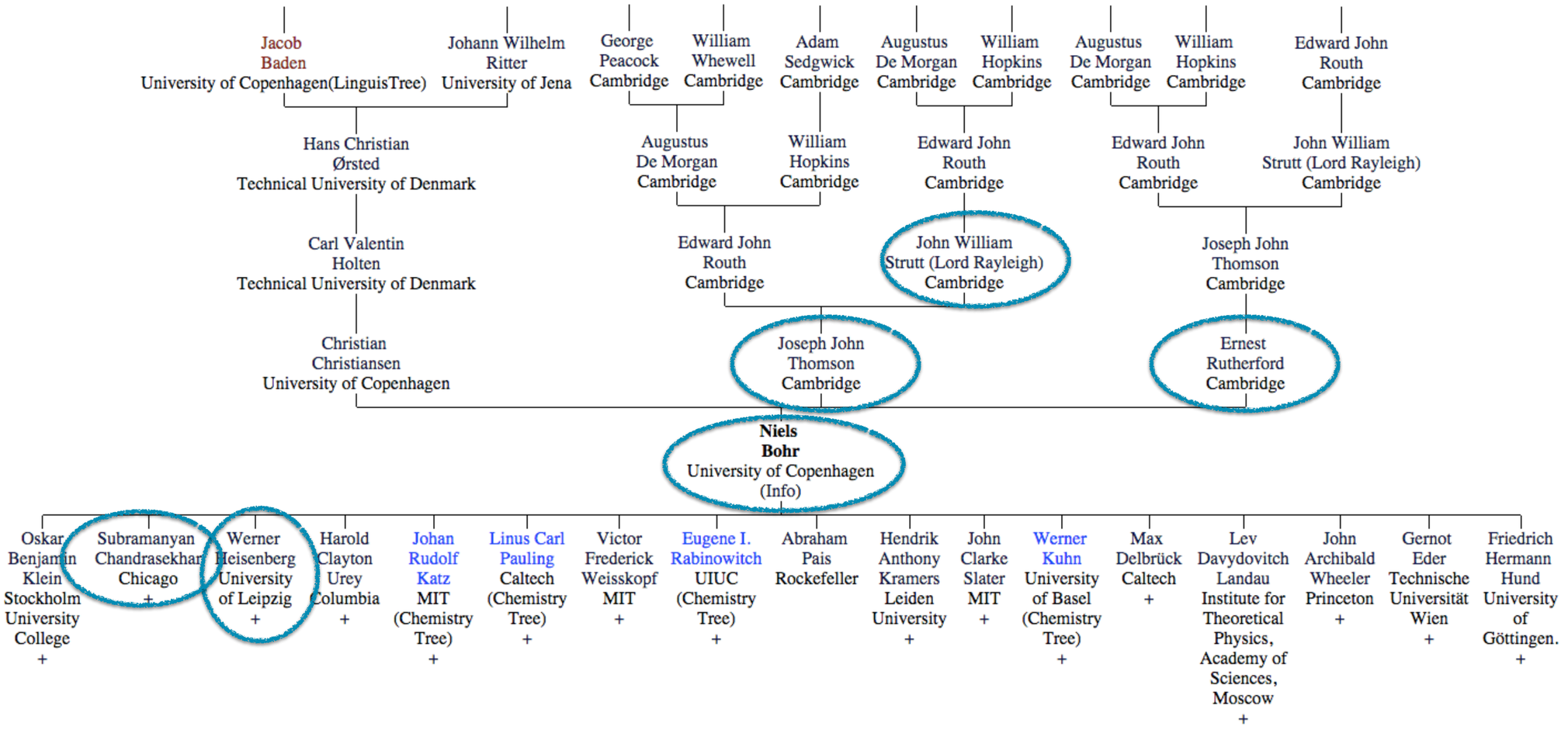
Michael Szell, Yifang Ma, Roberta Sinatra, Nature Physics 14 1075-1078 (2018)

How to publish in interdisciplinary journals?

nature
International weekly journal of science

Is it possible to get a paper published in *Nature* without already having published a *Nature* paper?

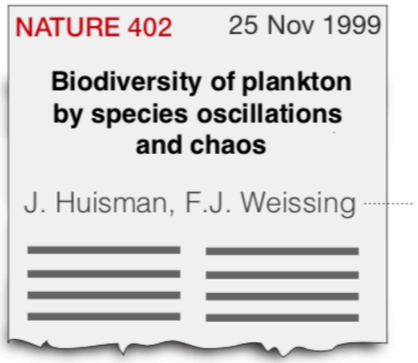
Does one need a Chaperone to publish in nature?



http://academictree.org/physics/

We classify principal investigators based on their publication history in the journal

Time



Category: New

F. J. Weissing never published before in Nature. The first time he published in Nature, on 25th November 1999, was as last author.

Category: Estabilished

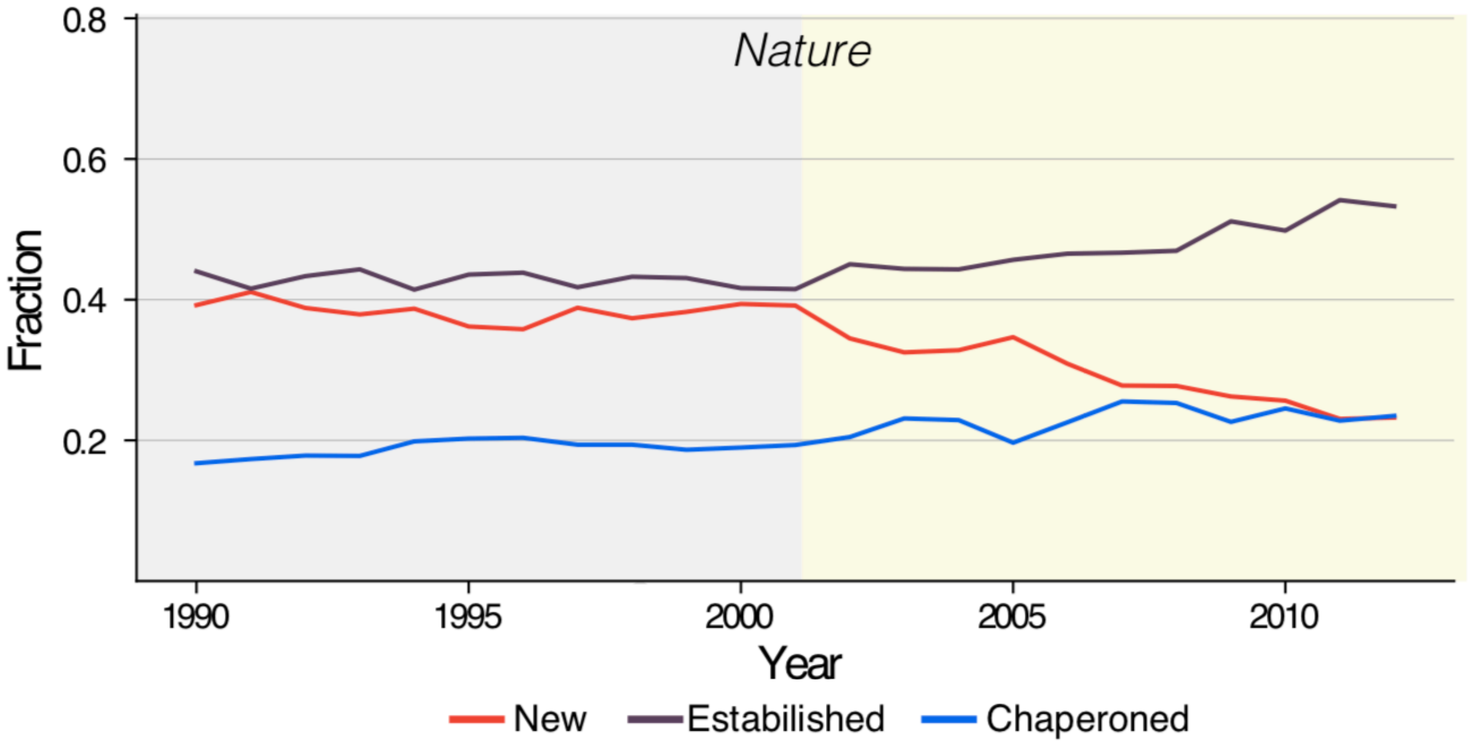
F.J. Weissing published before in Nature, in the issue 402 on 25th November 1999, as last author. He published another paper in Nature as last author on 31st May 2007.

Category: Chaperoned

O. Leimar published before in Nature, in the issue 447 on 31st May 2007, but not as last author. He published his first paper in Nature as last author on 16th October 2008.

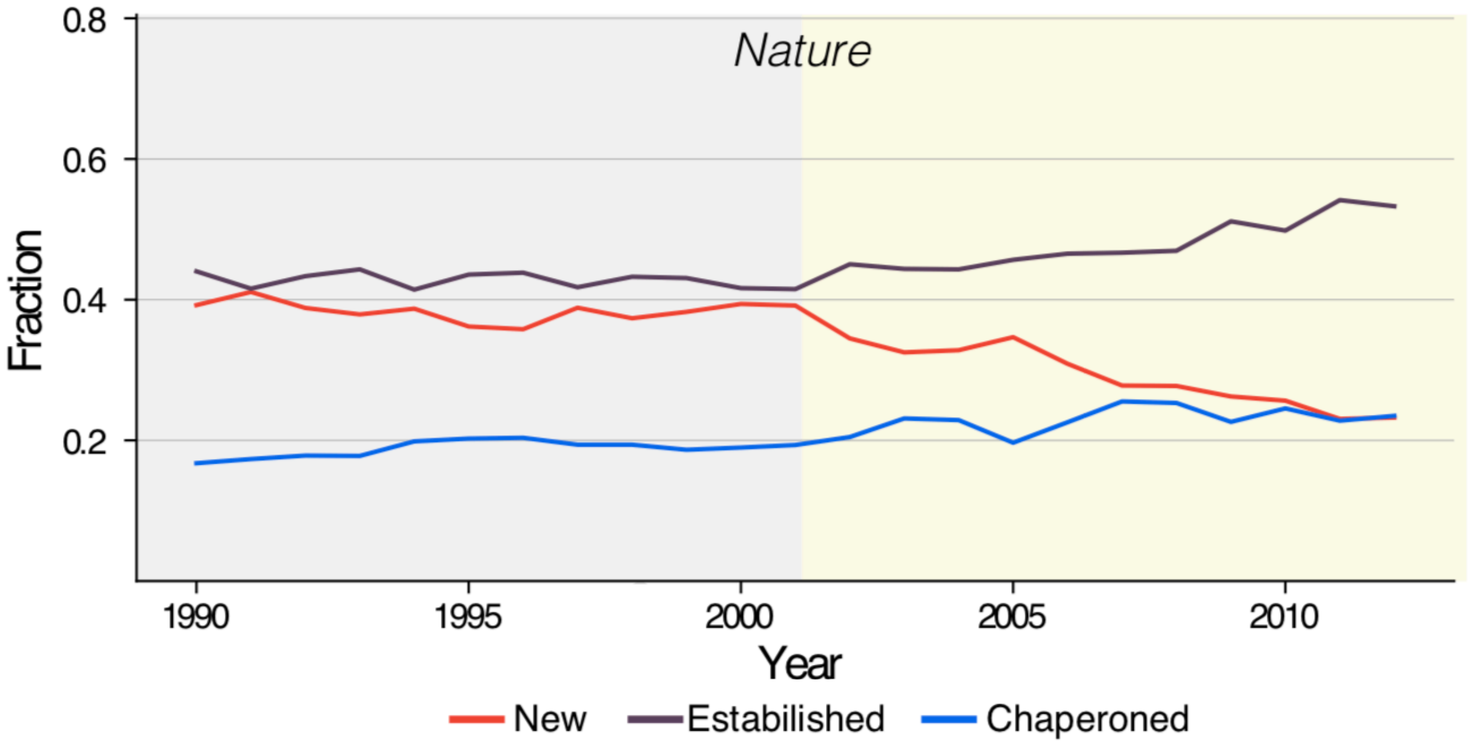
Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

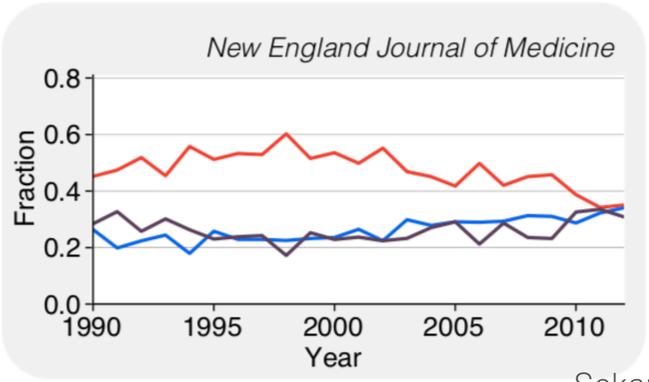
Proportion of New principal investigators is declining in Nature

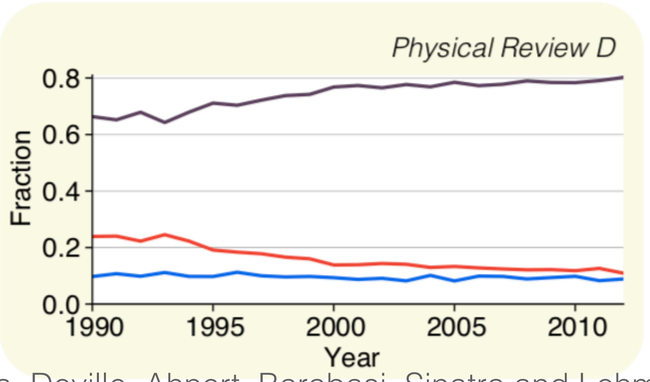


Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

Proportion of New principal investigators is declining (almost) everywhere



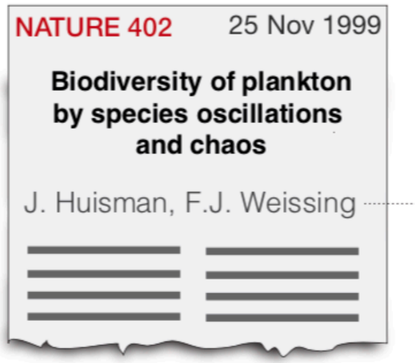




Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

How to capture the chaperone phenomenon?

Time



Category: New

F. J. Weissing never published before in Nature. The first time he published in Nature, on 25th November 1999, was as last author.

Category: Estabilished

F.J. Weissing published before in Nature, in the issue 402 on 25th November 1999, as last author. He published another paper in Nature as last author on 31st May 2007.

Category: Chaperoned

O. Leimar published before in Nature, in the issue 447 on 31st May 2007, but not as last author. He published his first paper in Nature as last author on 16th October 2008.

Different fields exhibit different magnitudes of the chaperone phenomenon

$$c = \frac{p(\text{chaperoned})}{p(\text{new})}$$

Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

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Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, submitted (2018)

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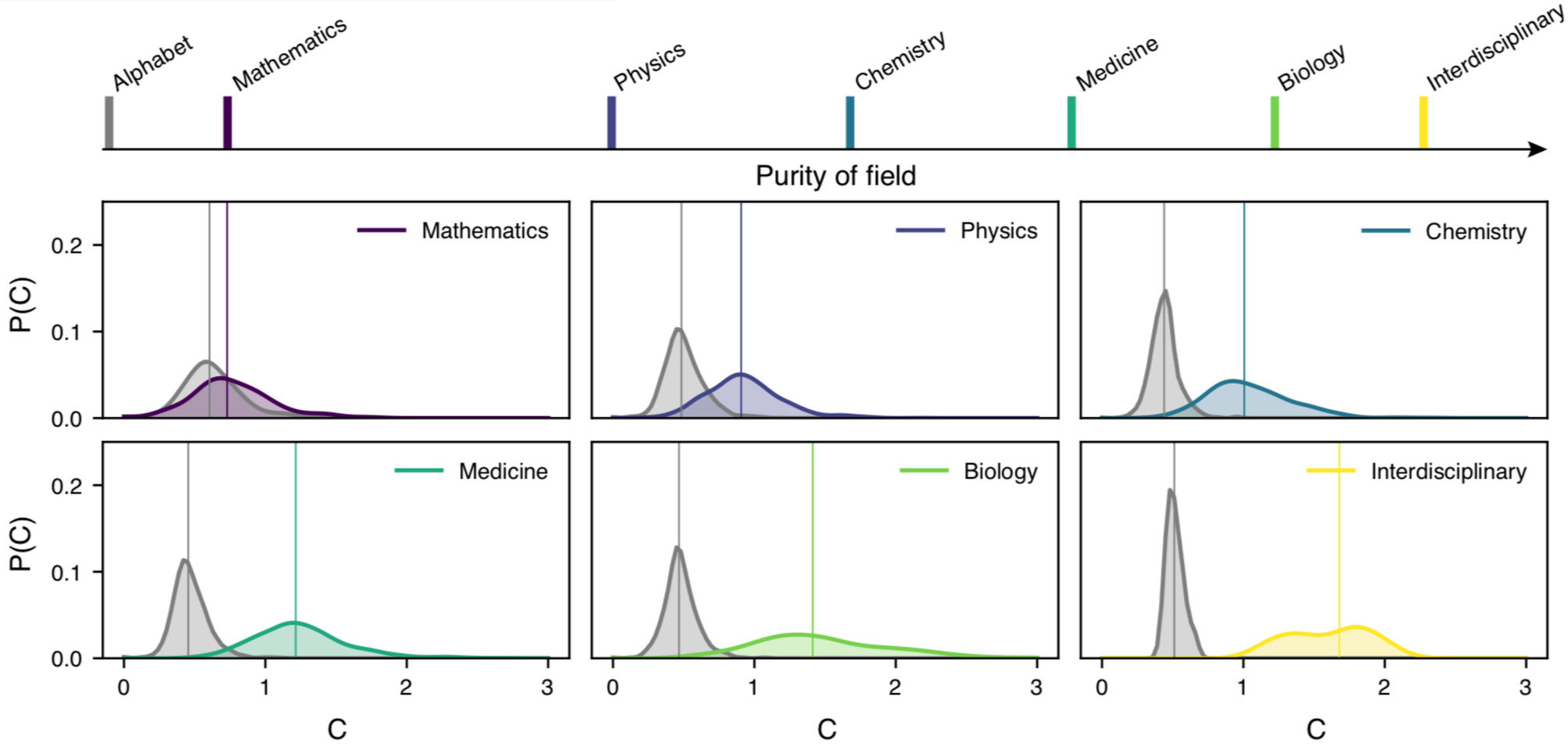

Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

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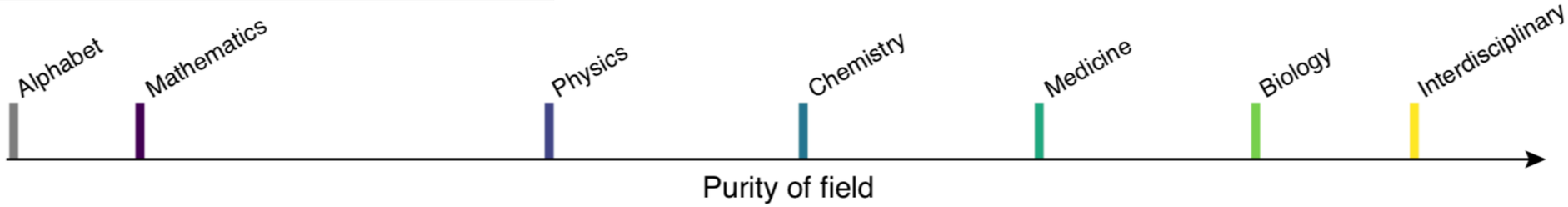
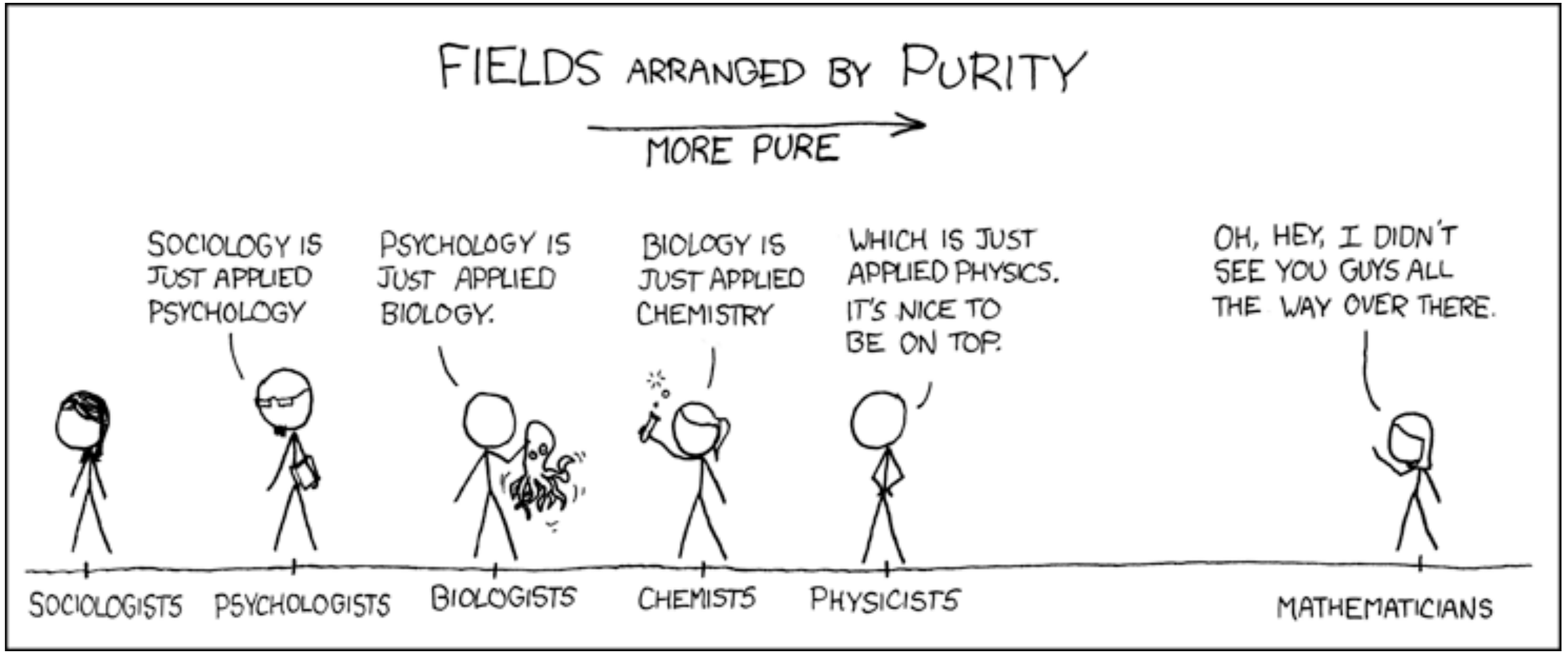
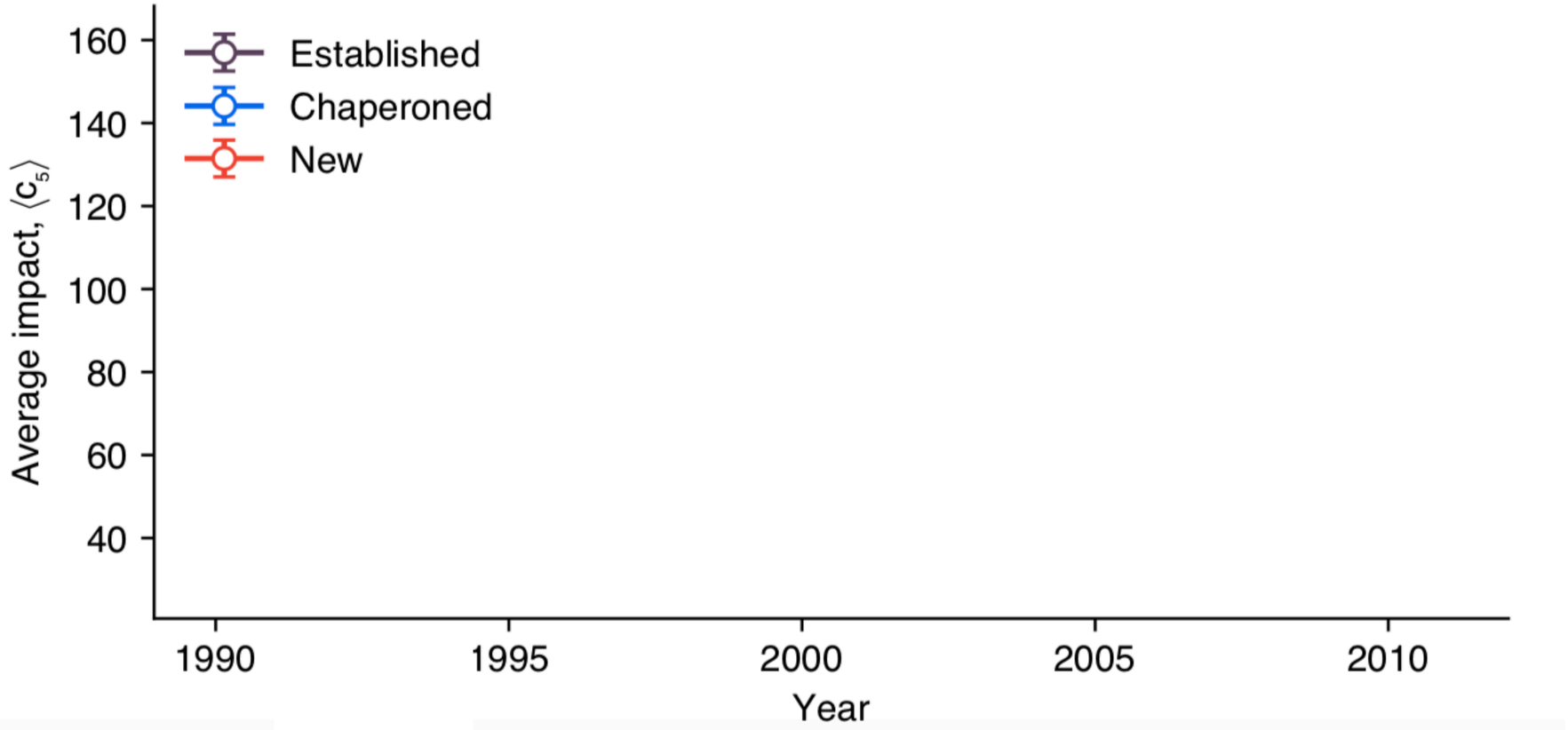




Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

Do new, chaperoned and established last-author papers receive different levels recognition?

Established and Chaperoned papers have higher impact than New papers



Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)

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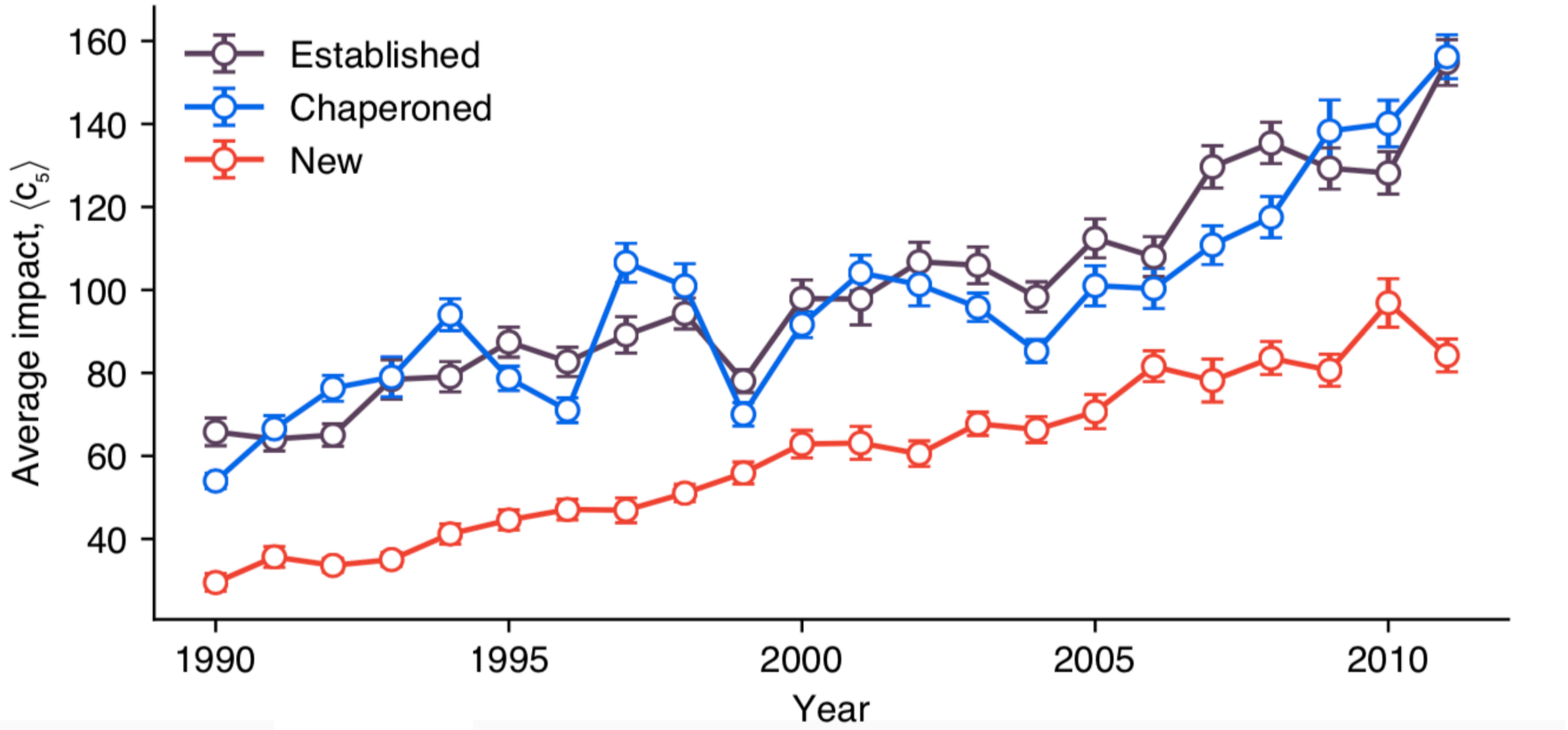

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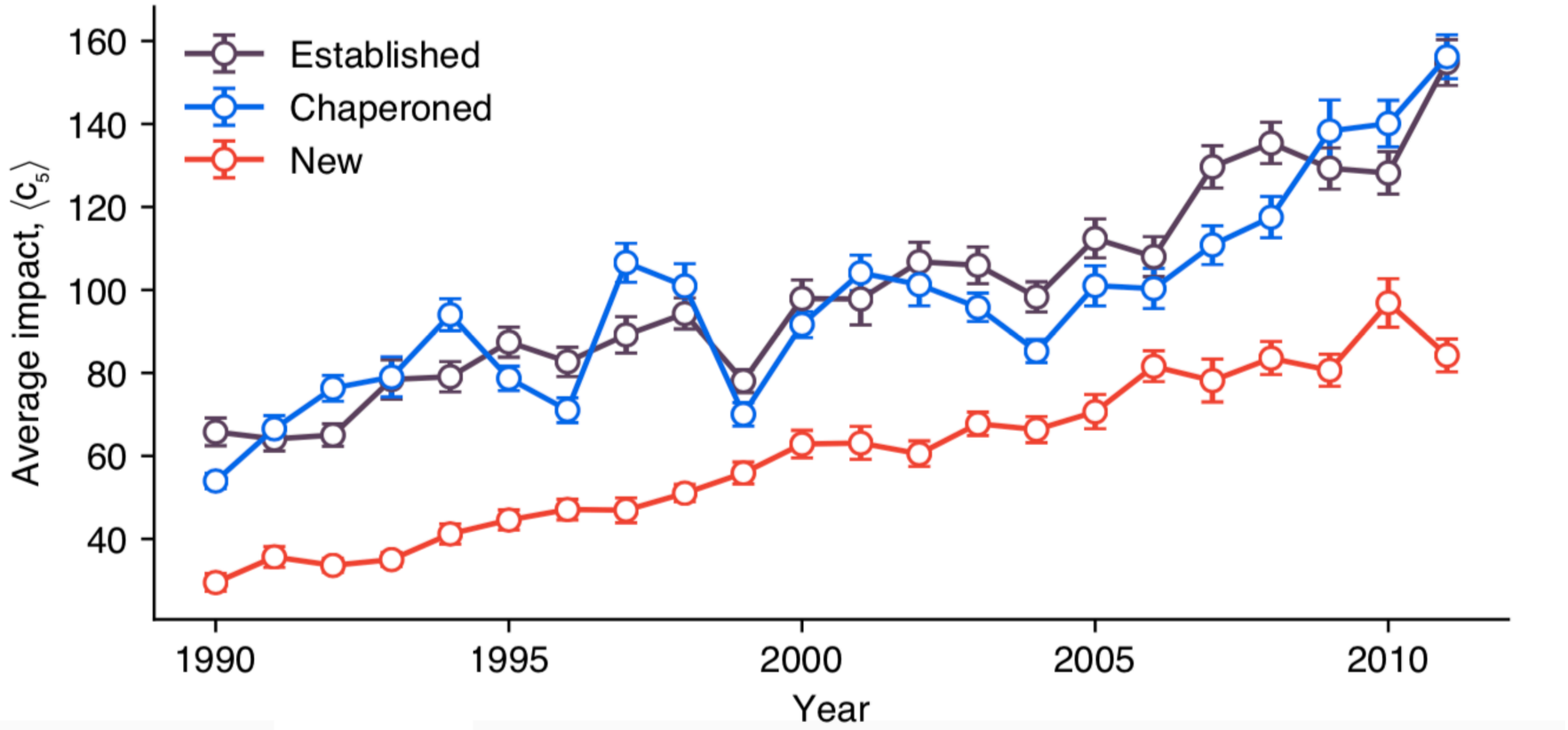
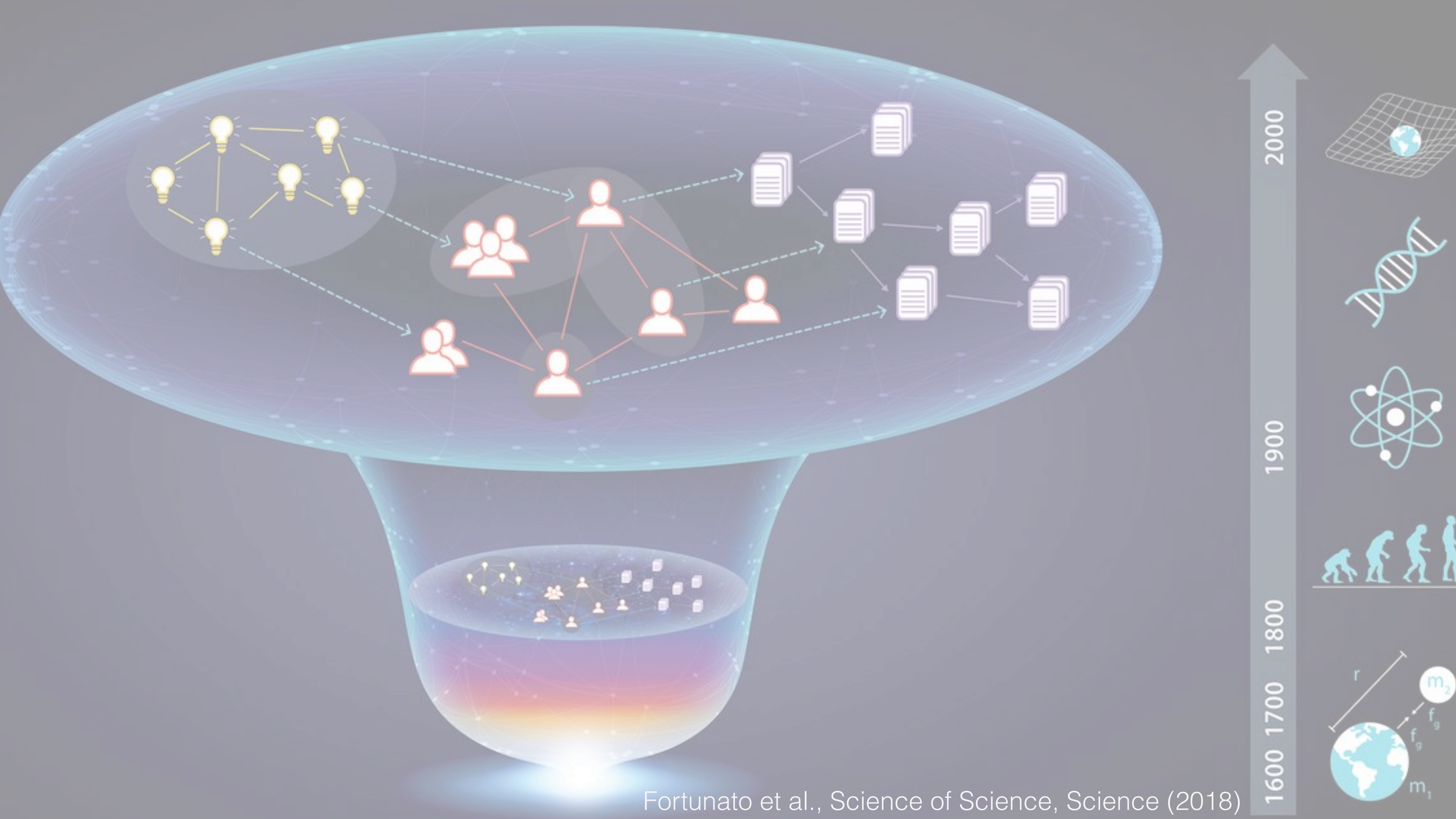


Sekara, Deville, Ahnert, Barabasi, Sinatra and Lehmann, PNAS 115, 12603 - 12607 (2018)



Fortunato et al., Science of Science, Science (2018)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Networks of Motifs from Sequences of Symbols

Roberta Sinatra,[1,2,*] Daniele Condorelli,[2,3] and Vito Latora[1,2]

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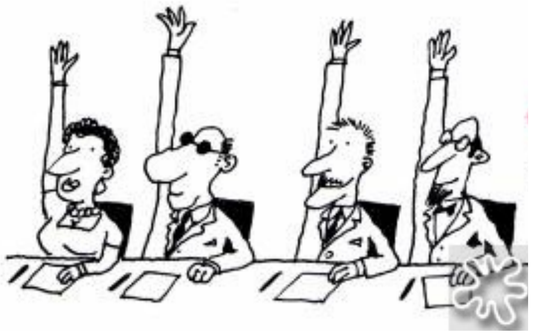
(Received 4 February 2010; revised manuscript received 16 August 2010; published 19 October 2010)

We introduce a method to convert an ensemble of sequences of symbols into a weighted directed network whose nodes are motifs, while the directed links and their weights are defined from statistically significant co-occurences of two motifs in the same sequence. The analysis of communities of networks of motifs is shown to be able to correlate sequences with functions in the human proteome database, to detect hot topics from online social dialogs, to characterize trajectories of dynamical systems, and it might find other useful applications to process large amounts of data in various fields.

DOI: 10.1103/PhysRevLett.105.178702 PACS numbers: 89.75.Hc, 87.18.Cf, 89.75.Fb



Collaborators on Science of Science projects

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Dan Larremore

Sune Lehmann

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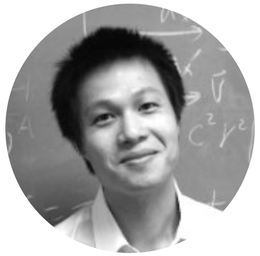
Mauro Martino

Federico Musciotto

Giancarlo Ruffo

Vedran Sekara



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Thank you


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