

Physics monitor

Most-cited high energy physics papers - all-time favourites

There is no official 'best seller' list of physics papers, but the number of times a published paper is subsequently referred to is one indicator of its scientific impact. Hrvoje Galic of the Stanford Linear Accelerator Centre (SLAC) has carefully analysed these citations. Last month (March, page 21) we published his 'hot topics' list - journal articles with the most citations in the last three years.

This month we continue with 'all-time favourites' - the 25 articles with the most citations in the last two decades. The tables reflect the situation on December 31, 1995 using information from the HEP-PREPRINT database (Ref. 1), a joint project of the SLAC and DESY libraries. Comparing the 'hot topics' lists shows the evolution of physics interest.

Theoretical fashion clearly plays a role and makes some themes more popular, even over a period of time. Experimental work is grossly undercited, probably because important results seem to be considered 'common knowledge' by the majority of non-experimentalists, and the use of convenient 'catch-all' references to the Review of Particle Properties. Papers published in smaller or non-English-language journals are generally less available and less cited. Finally, the database only collects citations found in preprints, and many otherwise important citations from non-preprinted articles are not included.

The 'all-time favourites' list shows the 25 journal papers with the most citations in the HEP-PREPRINT database since 1974. The most fruitful period in this field, according to the list, was the early seventies: seven articles from the list were published in just two years, 1973 and 1974. Some of the 'all-time favourites' are standards which have stood the test of time and figured among the 'hot topics' list.

The electroweak unification of electromagnetism and the weak nuclear force, followed by the Standard Model marriage of the electroweak picture with quark/gluon field theory, has had the most profound effect on physics in the last 20 years.

Thus Steven Weinberg's "Model of Leptons" which introduced electroweak unification is by far the most popular work. As recognized by the 1979 Nobel award, this work was foreshadowed by Sheldon Glashow's 1961 article on gauge symmetries, high on the list at fifth position. (The 1979 Nobel award was shared by Glashow, Abdus Salam and Weinberg. Salam's version of electroweak unification was not published in a journal but in a book, and its citations are thus not registered in the database). Second place on the list is held by the classic work by Glashow, Iliopoulos, and Maiani, which introduced the 'GIM' mechanism for the cancellation of divergences, demonstrated the need for a fourth quark, and extended the electroweak picture to cover both the quark and lepton sectors. Also important for the electroweak unification was 't Hooft and Veltman's proof of renormalizability, in position 23.

The Kobayashi and Maskawa treatment of CP violation in the

Standard Model and the generalization of the Cabibbo matrix at position 3 is another 'evergreen' which also features in the 'hot topics' list.

There are several classic papers on the quark dynamics of the Standard Model. Two milestone papers, by Politzer in 13th position and by Gross and Wilczek in 18th, introduce quark-gluon field theory (quantum chromodynamics - QCD), pointing out the two very different aspects of quark behaviour: permanent confinement in hadrons and what came to be known as 'asymptotic freedom', when the conditions allow quarks to be liberated from their hadron confinement. Stressing these two very different aspects of quark behaviour is Wilson's work on quark confinement, at number 6 on the list, immediately followed by Altarelli and Parisi's article on the asymptotic freedom side of the quark coin. The theory and phenomenology of QCD as applied to resonance physics by Shifman, Vainshtein, Zakharov appears in 9th position.

Having established the Standard Model, another lasting preoccupation is to look beyond it and extend the unification of physics forces to include strong interactions as well. The classic Georgi and Glashow paper which introduces the simplest template - SU(5) based Grand Unified Theory (GUT) is at fourth position. Another heroic attempt to unify all the forces of physics was that of Pati and Salam, at position 8 in the list. In position 25 is Nilles' useful review paper, carrying the flag for a supersymmetric extension of the Standard Model.

Another perennial focus of interest is dynamical symmetry breaking. Coleman and Eric Weinberg at position 10 present very general

All-time HEP favourites: the 25 most-cited high-energy physics papers based on the number of citations in the SLAC-SPIRES database between 1974 and 1995 inclusive

1) A Model of Leptons

S. Weinberg
Phys. Rev. Lett. 19 (1967) 1264
4480 citations

2) Weak Interactions with Lepton-Hadron Symmetry

S.L. Glashow, J. Iliopoulos, L. Maiani
Phys. Rev. D2 (1970) 1285
2560 citations

3) CP Violation in the Renormalizable Theory of Weak Interaction

M. Kobayashi, T. Maskawa
Progr. Theor. Phys. 49 (1973) 652
2509 citations

4) Unity of All Elementary Particle Forces

H. Georgi, S.L. Glashow
Phys. Rev. Lett. 32 (1974) 438
2086 citations

5) Partial Symmetries of Weak Interactions

S.L. Glashow
Nucl. Phys. 22 (1961) 579
1982 citations

6) Confinement of Quarks

K. G. Wilson
Phys. Rev. D10 (1974) 2445
1964 citations

7) Asymptotic Freedom in Parton Language

G. Altarelli, G. Parisi
Nucl. Phys. B126 (1977) 298
1739 citations

8) Lepton Number as the Fourth Colour

J. C. Pati, A. Salam
Phys. Rev. D10 (1974) 275
1678 citations

9) QCD and Resonance Physics. Theoretical Foundations

M.A. Shifman, A.I. Vainshtein, V.I. Zakharov
Nucl. Phys. B147 (1979) 385
1587 citations

10) Radiative Corrections as the Origin of Spontaneous Symmetry Breaking

S. Coleman, E. Weinberg
Phys. Rev. D7 (1973) 1888
1584 citations

11) Computation of the Quantum Effects due to a Four-Dimensional Pseudoparticle

G. 't Hooft
Phys. Rev. D14 (1976) 3432
1579 citations

12) Infinite Conformal Symmetry in Two-Dimensional Quantum Field Theory

A.A. Belavin, A.M. Polyakov, A.B. Zamolodchikov
Nucl. Phys. B241 (1984) 333
1572 citations

13) Reliable Perturbative Results for Strong Interactions?

H.D. Politzer
Phys. Rev. Lett. 30 (1973) 1346
1542 citations

14) Dynamical Model of Elementary Particles Based on an Analogy with Superconductivity. I.

Y. Nambu, G. Jona-Lasinio
Phys. Rev. 122 (1961) 345
1458 citations

15) Symmetry Breaking through Bell-Jackiw Anomalies

G. 't Hooft
Phys. Rev. Lett. 37 (1976) 8
1457 citations

16) Vacuum Configurations for Superstrings

P. Candelas, G. T. Horowitz, A. Strominger, E. Witten
Nucl. Phys. B258 (1985) 46
1433 citations

17) Quantum Geometry of Bosonic Strings

A.M. Polyakov
Phys. Lett. B103 (1981) 207
1423 citations

18) Ultraviolet Behaviour of Non-Abelian Gauge Theories

D.J. Gross, F. Wilczek
Phys. Rev. Lett. 30 (1973) 1343
1416 citations

19) Axial-Vector Vertex in Spinor Electrodynamics

S.L. Adler
Phys. Rev. 177 (1969) 2426
1400 citations

20) Review of Particle Properties

Particle Data Group (K. Hikasa et al.)
Phys. Rev. D45 (1992) S1
1364 citations

21) Supercollider Physics

E. Eichten, I. Hinchliffe, K. Lane, C. Quigg
Rev. Mod. Phys. 56 (1984) 579
1342 citations

22) Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems

A. H. Guth
Phys. Rev. D23 (1981) 347
1334 citations

23) Regularization and Renormalization of Gauge Fields

G. 't Hooft, M. Veltman
Nucl. Phys. B44 (1972) 189
1321 citations

24) Pseudoparticle Solutions of the Yang-Mills Equations

A.A. Belavin, A.M. Polyakov, A.S. Schwartz, Yu.S. Tyupkin
Phys. Lett. B59 (1975) 85
1287 citations

25) Supersymmetry, Supergravity and Particle Physics

H.P. Nilles
Phys. Rept. 110 (1984) 1
1264 citations

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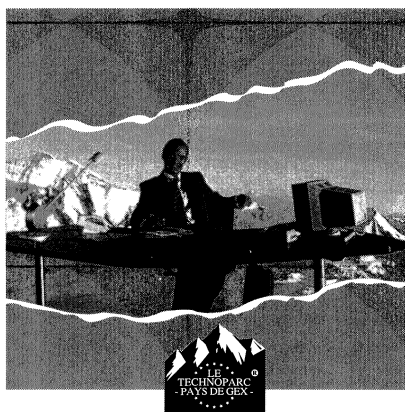
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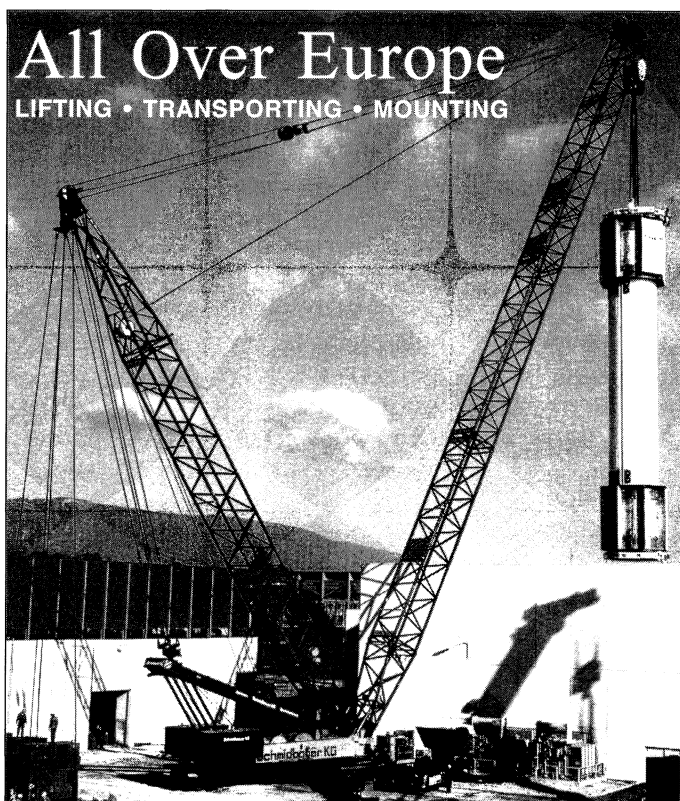
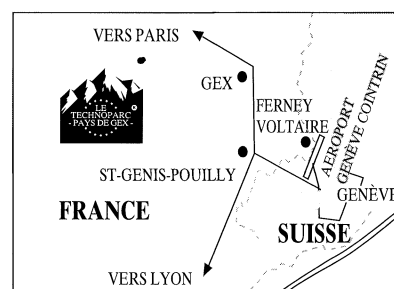
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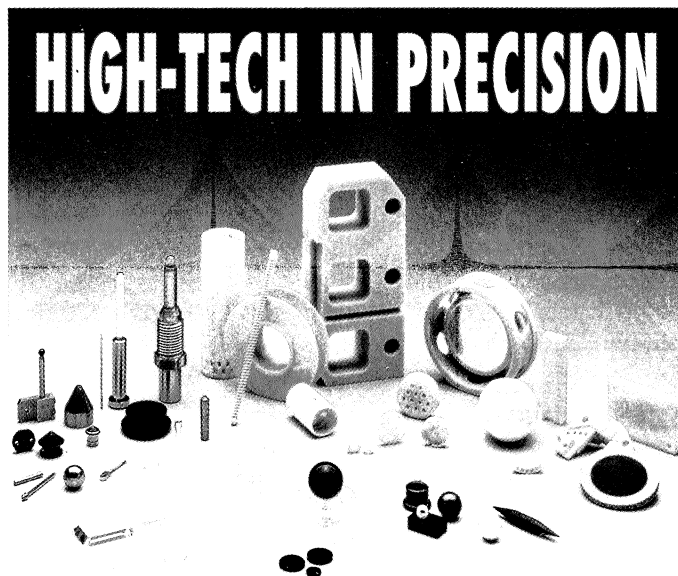
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arguments for establishing a spontaneous symmetry breaking mechanism. Another popular mechanism for symmetry breaking (positions 11 and 15) is 't Hooft's studies of instanton-induced quark interactions. Adler's paper on the fundamental anomalies which drive this idea appears in position 19. Dynamical generation of fermion masses, fermion condensates, and pseudoscalar mesons as Goldstone excitations are described in the Nambu and Jona-Lasinio paper (position 14). In 24th position is Belavin, Polyakov, Schwartz, and Tyupkin's demonstration of instanton solutions.

String ideas - the generalization of zero-dimensional particles to one-dimensional strings in a larger space - is a minor industry among theoreticians and is naturally also well represented. At position 12 is the Belavin, Polyakov, Zamolodchikov paper on the basics of two-dimensional conformal field theory. Two representative fundamental string theory articles are grouped together: Candelas, Horowitz, Strominger, and Witten in position 16 and Polyakov just ten citations away.

The 'hot topics' list of current papers published in the March issue was headed by citations to the Review of Particle Properties. However in the more general list, this review comes in 20th position.

The 1984 opus by Eichten, Hinchliffe, Lane and Quigg (position 21) provided the theoretical motivation for the next generation of proton colliders.

The increasing importance of particle physics ideas in cosmology is underlined by Guth's pioneer paper on the exponential 'inflation' of the early universe, in position 22.

A more complete version of the

table, listing the 50 most cited articles, is posted at SLAC's Web server (Ref. 2).

Information from Hrvoje Galic, SLAC Library Databases

References:

- 1) <http://www-spires.slac.stanford.edu/find/hep>
- 2) <http://www-spires.slac.stanford.edu/find/top40.html>

BEIJING Tau-charm factory workshop

From 5-9 February, an international meeting at the Institute of High Energy Physics (IHEP) in Beijing reviewed the progress on the feasibility study for the Beijing Tau-Charm Factory (BTCF - October 1995, page 8).

The next generation of particle accelerators are pursuing two complementary paths in their quest to crack open the Standard Model: one is the traditional high energy frontier being pushed by machines like the LHC and the linear colliders, and the other is the high precision frontier of the phi, tau-charm and B factories.

Interest in factory machines has grown in recent years since they address fundamental puzzles in the Standard Model such as why are there three fermion families, why do the quarks mix but apparently not the leptons, and what is the origin of CP violation?

The BTCF is designed as a dedicated experimental tool for the

tau lepton and charm quark. In addition to extremely high statistics, its particular strengths are the experimental environment at production threshold, which provides lower backgrounds than other machines, experimental measurement of the backgrounds (by operating the machine below threshold), and access to high-rate calibration sources for the detector (J/psi and psi prime). These and other features should allow tau and charm experiments that are either unique or cannot be performed elsewhere with comparable precision.

In an opening speech at the workshop, Zhou Guang-zhao, President of the Chinese Academy of Sciences, expressed the importance to China of high energy physics and the high regard for the IHEP research programme. With the good experience of Beijing's electron-positron collider, and recognizing the broad and exciting BTCF physics programme, the Chinese Academy of Sciences fully understands the enthusiasm for building the BTCF, and supports the project. He welcomed the active participation of the international high energy physics community in the accelerator and experimental programme.

After the plenary introductory talks, the real work began in the parallel working sessions, with physics groups organized by T. Huang, Joo Sang Kang and A. Pich. Among the initial priority physics goals are CP violation in tau lepton decays, CP violation and mixing in charm decays, the masses of the tau-neutrino and tau leptons, and mapping the spectrum of gluonic particles in charmonium decays. In addition the BTCF would allow precision measurements of the tau lepton and