

Database lists the top-cited physics papers

Citation tracking can point to the most influential trends in research.

Heath O'Connell and Michael Peskin analyse the chart for the year 2000 and report the hottest topics in high-energy physics.



A family photograph from the international Particle Data Group. Its annual Review of Particle Physics encapsulates all of the latest experimental developments and measurements, and it is invariably the top-cited particle physics paper of the year. The group effort involves many more people than appear here. Left to right, front row: Maury Goodman (Argonne), Charles Wohl (Lawrence Berkeley Laboratory – LBL), Keith Olive (Minnesota), Kenzo Nakamura (KEK) and John March-Russell (CERN). Middle row: Michael Barnett (LBL), Vitaly Lugoovsky (Protvino), Gail Harper (LBL), Betty Armstrong (LBL), Ken-ichi Hikasa (Tohoku), Wei-Ming Yao (LBL), Alberto Masoni (INFN Cagliari) and Petr Vogel (Caltech). Back row: Boris Filimonov (Protvino), Orin Dahl (LBL), Paul Gee (LBL), Matts Roos (Helsinki), Tom Trippe (LBL), Andreas Piepke (Alabama), Michelangelo Mangano (CERN), Gianni Conforto (Urbino), Ron Workman (George Washington University), Don Groom (LBL), Masaharu Tanabashi (Tohoku), Michael Doser (CERN) and Ramon Miquel (LBL).

The SPIRES-HEP database maintained by the library at the Stanford Linear Accelerator Center (SLAC) connects preprint or eprint versions to articles published in journals or conference proceedings, providing access to all phases of the publication history. The database lists virtually every high-energy physics paper published or even preprinted over the past 30 years.

In addition, most papers now have backward links to the papers that they cite and forward links to the papers citing them. These citation links provide a very effective means of searching the literature. In the past few years SPIRES-HEP has been automatically harvesting reference citations from eprints, creating a web of links that thoroughly indexes the literature. ►

1: Top-cited articles of 2000

Article	No. of citations	Article	No. of citations
1 Particle Data Group, 1998 Review of particle physics <i>Eur. Phys. J.</i> C3 1–794.	1236	6 Nathan Seiberg and Edward Witten, String theory and noncommutative geometry (hep-th/9908142).	397
2 Juan Maldacena, 1998 The large N limit of superconformal field theories and supergravity <i>Adv. Theor. Math. Phys.</i> 2 231–252 (hep-th/9711200).	498	7 Edward Witten, 1998 Anti-de Sitter space and holography <i>Adv. Theor. Math. Phys.</i> 2 253–291 (hep-th/9802150).	347
3 Lisa Randall and Raman Sundrum, 1999 An alternative to compactification <i>Phys. Rev. Lett.</i> 83 4690–4693 (hep-th/9906064).	446	8 Y Fukuda <i>et al.</i> , 1998 Evidence for oscillation of atmospheric neutrinos <i>Phys. Rev. Lett.</i> 81 1562–1567 (hep-ex/9807003).	325
4 Lisa Randall and Raman Sundrum, 1999 A large mass hierarchy from a small extra dimension <i>Phys. Rev. Lett.</i> 83 3370–3373 (hep-ph/9905221).	414	9 S S Gubser <i>et al.</i> , 1998 Gauge theory correlators from noncritical string theory <i>Phys. Lett.</i> B428 105–114 (hep-th/9802109).	316
5 Nima Arkani-Hamed, Savas Dimopoulos and Gia Dvali, 1998 The hierarchy problem and new dimensions at a millimeter <i>Phys. Lett.</i> B249 263 (hep-ph/9803315).	403	10 Ignatios Antoniadis <i>et al.</i> , 1998 New dimensions at a millimeter to a Fermi and superstrings at a TeV <i>Phys. Lett.</i> B436 257–263 (hep-ph/9804398).	301

As a by-product of this citation linkage, SPIRES-HEP can easily search out the papers most cited by publications in high-energy physics. The list of papers with the most citations in a given year provides a snapshot of the hottest topics that have engaged the attention of theorists and experimenters. For the past few years, SPIRES-HEP has posted a scientific review of the year's top-cited papers. The whole collection of these reviews can be found on the Web at "<http://www.slac.stanford.edu/library/topcites>".

We have recently posted the "top-cited" lists for 2000. These materials include a list of the papers with more than 100 citations in the past year and a list of the papers with more than 1000 citations over the history of the SPIRES-HEP database.

So what are, by this measure, the hottest topics of 2000? Table 1 lists the top 10 cited papers and the number of citations of those papers in 2000. These papers represent major areas of activity that are discussed further in the review posted at the SPIRES Web site. The top-cited reference in high-energy physics is always the Review of Particle Properties. Below this in the list, the following areas are represented. (Papers appearing in the "top 10 cited list" are referred to by a number that indicates their position on the list.)

Maldacena's duality

A broad swath of developments in string theory and related areas of mathematical physics has resulted from Maldacena's 1997 paper (2), which propose a relation between supergravity and superstring theories in $(d+1)$ -dimensional anti-de Sitter space and supersymmetric Yang-Mills theories in d -dimensions.

Anti-de Sitter space, the homogeneous space of constant negative curvature, has a boundary in the sense that light signals propagate to space-like infinity in finite time. Maldacena proposed that, for a gravity theory living in the interior of the space, there would be a corresponding, and equivalent, scale-invariant quantum field theory living on the boundary. Subsequently, Witten (7), and Gubser, Klebanov and Polyakov (9), gave a precise relation between correlation functions in the boundary theory and S-Matrix elements for the gravity theory in the interior.

These developments have led to many insights, illuminating both the properties of strongly coupled Yang-Mills theory and quantum gravity theories. It is remarkable that Maldacena's paper has managed, in just three years, to accumulate more than 1600 citations and to vault to position 25 on the all-time citation list.

Extra space dimensions

Though string theory predicts the existence of seven extra space dimensions, these have conventionally been considered to be unobservably small and irrelevant to ordinary particle physics. However, the next three papers on the "top-cited" list involve theoretical models in which extra space dimensions play a direct role in particle physics and, in particular, explain the mass scale of the Higgs boson. Randall and Sundrum (3, 4) have proposed two different scenarios in which our four-dimensional universe is a flat, three-dimensional surface in anti-de Sitter space.

Arkani-Hamed, Dimopoulos and Dvali (5) have proposed a scenario in which our universe is a surface in a large, flat space-time,

2: Top citations within each eprint archive

Archive	Article	No. of citations
GR-QC	S W Hawking, 1975 Particle creation by black holes <i>Commun. Math. Phys.</i> 43 199–220.	61
HEP-EX	Torbjorn Sjostrand, 1994 High-energy physics event generation with PYTHIA 5.7 and JETSET 7.4 <i>Comput. Phys. Commun.</i> 82 74–90.	94
HEP-LAT	Herbert Neuberger, 1998 Exactly massless quarks on the lattice <i>Phys. Lett.</i> B417 141–144 (hep-lat/9707022).	68
HEP-PH	Y Fukuda <i>et al.</i> , 1998 Evidence for oscillation of atmospheric neutrinos. <i>Phys. Rev. Lett.</i> 81 1562–1567 (hep-ex/9807003).	265
HEP-TH	Juan Maldacena, 1998 The Large N limit of superconformal field theories and supergravity <i>Adv. Theor. Math. Phys.</i> 2 231–252 (hep-th/9711200).	465
NUCL-EX	J P Bondorf <i>et al.</i> , 1995 Statistical multifragmentation of nuclei <i>Phys. Rept.</i> 257 133–221.	16
NUCL-TH	R Wiringa, V Stoks and R Schiavilla, 1995 An accurate nucleon–nucleon potential with charge independence breaking <i>Phys. Rev.</i> C51 38–51 (nucl-th/ 9408016).	53

the size of which may approach the millimetre scale. Further consequences of this model are developed in paper 10. Both of the models 4 and 5 will have crucial tests at CERN's LHC collider, which may give direct experimental evidence for the presence of new space dimensions (*CERN Courier* March 2000 p7).

Non-commutative field theory

Many ideas about quantum gravity lead to the idea that space–time co-ordinates are non-commuting operators. Non-commutative Yang–Mills theory, which was invented by Connes, gives a simple field theory model in which consequences of the possible non-commutativity of space can be studied. Paper 6, by Seiberg and Witten, explained the connection between Connes' model and various compactifications of string theory, launching an intense investigation into non-commutative dynamics.

Neutrino physics

In experimental particle physics the most surprising development of the past few years has been the discovery by the Superkamiokande collaboration of atmospheric neutrino oscillations (8). This experimental result indicates the presence of neutrino mass and large mixing among the lepton generations. It has led to many speculations on the origin of flavour mixing and to a new, intense level of experimentation on neutrino properties.

The complete list of the top 40 cited papers of 2000 and a more detailed scientific review can be found at the SLAC Web site. The site also includes a "top-cited" list for each eprint archive relevant to high-energy physics. In Table 2 the top-cited paper (exclusive of the Particle Data Group's Review of Particle Properties) in each archive is shown.

We make no claim that the papers that we have listed here are currently the most important papers in high-energy physics. Year-by-year accounting is influenced as much by fashion as by logical scientific development. Both the standard electroweak model and string theory spent many years in the cellar of the citation counts before rising to their current prominence. If you favour a trend, a model or an experiment that is not listed here, more power to you. We hope that your insights will be well represented on our lists before the end of the decade.

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