Exploring the Anatomy of Physics

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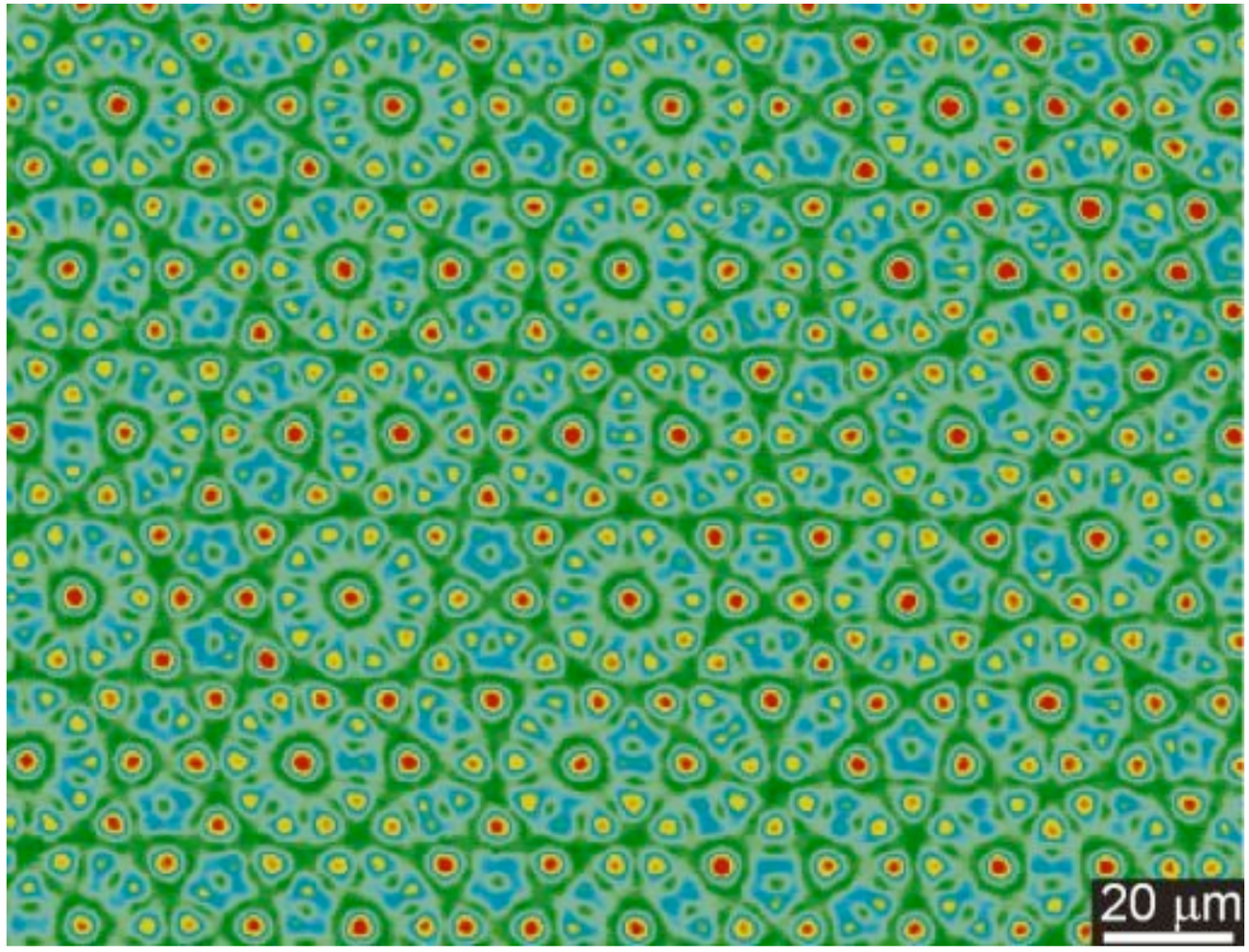
IC2S2, Jun 24, 2016

The topic of your thesis "Statistical physics approaches to large-scale socio-economic networks" is ***not attributable to the field of physics****. The amount of physics is also not sufficient to have your work classified as interdisciplinary.*

What is physics?



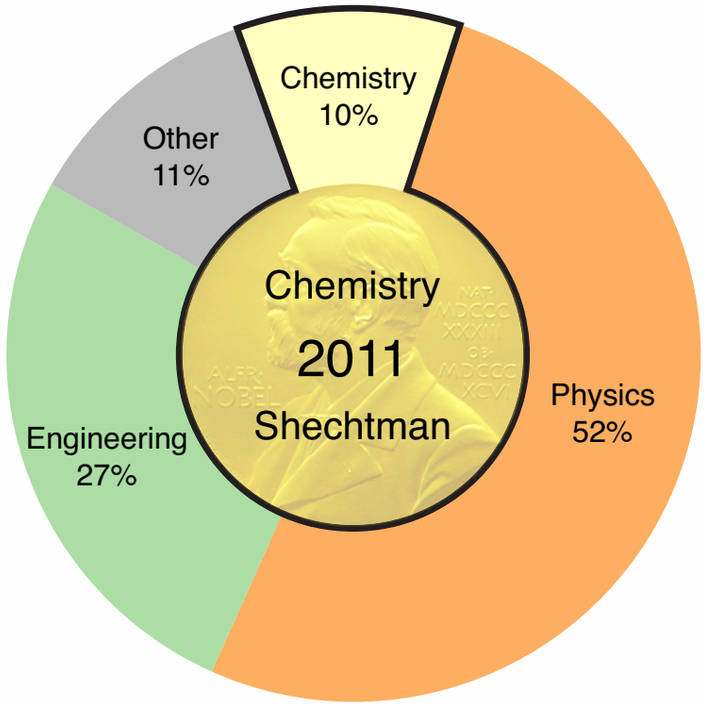
Material scientist

What is physics?

Material scientist
Nobel prize in chemistry

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

What is physics?



Material scientist

Nobel prize in chemistry

Cited by physicists (6x)

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

What is physics?

What is physics?

Physics is what physicists do.

- Sam Edwards

What is [*field*]?

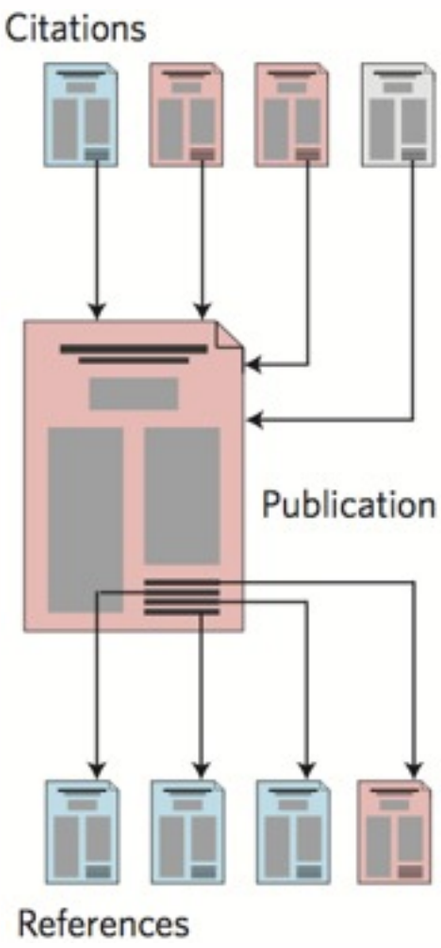
[*field*] is what [*people in the field*] do.

Basic units of science: publication and citation

WEB OF KNOWLEDGE℠

THOMSON REUTERS

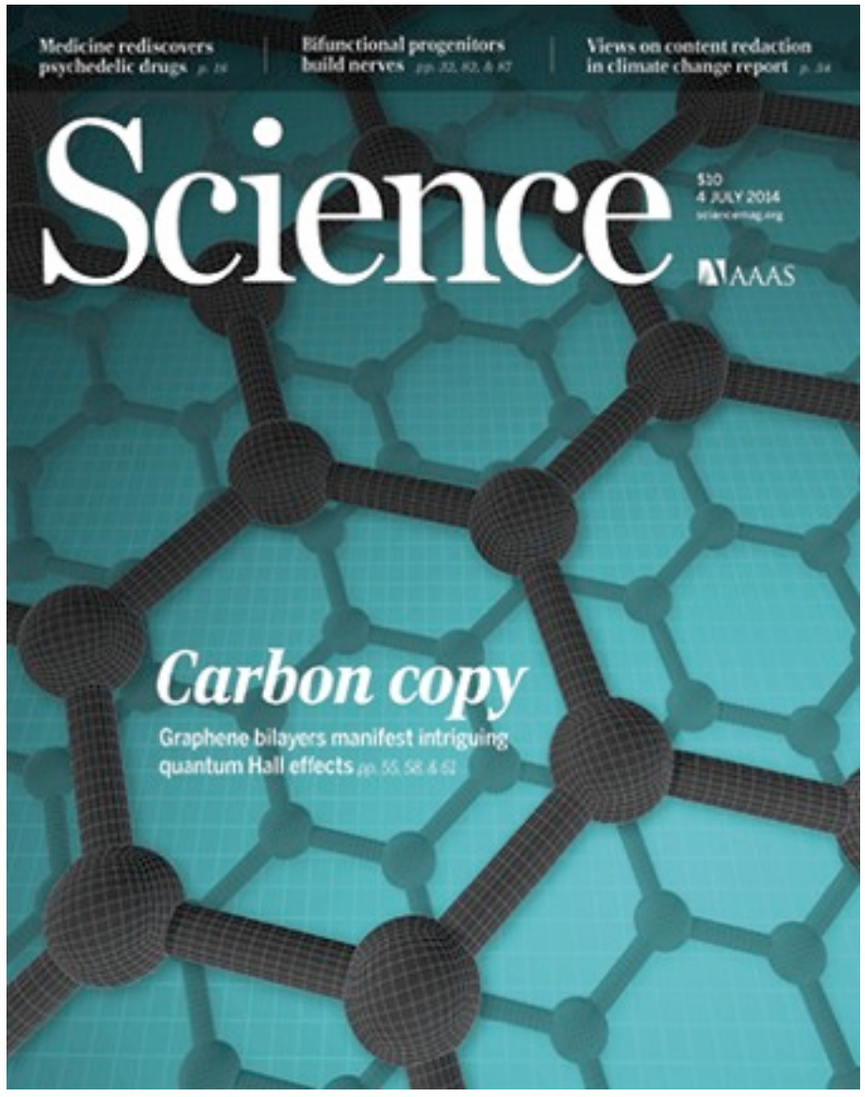
- 40M papers from 23000 journals
- 113 years
- 500M citations



Journal classification with
WoS, Scimago, Wikipedia

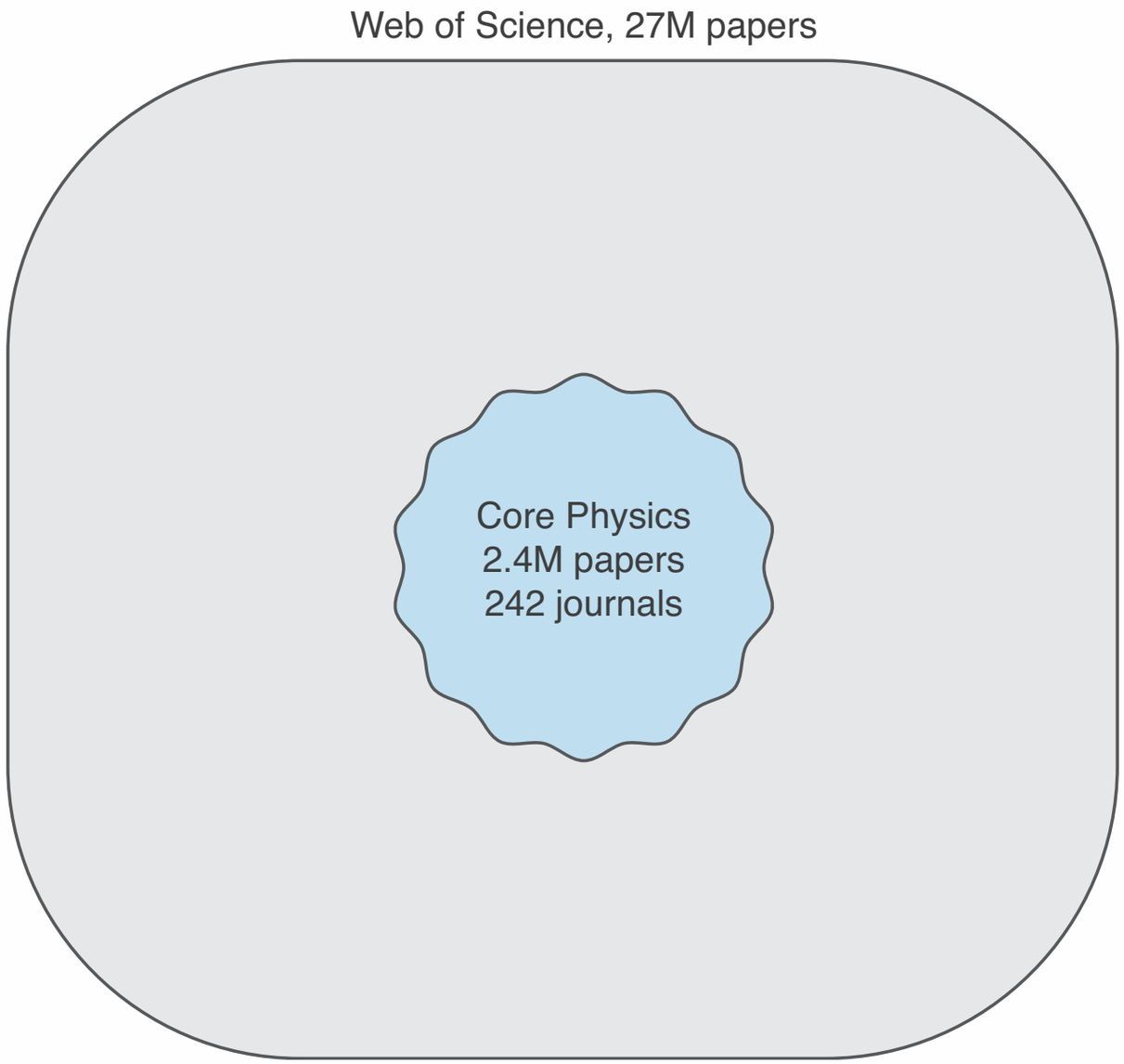
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

Papers in physics journals are not all physics papers



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

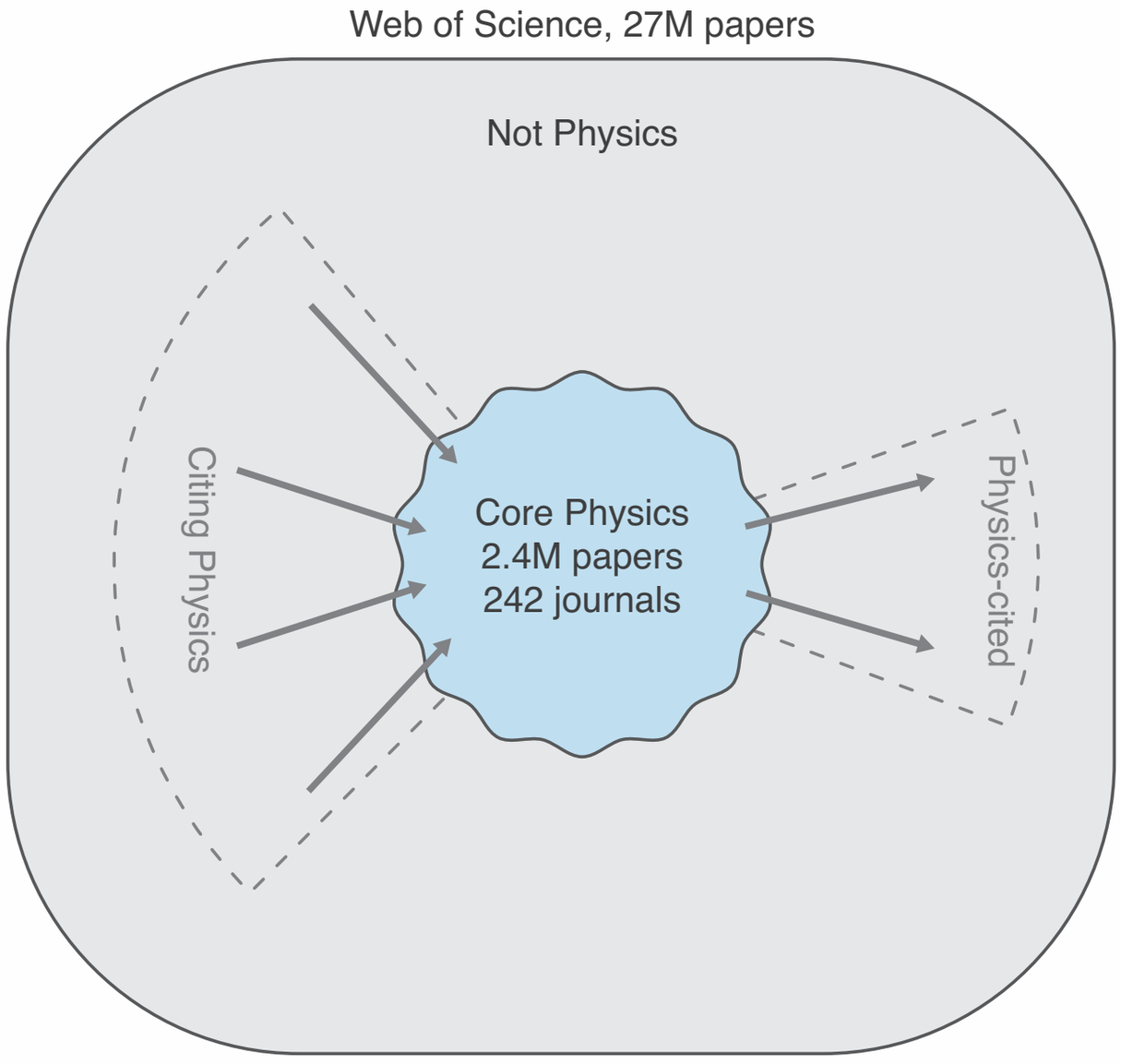
Detecting physics papers



Physics is what is citing + cited by core physics

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

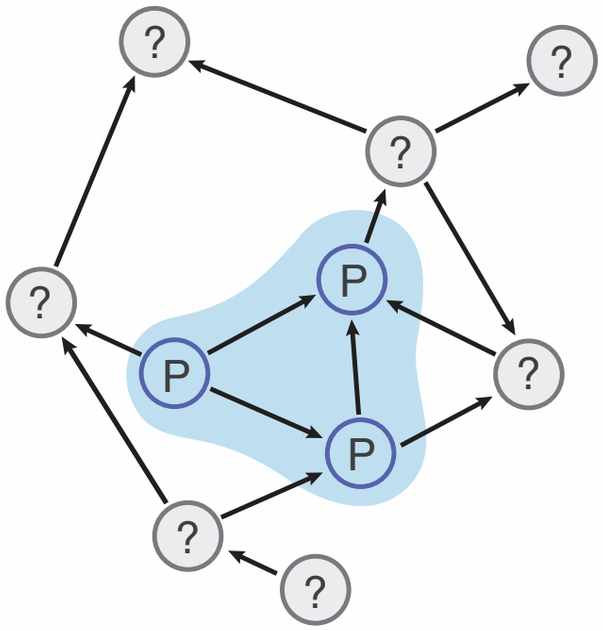
Detecting physics papers



Physics is what is citing + cited by core physics

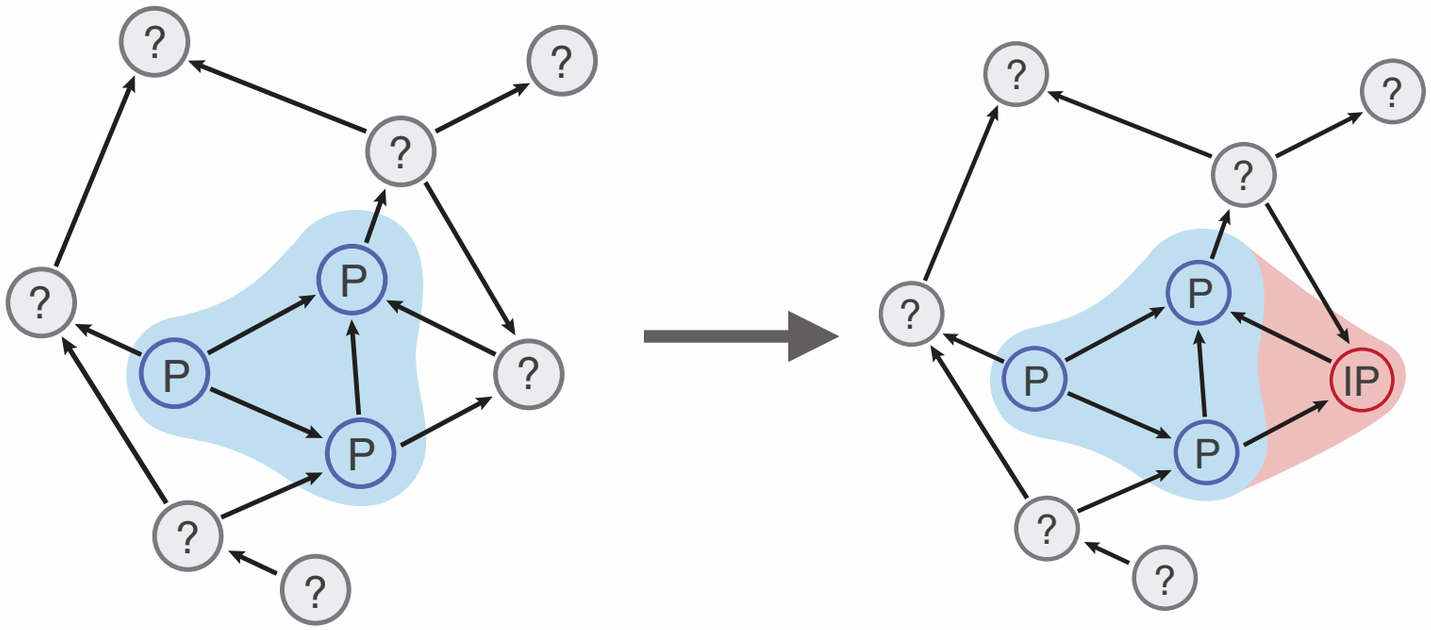
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

Detecting physics papers



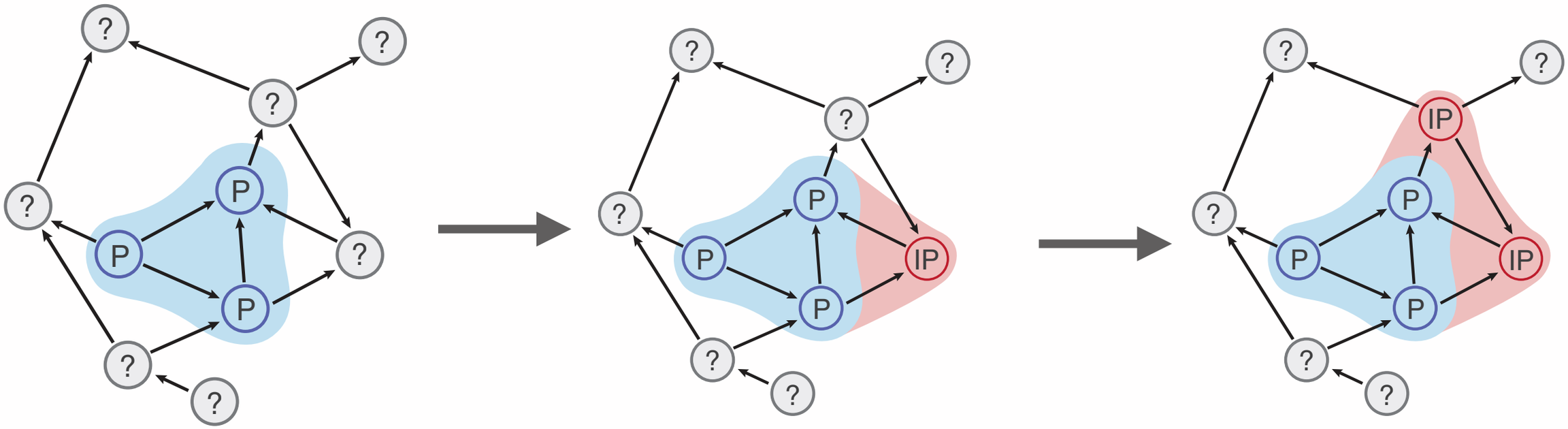
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

Detecting physics papers



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

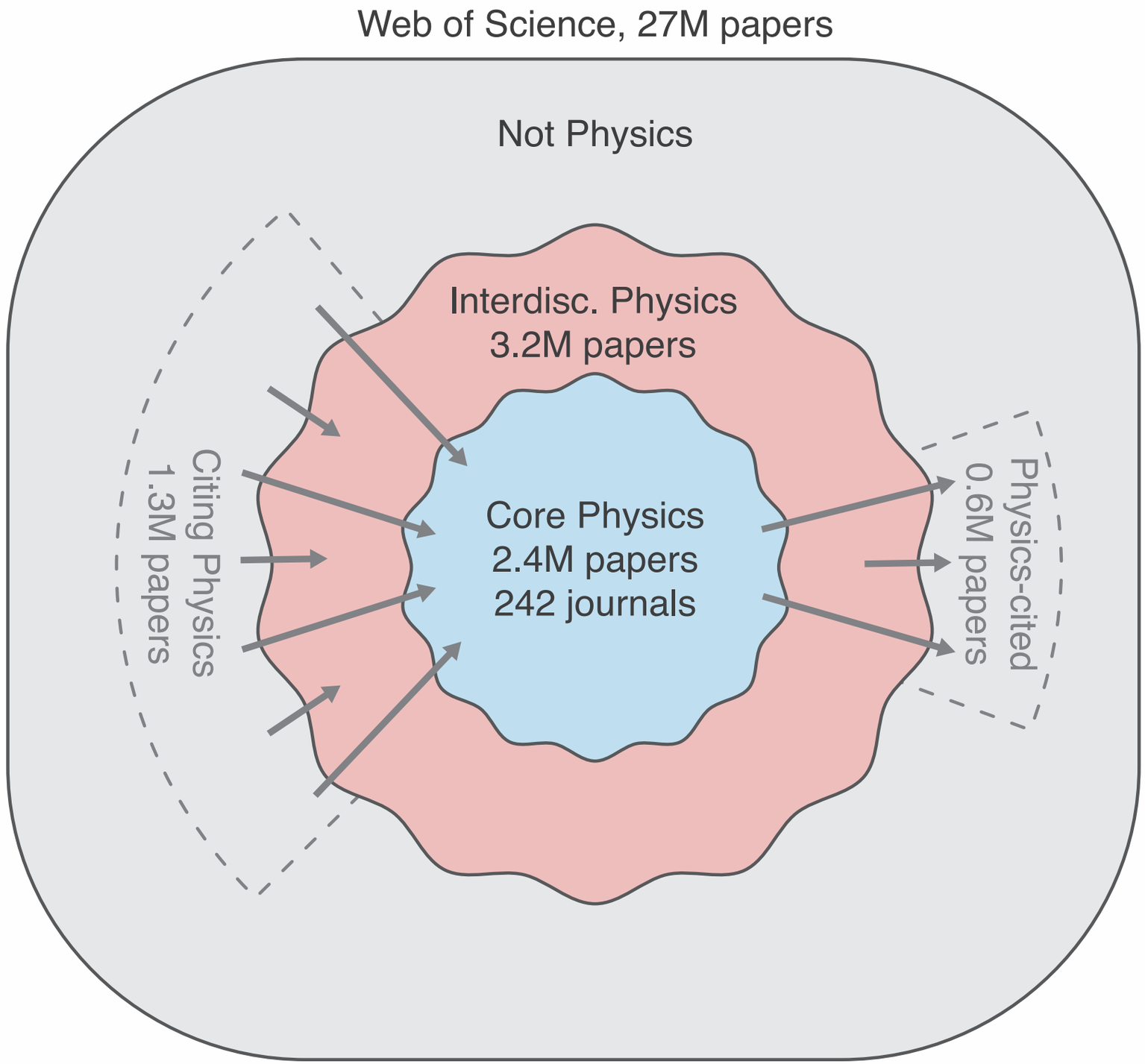
Detecting physics papers



Like label propagation in machine learning

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

Detecting physics papers



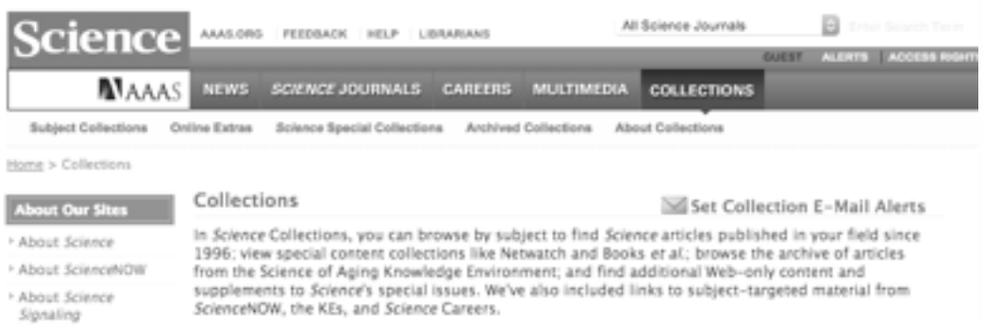
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

Validation

Using annotated papers crawled from interdisciplinary journals

PNAS archive (1915-2013)

Science collection (1966-2013)



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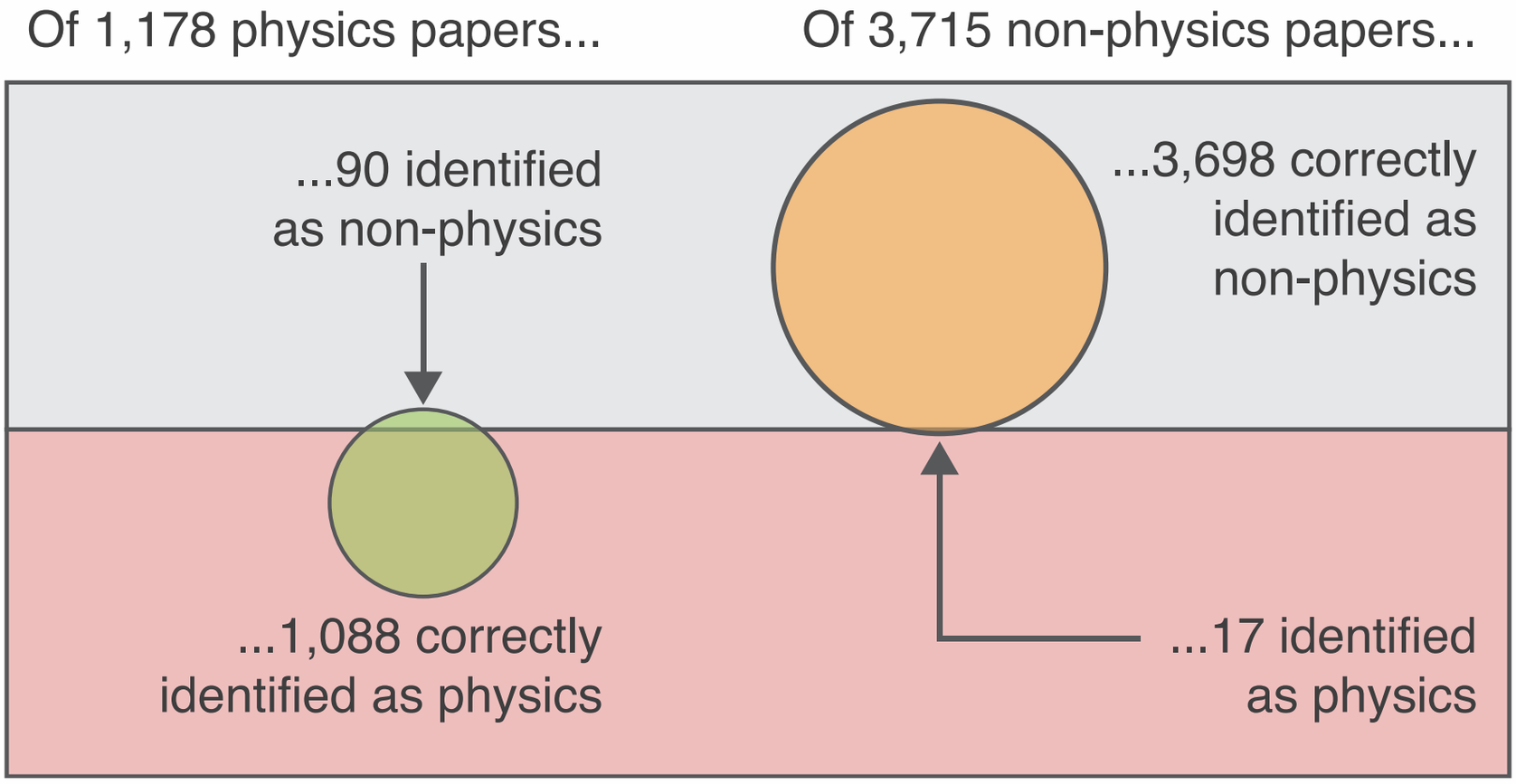


92.4% true positives

0.5% false positives

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

Notable example of “non-physics physics”

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 from interdisciplinary physics (2.4x)

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

There is a story behind every paper

1. Scatchard, George. “The attractions of proteins for small molecules and ions”. *Annals of the New York Academy of Sciences* 51.4 (1949).

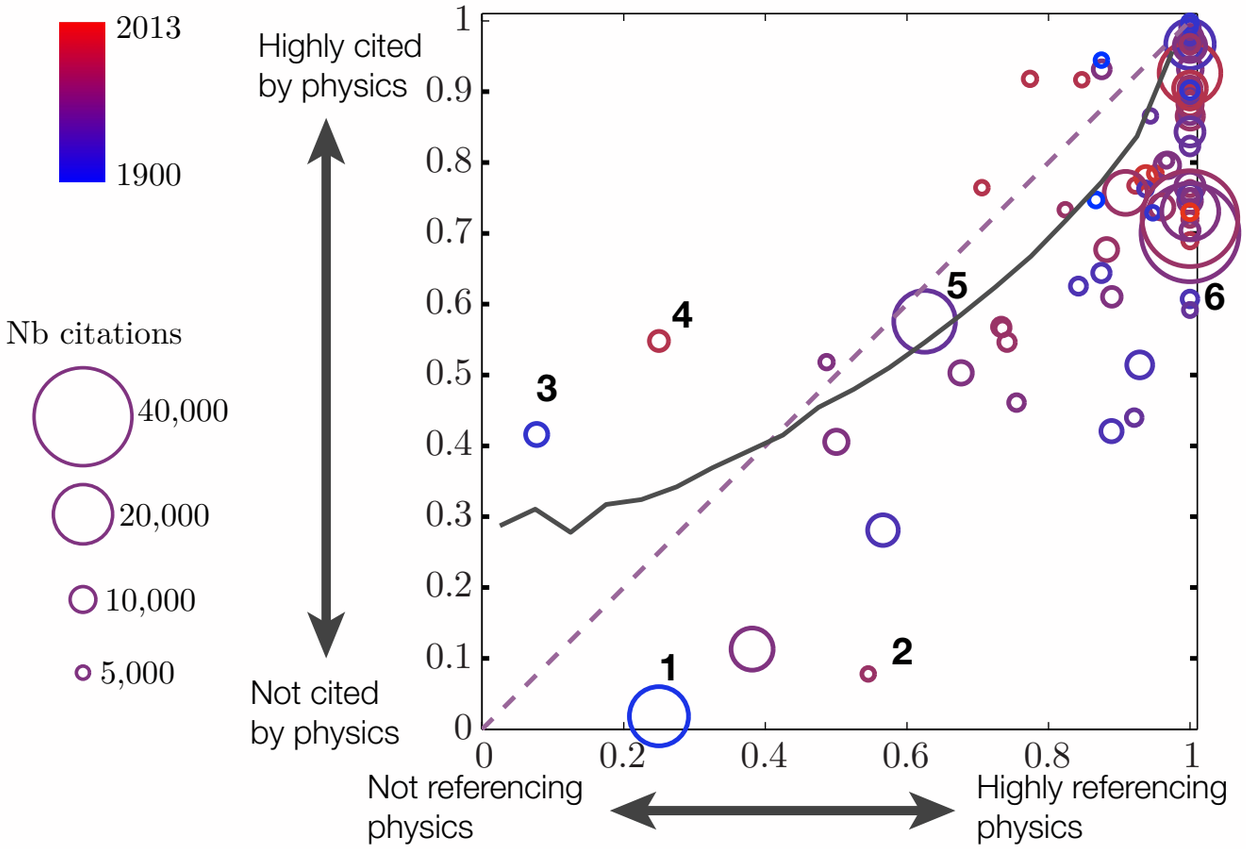
2. Effect of nonstoichiometry on the electrophysical properties of the layered compounds ge3bi2te6 and gebi2te4 (1994)

3. Hodgkin, Alan L., and Andrew F. Huxley. "A quantitative description of membrane current and its application to conduction and excitation in nerve." *The Journal of physiology* 117.4 (1952).

4. Humphrey, William, Andrew Dalke, and Klaus Schulten. "VMD: visual molecular dynamics." *Journal of molecular graphics* 14.1 (1996).

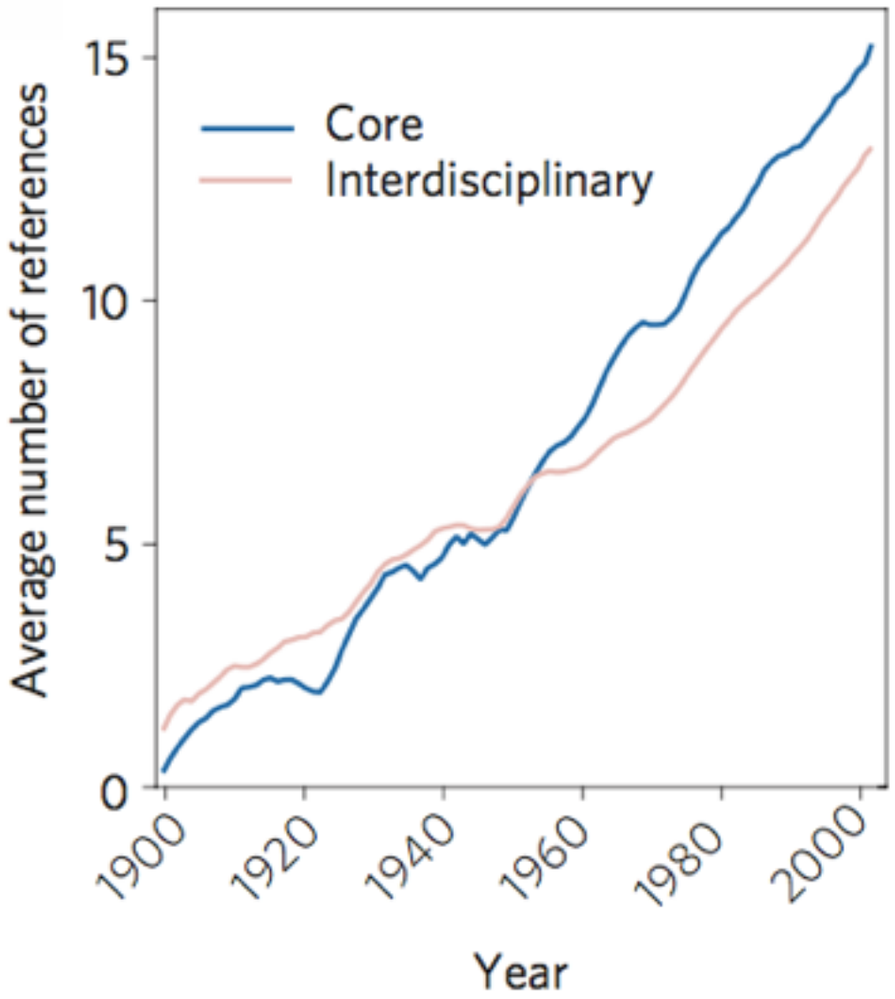
5. Shannon, RD T. "Revised effective ionic radii and systematic studies of interatomic distances in halides and chalcogenides." *Acta Crystallographica Section A* 32.5 (1976).

6. Lee, Chengteh, Weitao Yang, and Robert G. Parr. "Development of the Colle-Salvetti correlation-energy formula into a functional of the electron density." *Physical Review B* 37.2 (1988).

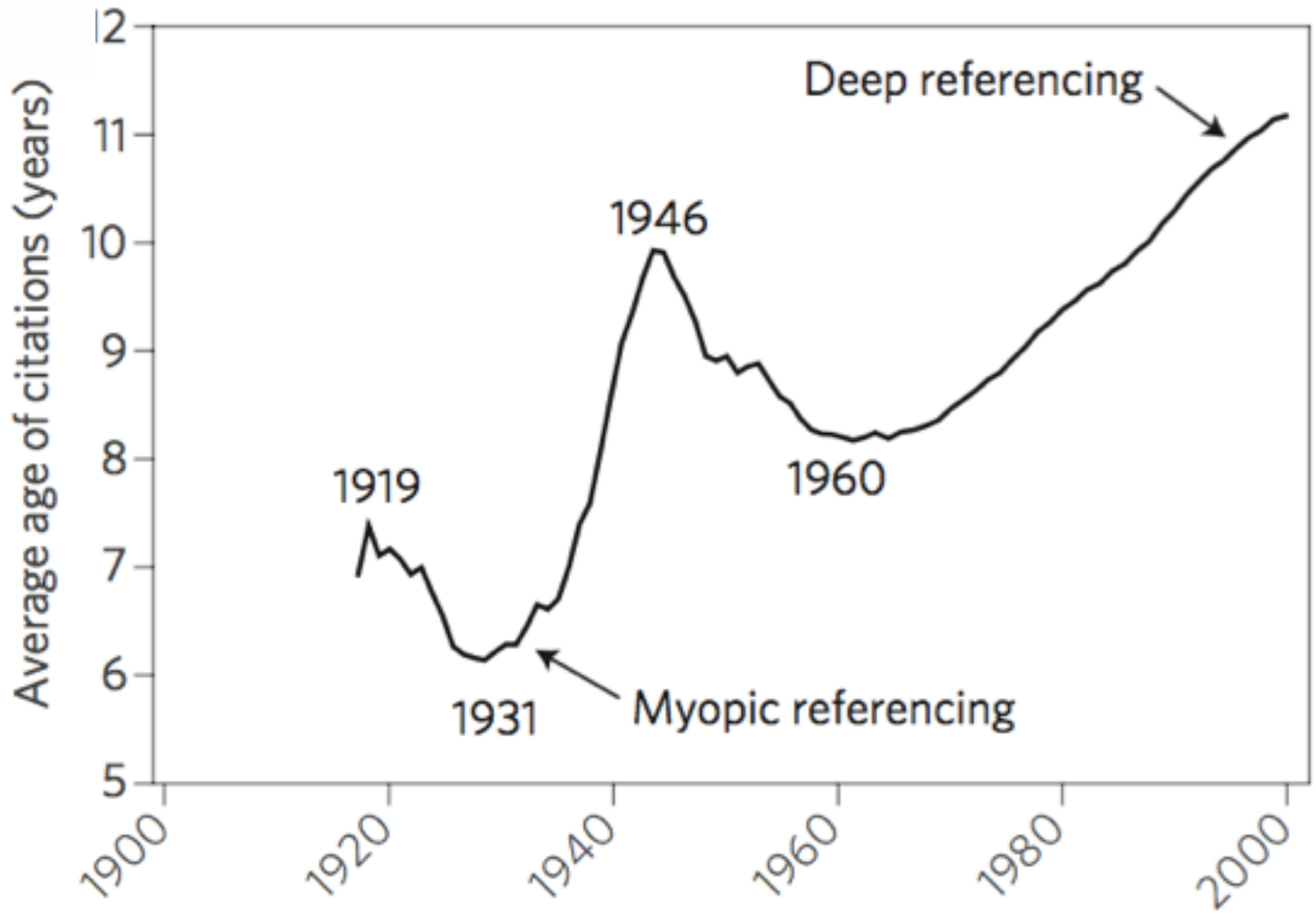


Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

How is physics citing?



References grow



The way we cite changes over time

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

Detecting subfields of physics with PACS

PACS 2010 Regular Edition

Individuals—Find applicable codes from *PACS 2010*

If you are a researcher preparing a manuscript for submission to a journal that requires the author to sugg
codes included in the latest edition of *PACS*. Use your browser's search feature to find the applicable terms

- Alphabetical Index to *PACS 2010*

Complementing your search for appropriate codes, you may wish to browse *PACS* to view the codes as they
PACS 2010, along with its two appendices and supplement. Within each section, new codes appear highlight

00—General
01. Communication, education, history, and philosophy
02. Mathematical methods in physics
03. Quantum mechanics, field theories, and special relativity
04. General relativity and gravitation
05. Statistical physics, thermodynamics, and nonlinear dynamical systems
06. Metrology, measurements, and laboratory procedures
07. Instruments, apparatus, and components common to several branches of physics and astronomy

10—The Physics of Elementary Particles and Fields
11. General theory of fields and particles
12. Specific theories and interaction models; particle systematics
13. Specific reactions and phenomenology
14. Properties of specific particles

20—Nuclear Physics
21. Nuclear structure
23. Radioactive decay and in-beam spectroscopy
24. Nuclear reactions: general
25. Nuclear reactions: specific reactions
26. Nuclear astrophysics

30—Atomic and Molecular Physics
31. Electronic structure of atoms and molecules: theory
32. Atomic properties and interactions with photons
33. Molecular properties and interactions with photons
34. Atomic and molecular collision processes and interactions
36. Exotic atoms and molecules; macromolecules; clusters
37. Mechanical control of atoms, molecules, and ions

40—Electromagnetism, Optics, Acoustics, Heat Transfer, Classical Mechanics, and Fluid Dynamics
41. Electromagnetism; electron and ion optics
42. Optics
43. Acoustics
44. Heat transfer
45. Classical mechanics of discrete systems
46. Continuum mechanics of solids
47. Fluid dynamics

50—Physics of Gases, Plasmas, and Electric Discharges
51. Physics of gases
52. Physics of plasmas and electric discharges

60—Condensed Matter: Structural, Mechanical and Thermal Properties
61. Structure of solids and liquids; crystallography
62. Mechanical and acoustical properties of condensed matter
63. Lattice dynamics
64. Equations of state, phase equilibria, and phase transitions
65. Thermal properties of condensed matter
66. Nonelectronic transport properties of condensed matter
67. Quantum fluids and solids
68. Surfaces and interfaces; thin films and nanosystems (structure and nonelectronic properties)

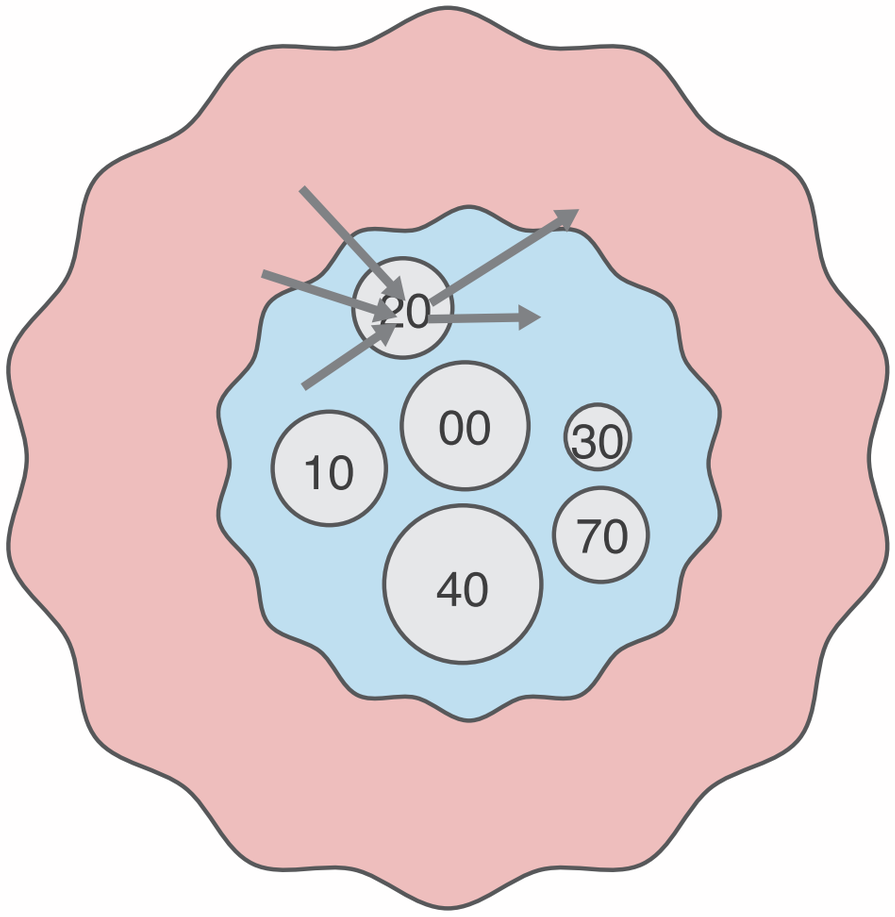
70—Condensed Matter: Electronic Structure, Electrical, Magnetic, and Optical Properties
71. Electronic structure of bulk materials
72. Electronic transport in condensed matter
73. Electronic structure and electrical properties of surfaces, interfaces, thin films, and low-dimensional stru
74. Superconductivity
75. Magnetic properties and materials
76. Magnetic resonances and relaxations in condensed matter, Mössbauer effect
77. Dielectrics, piezoelectrics, and ferroelectrics and their properties
78. Optical properties, condensed-matter spectroscopy and other interactions of radiation and particles wit
79. Electron and ion emission by liquids and solids; impact phenomena

80—Interdisciplinary Physics and Related Areas of Science and Technology
81. Materials science
82. Physical chemistry and chemical physics
83. Rheology
84. Electronics; radiowave and microwave technology; direct energy conversion and storage
85. Electronic and magnetic devices; microelectronics
87. Biological and medical physics
88. Renewable energy resources and applications
89. Other areas of applied and interdisciplinary physics

90—Geophysics, Astronomy, and Astrophysics
91. Solid Earth physics
92. Hydrospheric and atmospheric geophysics
93. Geophysical observations, instrumentation, and techniques
94. Physics of the ionosphere and magnetosphere
95. Fundamental astronomy and astrophysics; instrumentation, techniques, and astronomical observations
96. Solar system; planetology
97. Stars
98. Stellar systems; interstellar medium; galactic and extragalactic objects and systems; the Universe

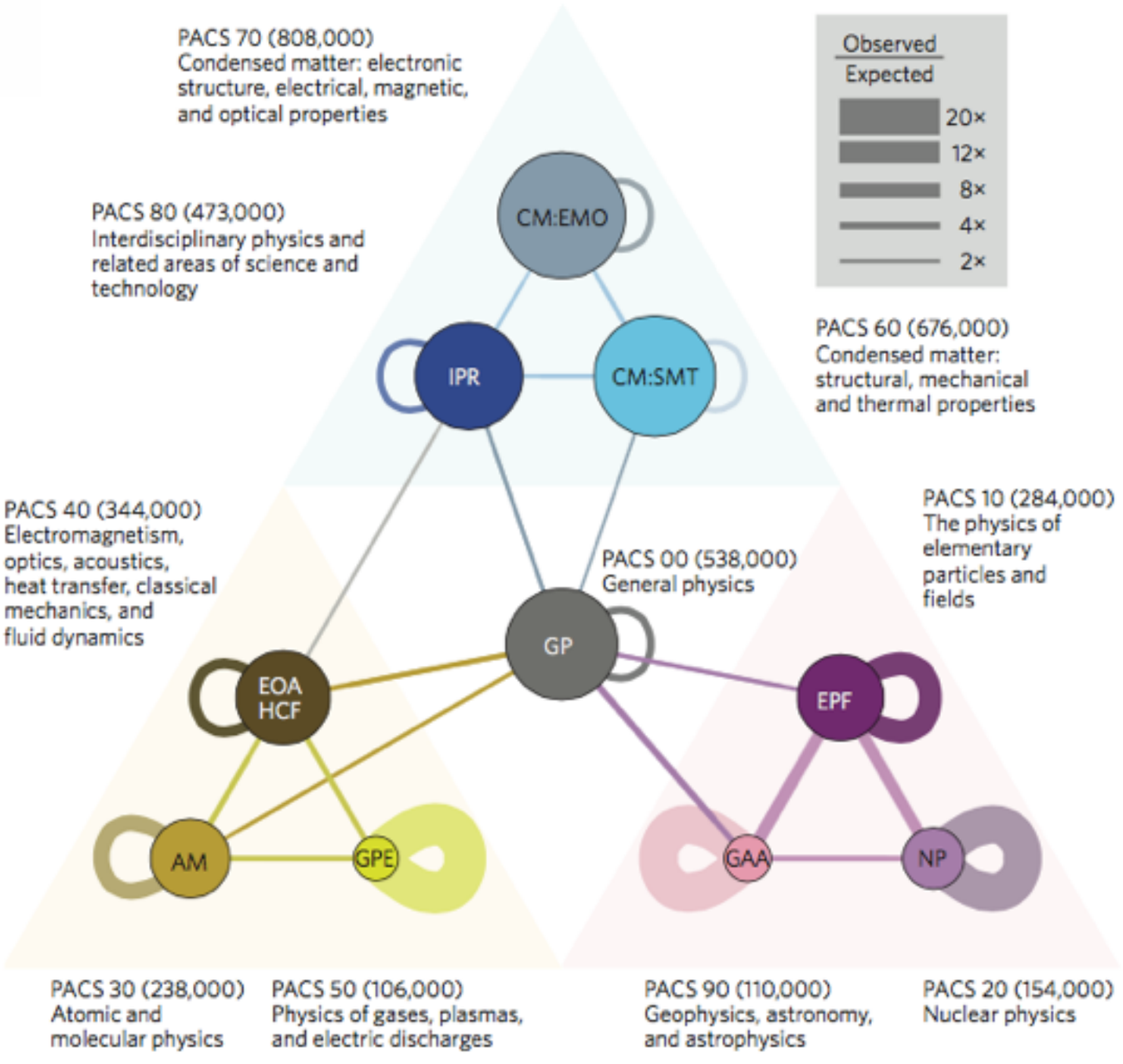
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

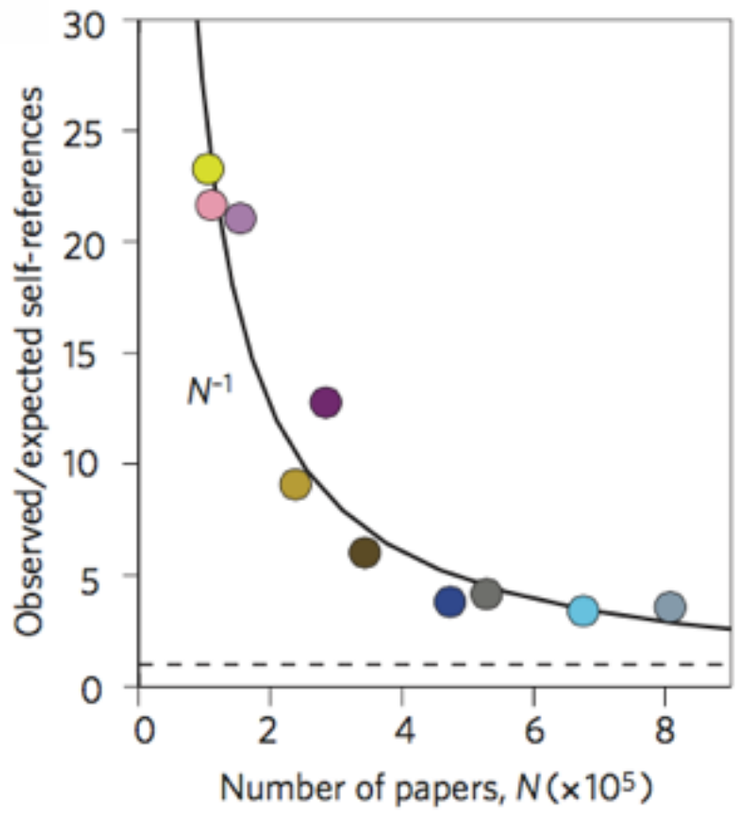
Detecting subfields of physics with PACS



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

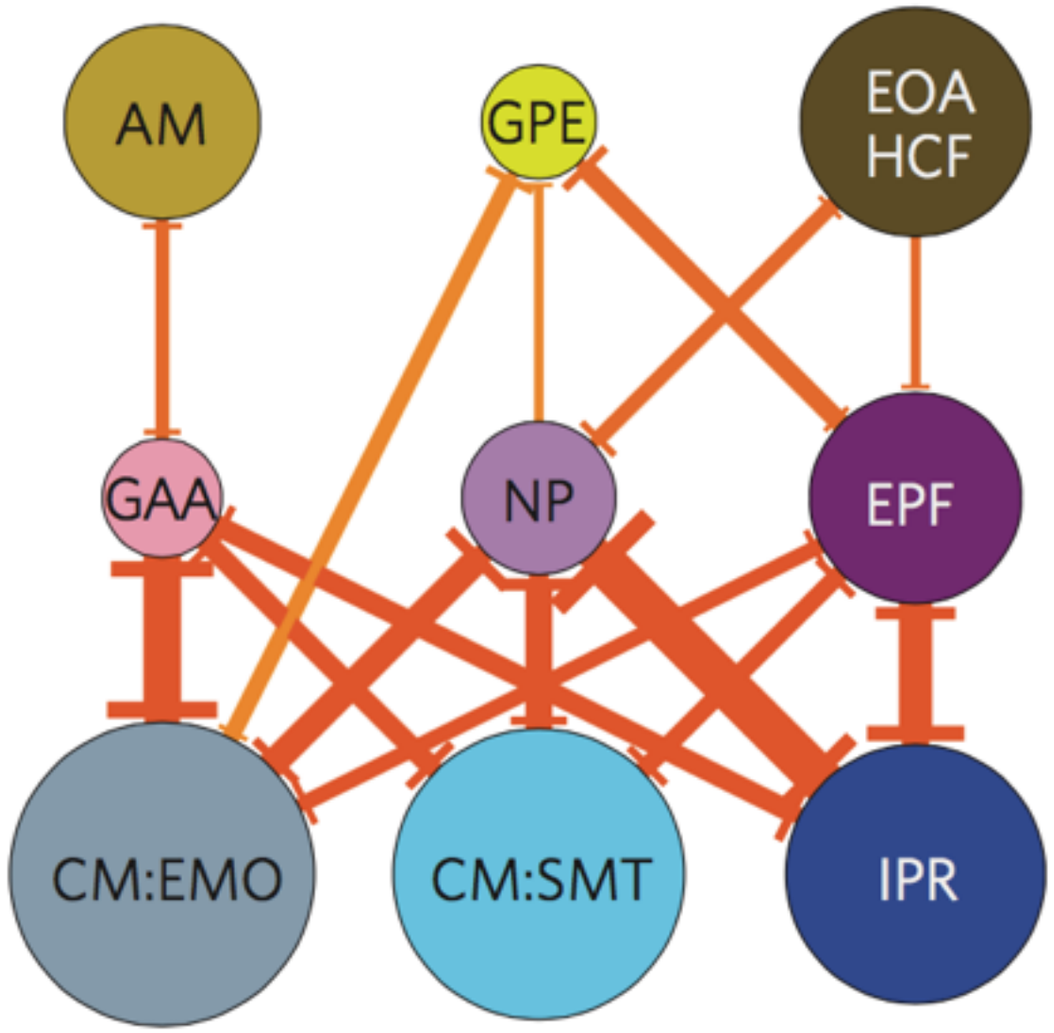
Small subfields are more insular and self-referential





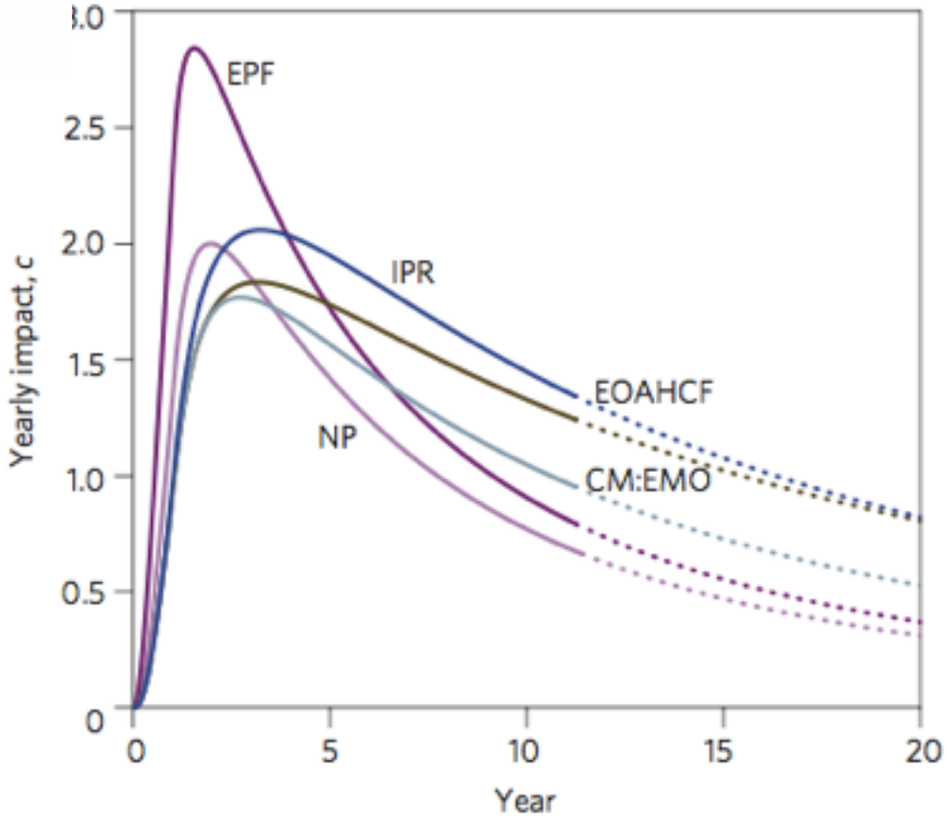
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

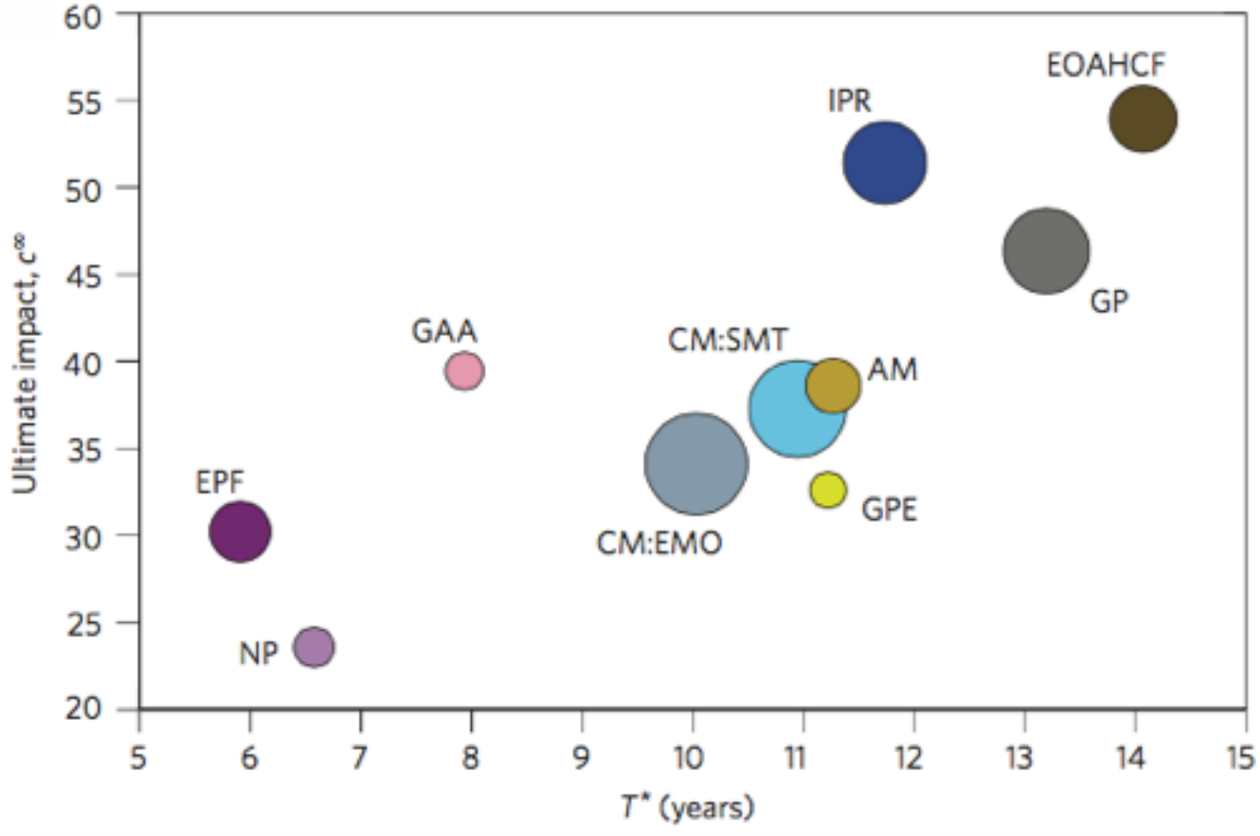
Small subfields are more insular and self-referential



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

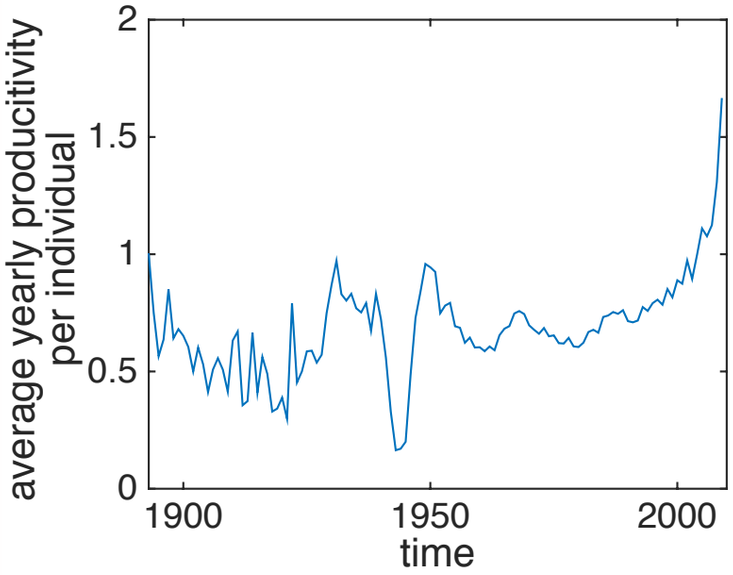
Long-term impacts vary strongly





Wang, Song, Barabási, Science 342, 127-132 (2013)
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

Do we publish more or are there just more authors?



Wuchty, Jones, Uzzi, Science 316, 1036-1039 (2007)
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

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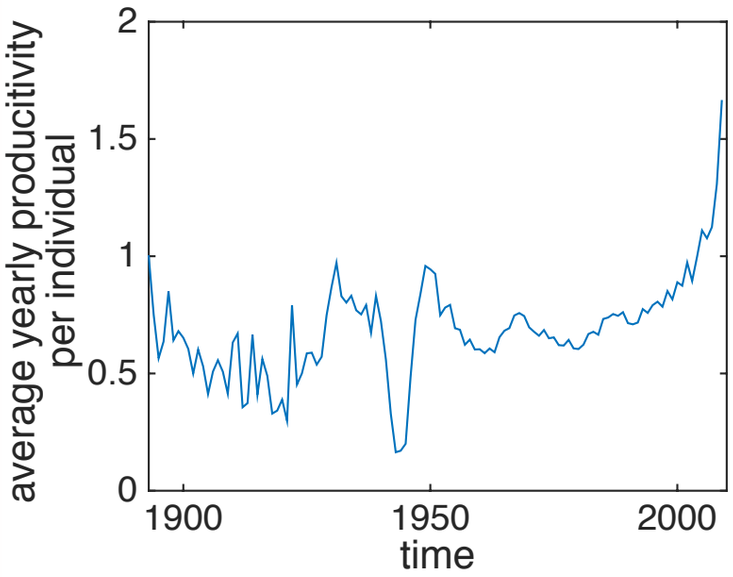

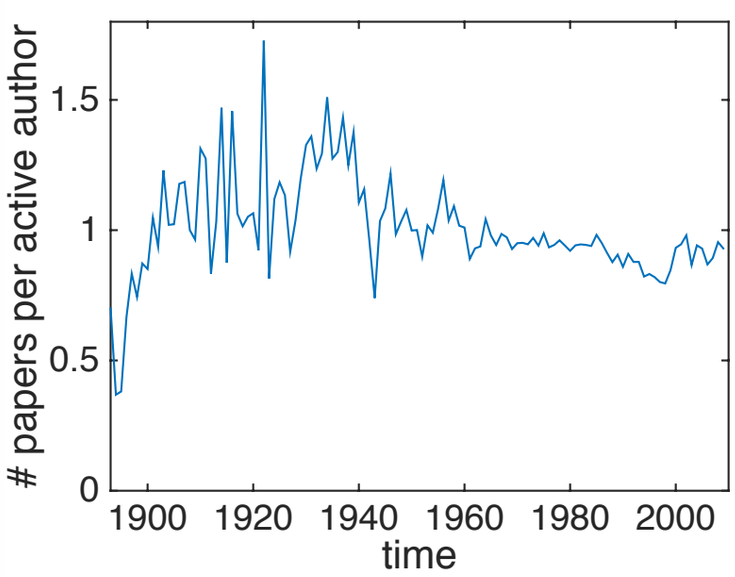

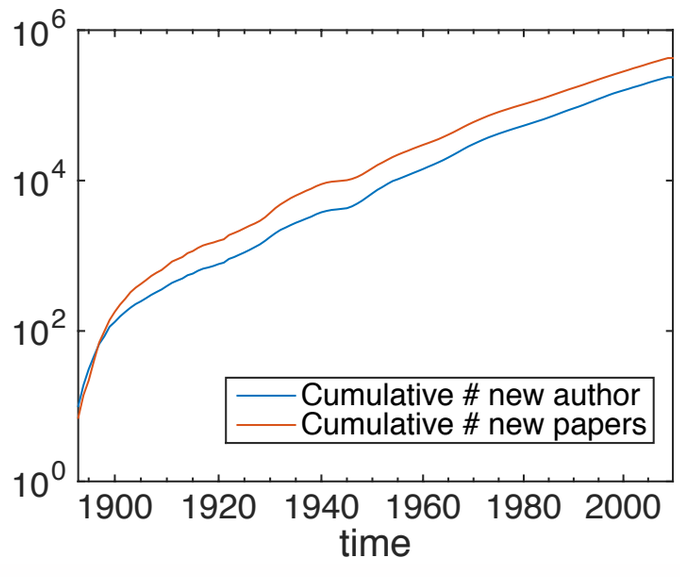

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Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

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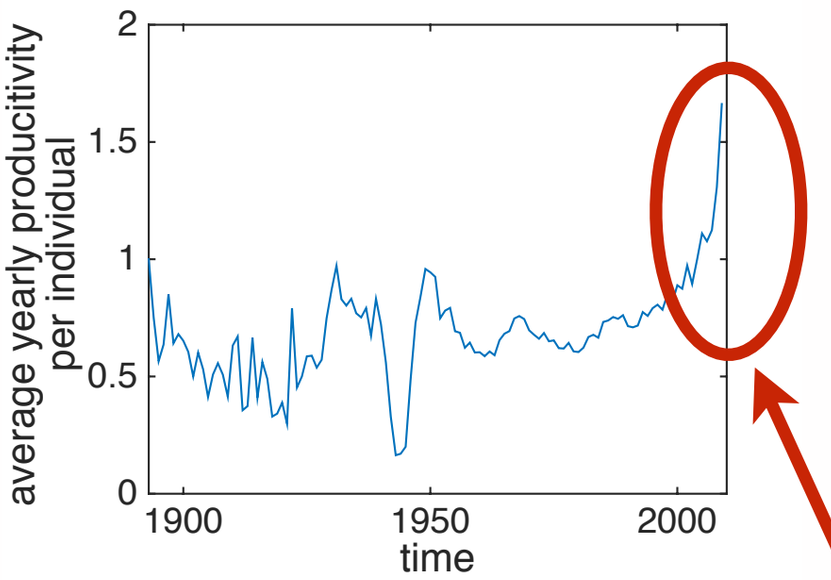
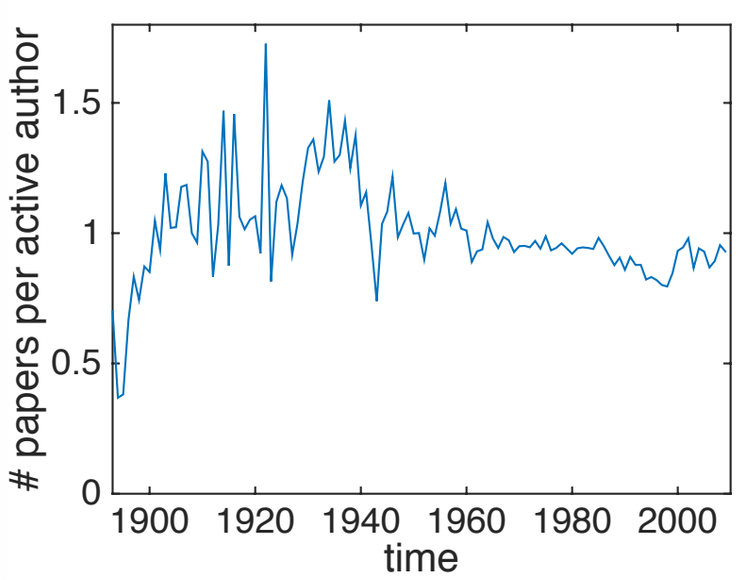
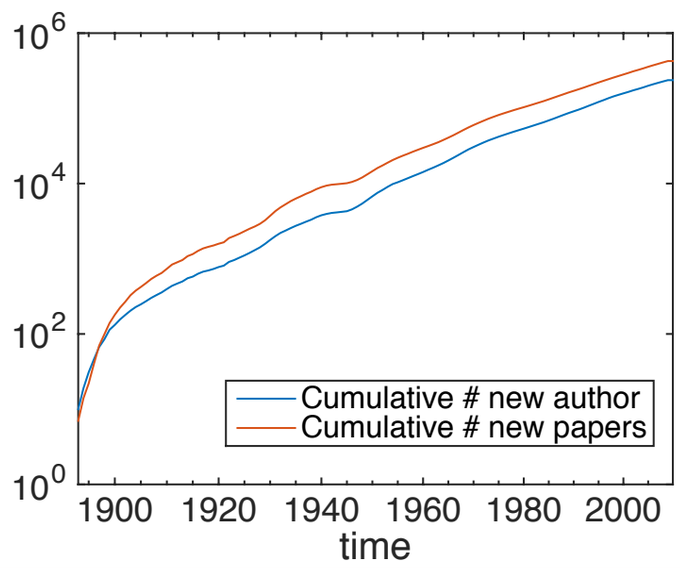


due to increasing team size





There are just more authors.
Individual productivity increases because team size increases.

Wuchty, Jones, Uzzi, Science 316, 1036-1039 (2007)
Sinatra, Deville, Szell, Wang, Barabási, Nature Physics, 11, 791 (2015)

The definition of fields is relevant for all science!

- Grants
- Scope of journals and paper reviews
- Fellowships

Let the data decide,
not arbitrary traditions!

I find the topic very interesting and think that it fits well in the field of statistical physics.

universität wien

DISSERTATION

Titel der Dissertation

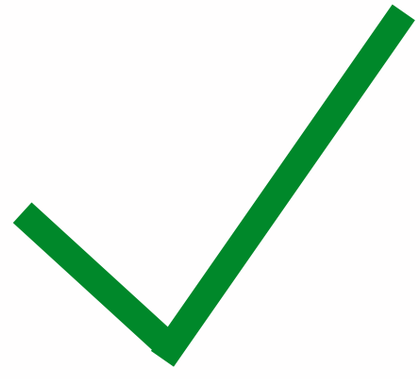
Statistical physics approaches to
large-scale socio-economic networks

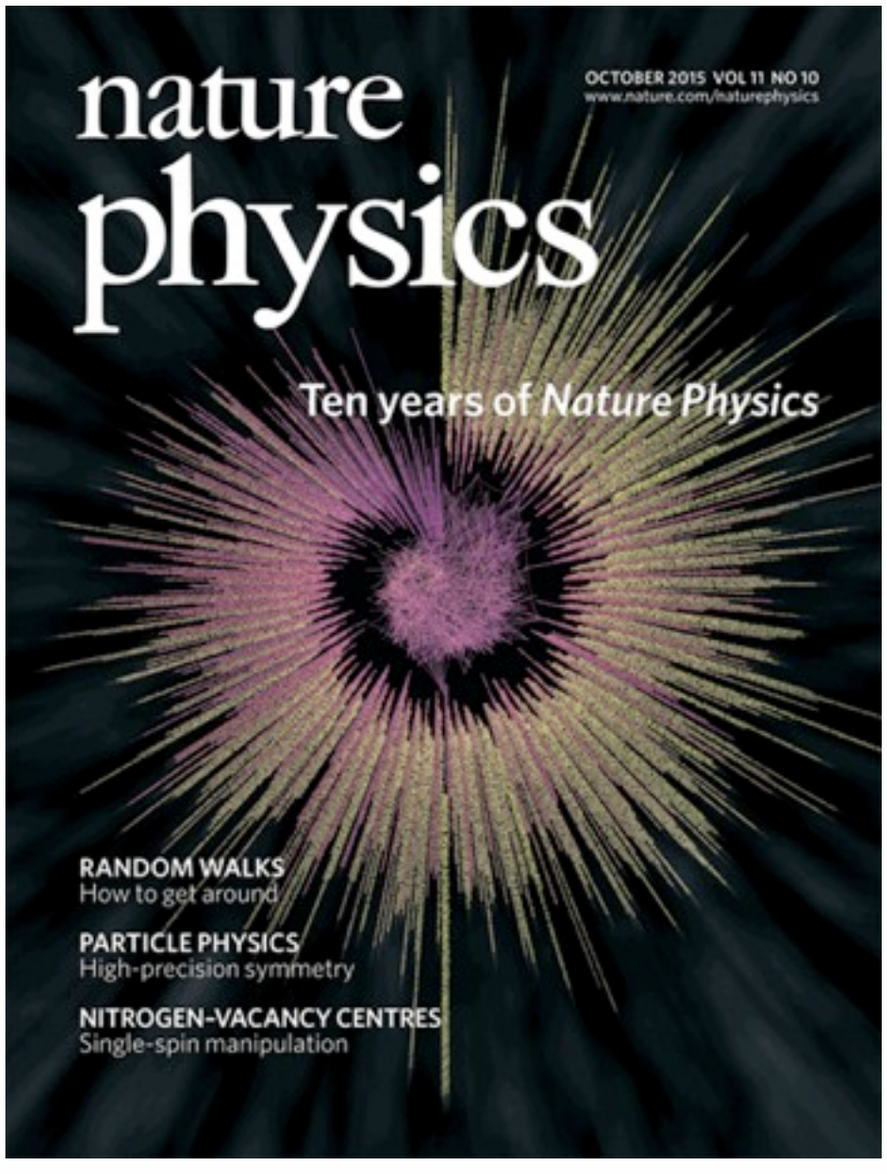
Verfasser

Dipl.-Ing. Michael Szell

angestrebter akademischer Grad

Doktor der Naturwissenschaften (Dr.rer.nat.)





Many of us involved in hiring committees or thesis defences in physics have been confronted with the question: can a particular body of work be considered physics, or is a particular scientist a physicist? The futility of the debate is often unnerving, and the analysis of the physics literature shows us why: there is not a single standard of what physics is.

Acknowledgements

Roberta Sinatra

Pierre Deville

Dashun Wang

Albert-László Barabási

AFOSR
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Sinatra et al. Nature Physics 11, 791-796 (2015)

Deville et al. Sci. Rep. 4:4770, (2014)

Szell and Sinatra, PNAS 112:48, 14749-14750 (2015)