# MEDAGLIE FIELDS

*Franco Eugeni*


*"Secondo la nostra esperienza fino a oggi, abbiamo il diritto di essere convinti che la natura é la realizzazione di tutto ció che si puó immaginare di piú matematica-mente semplice"(Albert Einstein)*

## INTRODUZIONE.

Tra le tante discipline premiate annualmente con il prestigioso premio Nobel, finanziato dal lascito del famoso chimico svedese Alfred B. Nobel (1833-1896), appare la mancanza di una importante disciplina: precisamente la Matematica. Eppure si tratta di una disciplina che ha allenato menti e scienziati alla concezione critica dell'astratto e che in pari misura ha contribuito altamente al progresso della tecnologia. Non é stato mai chiarito il motivo storico, forse psicologico, che convinse Nobel a non inserire questa disciplina. Secondo alcuni "*gossip*", non sappiamo quanto attendibili, il problema sarebbe nato da alcuni contrasti tra lo stesso Nobel e il matematico connazionale Gosta Mittag Leffler (1846-1927), secondo alcuni a causa di questioni di donne, delle cui emancipazioni Mittag Leffler, era un appassionato difensore e promotore!

Fu così che i matematici istituirono quello che oggi è considerato un premio equivalente: ***la medaglia Fields.***

LE ORIGINI DEL PREMIO

Nel 1924 il matematico canadese John Charles Fields (1863-1932), a parte le sue importanti ricerche sulla teoria delle funzioni algebriche, e fu considerato l'organizzatore della trattazione dello sviluppo delle idee sul tema, sviluppate precedentemente. sulle quali esistevano ochi riferimenti ai risultati e ai metodi di studio. Egli inoltre eccelse come organizzatore di eventi matematici. Nel 1922, Fields propose di ripartire con i Congressi internazionali, dopo la 1° Guerra, e propose di tenere il Congresso Internazionale di Matematica a Toronto, sotto gli auspici della International Mathematical Union. Egli fu in questa occasione un abile politico, e fu in grado di convincere molti oppositori dell'Unione a partecipare al Congresso di Toronto, che ebbe grande successo. Fields trascorse vari mesi in Europa lavorando inesorabilmente per rendere il Congresso di Toronto possibile. Nel suo viaggio ottenne anche significativi finanziamenti che gli permisero di pagare le spese di viaggio per il Canada, ai matematici europei, per partecipare al Congresso Internazionale dei Matematici.

I fondi ottenuti superarono ogni logica previsione, così che la somma residua, a Convegno finito, era ancora notevole, grazie all'abilità persuasiva e manageriale dello stesso Fields.

.Così Fields decise di utilizzare la somma residua per istituire un premio, che consisteva in due medaglie e un compenso da assegnare, negli ipotetici successivi Congressi Internazionali di Matematica, a giovani ricercatori che si fossero distinti nell'eccellenza delle loro ricerche.

Le proposte iniziali sono nate il 24 febbraio 1931. Era tutto pronto nel 1932 quando Fields si recò a Zurigo per presentare la sua proposta di Medaglie. Tuttavia iniziò ad avere problemi di salute nel maggio del 1932, quando iniziò a soffrire di problemi cardiaci. Pochi giorni prima della sua morte, avvenuta nell'anno, egli lasciò scritte le sue volontà e un importo di $ 47000 da aggiungere ai fondi per le medaglie. Egli non visse abbastanza per partecipare al Congresso del 1932, ma le sue idee furono portate avanti dai suoi collaboratori. Approvata l'idea di Fields in occasione del Congresso Internazionale dei Matematici di Zurigo appunto del 1932.


Medaglia Fields in oro, con inciso, su un lato (vedi immagine precedente ) il volto di Archimede e la citazione: "*Transire suum pectus mundoque potiri"*. Sul retro (immagine a sinistra) è l'incisione:

"*Congregati ex toto orbe mathematici ob scripta insignia tribuere"*.

Un premio di 15.000 dollari canadesi è assegnato con ogni medaglia Fields. Le prime Medaglie Fiels furono consegnate al Congresso successivo organozzato ad Oslo nel 1936. Esse sono state nominate "Medaglie Fields", nonostante il desiderio contrario del fondatore.

Il premio sarebbe stato assegnato a matematici di etá non superiore ai quaranta anni, seguendo una idea che fu anche dei Bourbakisti, in riconoscimento appunto di ricerche significative e di eccellenza

NOTA. Fields ricevette importanti onorificenze. È stato eletto fellow borsista alla Royal Society of Canada nel 1907 e nel 1913, fellow della Royal Society of London. Nel 1924 è stato Presidente del Congresso Internazionale dei Matematic di Toronto. È stato vicepresidente del successivo Congresso Internazionale dei Matematici a Bologna del 1928. Ha ricoperto la carica di Presidente del Royal Canadian Institute dal 1919 al 1925. È stato presidente della International Mathematical Union, vicepresidente della British Association per l'avanzamento della scienza. Egli è stato anche eletto membro dell'Accademia russa delle scienze e dell' Istituto di Coimbra. E' stato nominato *Commendatore della Corona d'Italia*, ma dovette rifiutare l'offerta per una legge di divieto del governo canadese nei confronti di titoli del governo italiano.

LE PRIME MEDAGLIE ASSEGNATE

Al Congresso di Zurigo del 1932, che sarebbe stata forse la prima data utile, Fields non partecipò in quanto era stato colpito da una grave malattia e le medaglie non furono assegnate.

Le prime due medaglie Fields, in assoluto, furono assegnate al Congresso di Oslo nel 1936.

A causa della II Guerra, non vi furono altri congressi fino al quello di Harvard del 1950.

Nel 1966, in seguito all'espansione della ricerca matematica, si decise di assegnare altre due medaglie, per un totale di quattro premiati.

**Seguono le schede dei quattro premiati nel 1966.**

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| | Nome: | Michael Francis ATIYAH |
| | Nato il: | 22 Aprile 1929 |
| | A: | Londra |

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|  | Università: | Oxford University |
| Did joint work with Hirzebruch in K-theory; proved jointly with Singer the index theorem of elliptic operators on complex manifolds; worked in collaboration with Bott to prove a fixed point theorem related to the "Lefschetz formula". | | |
|  | Nome : | Paul Joseph COHEN |
| | Nato il : | 2 Aprile 1934 |
| | A: | Long Branch, New Jersey (USA) |
| | Università: | Stanford University |
| Used technique called "forcing" to prove the independence in set theory of the axiom of choice and of the generalized continuum hypothesis. The latter problem was the first of Hilbert's problems of the 1900 Congress. | | |

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|  | Nome: | Alexander GROTHENDIECK |
| | Nato il: | 28 Marzo 1928 |
| | A: | Berlino |
| | Università: | University of Paris |
| Built on work of Weil and Zariski and effected fundamental advances in algebraic geometry. He introduced the idea of K-theory (the Grothendieck groups and rings). Revolutionized homological algebra in his celebrated "Tohoku paper". | | |

# I Premi del 1970

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|  | Nome: | Alan BAKER |
| | Nato il: | 19 Agosto 1939 |
| | A: | Londra |
| | Università: | Cambridge University |
| Generalized the Gelfond-Schneider theorem (the solution to Hilbert's seventh problem). From this work he generated transcendental numbers not previously identified. | | |

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|  | Nome: | Heisuke HIRONAKA |
| | Nato il: | 9 Aprile 1931 |
| | A: | Yamaguchi-ken (Giappone) |
| | Università: | Harvard University |
| Generalized work of Zariski who had proved for dimension <=3 the theorem concerning the resolution of singularities on an algebraic variety. Hironaka proved the results in any dimension. | | |

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|  | Nome: | Serge NOVINOK |
| | Nato il: | 20 Marzo 1938 |
| | A: | Gorki (URSS) |
| | Università: | Belorusskii University |
| Made important advances in topology, the most well-known being his proof of the topological invariance of the Pontrjagin classes of the | | |

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| differentiable manifold. His work included a study of the cohomology and homotopy of Thom spaces. |

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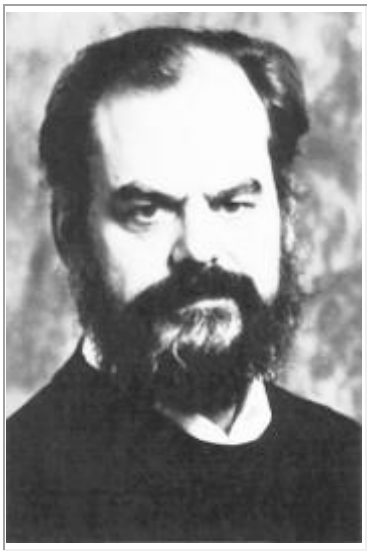
|  | Nome: | John Griggs THOMPSON |
| | Nato il: | 13 Ottobre 1932 |
| | A: | Kansas (USA) |
| | Università: | University of Chicago |
| Proved jointly with W. Feit that all non-cyclic finite simple groups have even order. The extension of this work by Thompson determined the minimal simple finite groups, that is, the simple finite groups whose proper subgroups are solvable. | | |

# I premi (2 medaglie) del 1974

Tra i due matematici premiati spicca l'italiano Enrico Bombieri.

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| | Nome: | Enrico BOMPIERI |

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|  | Nato il: | 26 Novembre 1946 |
| | A: | Milano |
| | Università: | Università di Pisa |
| Major contributions in the primes, in univalent functions and the local Bieberbach conjecture, in theory of functions of several complex variables, and in theory of partial differential equations and minimal surfaces - in particular, to the solution of Bernstein's problem in higher dimensions. | | |

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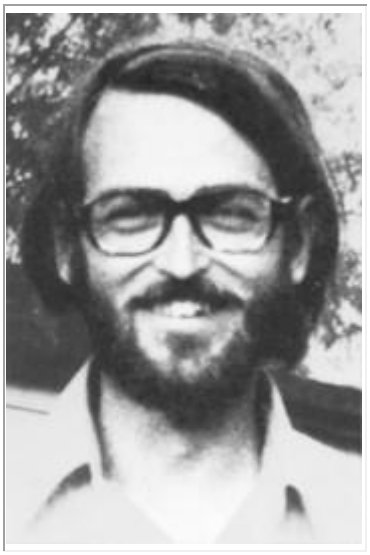
|  | Nome: | David Bryant MUMFORD |
| | Nato il: | 11 Luglio 1937 |
| | A: | Worth, Sussex (Inghilterra) |
| | Università: | Harvard University |
| Contributed to problems of the existence and structure of varieties of moduli, varieties whose points parametrize isomorphism classes of some type of geometric object. Also made several | | |

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| important contributions to the theory of algebraic surfaces. |

# Premi (quattro medaglie) del 1978

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|  | Nome: | Pierre René DELIGNE |
| | Nato il: | 3 Ottobre 1944 |
| | A: | Bruxel |
| | Università: | Institut des Hautes études Scientifiques |
| Gave solution of the three Weil conjectures concerning generalizations of the Riemann hypothesis to finite fields. His work did much to unify algebraic geometry and algebraic number theory. | | |

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| | Nome: | Charles Louis FEFFERMAN |

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|  | Nato il: | 18 Aprile 1949 |
| | A: | Washington D.C. |
| | Università: | Princeton University |
| Contributed several innovations that revised the study of multidimensional complex analysis by finding correct generalizations of classical (low-dimensional) results. | | |

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|  | Nome: | Gregori Aleksandrovitch MARGULIS |
| | Nato il: | 24 Febbraio 1948 |
| | A: | Mosca |
| | Università: | Moscow University |
| Provided innovative analysis of the structure of Lie groups. His work belongs to combinatorics, differential geometry, ergodic theory, dynamical systems, and Lie groups. | | |

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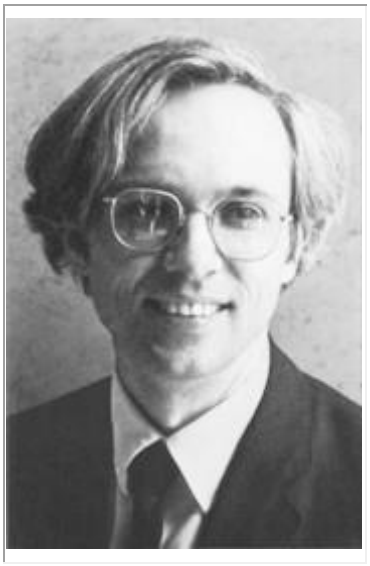
|  | Nome: | Daniel G. QUILLEN |
| | Nato il: | 22 Giugno 1940 |
| | A: | Orange, New Jersey (USA) |
| | Università: | Massachusetts Institute of Technology |
| The prime architect of the higher algebraic K-theory, a new tool that successfully employed geometric and topological methods and ideas to formulate and solve major problems in algebra, particularly ring theory and module theory. | | |

# I premi (quattro medaglie) del 1982

Da questo anno in poi alcuni matematici verranno premiati con il **Premio Nevanlinna**, come nel caso di Robert Tarjan, che fu il primo premiato.

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| | | Nome: | Alain CONNES |
| | | Nato il: | 1 Aprile 1947 |
| | | A: | Darguignan (Francia) |

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|  | | Università: | Institut des Hautes études Scientifiques |
| | Contributed to the theory of operator algebras, particularly the general classification and structure theorem of factors of type III, classification of automorphisms of the hyperfinite factor, classification of injective factors, and applications of the theory of C*-algebras to foliations and differential geometry in general. | | |

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|  | Nome: | William P. THURSTON |
| | Nato il: | 30 Ottobre 1946 |
| | A: | Washington D.C. |
| | Università: | Princeton University |

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| Revolutionized study of topology in 2 and 3 dimensions, showing interplay between analysis, topology, and geometry. Contributed idea that a very large class of closed 3-manifolds carry a hyperbolic structure. |

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|  | Nome: | Shing-Tung YAU |
| | Nato il: | 4 Aprile 1949 |
| | A: | Kwuntung (Cina) |
| | Università: | Institute for Advanced Study |
| Made contributions in differential equations, also to the Calabi conjecture in algebraic geometry, to the positive mass conjecture of general relativity theory, and to real and complex Monge-Ampére equations. | | |

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| | Nome: | Robert Endre Tarjan |

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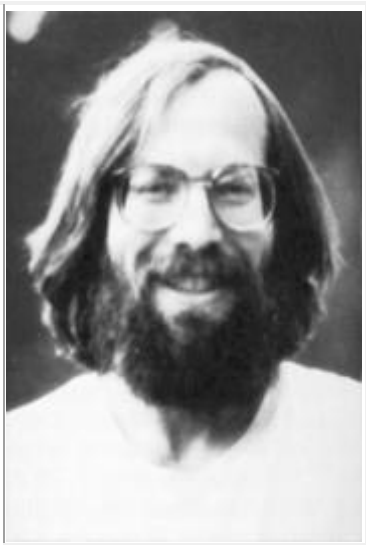
|  | Nato il: | 30 Aprile 1948 |
| | A: | California (USA) |
| | Università: | University of New York |
| Received the first Nevanlinna Prize for outstanding contributions to mathematical aspects of information science. "Pure mathematics enjoys the luxury of studying its constructions, whether finite or infinite, in complete independence of all questions of efficiency" explained Jacob Schwartz, who spoke on Tarjan's work. "By contrast, theoretical computer science must ultimately concern itself with computing engines which operate with limited speed and data storage, and therefore must take efficiency as one of its central concerns. Two closely related activities, algorithm design and algorithm analysis, grow out of this inevitable concern." The awards were announced in 1982 even though the Warsaw Congress was not held until 1983. | | |

# I Premi del 1986

Il Premio Nevanlinna viene assegnato in quest'anno a Leslie Valiant.

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| | Nome: | Simon K. DONALDSON |

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|  | Nato il: | 20 Agosto 1957 |
| | A: | Cambridge (Inghilterra) |
| | Università: | Oxford Univerisy |
| Received medal primarily for his work on topology of four-manifolds, especially for showing that there is a differential structure on euclidian four-space which is different from the usual structure. | | |

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|  | Nome: | Gerd FALTINGS |
| | Nato il: | 28 Luglio 1954 |
| | A: | Gelsenkirchen-Buer (Germania) |
| | Università: | Princeton University |
| Using methods of arithmetic algebraic geometry, he received medal primarily for his proof of the Mordell Conjecture. | | |

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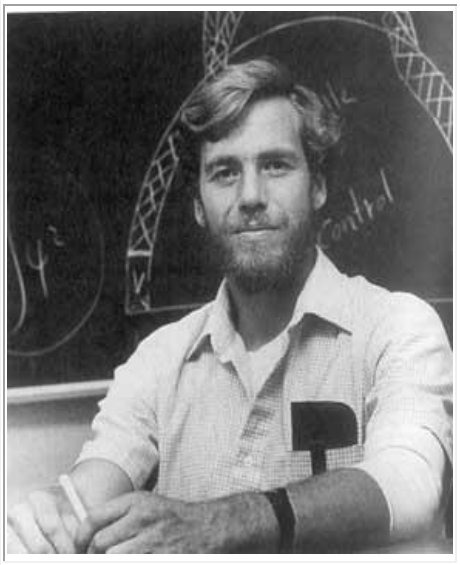
|  | Nome: | Michael H. FREEDMAN |
| | Nato il: | 21 Aprile 1951 |
| | A: | Los Angeles |
| | Università: | University of California, San Diego |
| Developed new methods for topological analysis of four-manifolds. One of his results is a proof of the four-dimensional Poincaré Conjecture. | | |

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|  | Nome: | Leslie VALIANT |
| | Nato il: | 30 Aprile 1948 |
| | A: | California (USA) |
| | Università: | University of New York |
| ``Valiant has contributed in a decisive way to the growth of almost every branch of the fast growing young tree of theoretical computer science, his | | |

theory of counting problems being perhaps his most important and mature work"

Volker Strassen

# I premi del 1990

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| | Nome: | Vaughan JONES |
| | Nato il: | 31 Dicembre 1952 |
| | A: | Gisborne (Nuova Zelanda) |
| | Universitá: | University of California, Berkeley |

In 1984 Jones discovered an astonishing relationship between von Neumann algebras and geometric topology. As a result, he found a new polynomial invariant for knots and links in 3-space. His invariant had been missed completely by topologists, in spite of intense activity in closely related areas during the preceding 60 years, and it was a complete surprise. As time went on, it became clear that his discovery had to do in a bewildering variety of ways with widely separated areas of mathematics and physics .... These included (in addition to knots and links) that part of statistical mechanics having to do with exactly solvable models, the very new area of quantum groups, and also Dynkin diagrams and the

representation theory of simple Lie algebras. The central connecting link in all this mathematics was a tower of nested algebras which Jones had discovered some years earlier in the course of proving a theorem which is known as the "Index Theorem".

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| | Nome: | Vladimir DRINFELD |
| | Nato il: | 1 Novembre 1954 |
| | A: | Kharnov (URSS) |
| | Universitá: | Physical Institute of Kharnov |

Drinfeld's main achievements are his proof of the Langlands conjecture for GL(2) over a functional field; and his work in quantum group theory. Although he only proved a special case of the Langlands conjecture, Drinfeld has introduced important new ideas in his solution and made a real breakthrough. He introduced the idea of an elliptic module in his proof and this notion is leading to a whole new topic within number theory. The interactions between mathematics and mathematical physics studied by Atiyah led to the introduction of instantons - solutions, that is, of a certain nonlinear system of partial differential equations, the self-dual Yang-Mills equations,

which were originally introduced by physicists in the context of quantum field theory. Drinfeld and Manin worked on the construction of instantons using ideas from algebraic geometry.

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| | Nome: | Shige-fumi MORI |
| | Nato il: | 23 Febbraio |
| | A: | Nagoya (Giappone) |
| | Universitá: | University of Kyoto |
| He received this Medal for some remarkable work over a 12 year period. He worked on algebraic manifolds with ample tangent bundles and was the first to prove the Hartshorne conjecture in 1978. This conjecture, posed in 1970, claimed that projective spaces are the only smooth complete algebraic varieties with ample tangent bundles. | | |

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|---|---|---|
| | Nome: | Edward WITTEN |

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|---|---|---|
| | Nato il: | 26 Agosto 1951 |
| | A: | Baltimora, Maryland (USA) |
| | Universitá: | Institute of Advanced Studies, Princeton |

In his study of these areas of theoretical physics, Witten has achieved a level of mathematics which has led him to be awarded the highest honour that a mathematician can receive, namely a Fields Medal. He received the medal at the International Congress of Mathematicians which was held in Kyoto, Japan in 1990. The Proceedings of the Congress contains two articles describing Witten's mathematical work which led to the award. The main tribute is the article by Atiyah, but Atiyah could not be in Kyoto to deliver the address so the address at the Congress was delivered by Faddeev who quotes freely from Atiyah.

# I premi del 1994

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|---|---|---|
| | Nome: | Pierre-Louis Lions |
| | Nato il: | 5 Agosto 1956 |
| | A: | Grasse (Francia) |

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| | Universitá: | Universite de Paris-Dauphine |
| The first area of Lions work that is highlighted by both and is his work on "viscosity solutions" for nonlinear partial differential equations. The method was first introduced by Lions in joint work with M G Crandall in 1983 in which they studied Hamilton-Jacobi equations. Lions and others have since applied the method to a wide class of partial differential equations, the so-called "fully nonlinear second order degenerate elliptic partial differential equations". | | |

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| | Nome: | Jean-Christophe YOCCOZ |
| | Nato il: | 29 Marzo 1957 |
| | A: | Ostende (Francia) |

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| | Universitá: | Universite de Paris-Sud |
| He combines an extremely acute geometric intuition, an impressive command of analysis, and a penetrating combinatorial sense to play the chess game at which he excels. He occasionally spends half a day on mathematical "experiments", by hand or by computer. "When I make such an experiment", he says, "it is not just the results that interest me, but the manner in which it unfolds, which sheds light on what is really going on." Yoccoz has developed a method of combinatorial study of Julia sets and Mandelbrot sets - called "Yoccoz puzzles" - which permit deep insight. | | |

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| | Nome: | Jean BOURGAIN |
| | Nato il: | 28 Febbraio 1954 |
| | A: | Ostende (Belgio) |

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| | Universitá: | Free University of Brussels |
| Bourgain has made outstanding contributions across a whole range of topics in analysis. At the International Congress of Mathematicians in Zurich in 1994, Bourgain received his greatest honour for this work when he was awarded a Fields Medal. Caffarelli addressed the Congress on Bourgain's work which had led to this great honour. Bourgain's work touches on several central topics of mathematical analysis: the geometry of Banach spaces, convexity in high dimensions, harmonic analysis, ergodic theory, and finally, nonlinear partial differential equations from mathematical physics. | | |

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| | Nome: | Efim Zelmanov |
| | Nato il: | 7 Settembre 1955 |
| | A: | Mosca |

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| | Universitá: | Novosibirsk State University |
| In 1994 Zelmanov was awarded a Fields Medal for this work at the International Congress of Mathematicians in Zurich in 1994. Let me explain the background to the restricted Burnside problem, the solution of which was the main reason for the award of the Medal, and also explain how Zelmanov, not a group theorist by training, came to solve one of the most fundamental questions in group theory. | | |

# I premi del 1998

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|---|---|---|
| | Nome: | Richard E. BORCHERDS |
| | Nato il: | 29 Novembre 1969 |
| | A: | San Francisco (USA) |
| | Universitá: | Cambridge University |

Received a medal for his work in the fields of algebra and geometry, in particular for his proof of the so-called Moonshine conjecture. This conjecture was formulated at the end of the '70s by the British mathematicians John Conway and Simon Norton and presents two mathematical structures in such an unexpected relationship that the experts gave it the name "Moonshine".

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| | Nome: | Maxim KONTSEVIC |
| | Nato il: | 20 Novembre 1963 |
| | A: | Lione (Francia) |
| | Universitá: | Institut des Hautes Etudes Scientifiques |

Has established a reputation in pure mathematics and theoretical physics, with influential ideas and deep insights. He has been influenced by the work of Richard Feynmann and Edward Witten. Kontsevich is an expert in the so-called "string theory" and in quantum field theory. He made his name with contributions to four problems of geometry. He was able to prove a conjecture of Witten and demonstrate the mathematical equivalence of two models of so-called quantum gravitation. The quantum theory of gravity is an intermediate step towards a complete unified theory.

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| | Nome: | William Timothy GOWERS |

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| | Nato il: | 20 Novembre 1963 |
| | A: | Michigan (Usa) |
| | Universitá: | Cambridge University |
| Has provided important contributions to functional analysis, making extensive use of methods from combinatorial theory. These two fields apparently have little to do with each other, and a significant achievement of Gowers has been to combine these fruitfully. Functional analysis and combinatorial analysis have in common that many of their problems are relatively easy to formulate, but extremely difficult to solve. | | |

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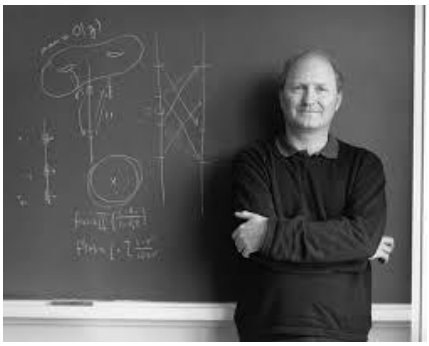
|  | Nome: | Curtis T. McMULLEN |
| | Nato il: | 21 Maggio 1958 |
| | A: | Inghilterra |
| | Universitá: | Harvard University |
| Has been awarded a medal primarily in recognition of his work in the fields of geometry and "complex dynamics," a branch of the theory of dynamic systems, better known perhaps as chaos theory. McMullen has | | |

made contributions in numerous fields of mathematics and fringe areas. He already provided one important result in his doctoral thesis. The question was how to calculate all the solutions of an arbitrary equation. For simple equations it is possible to obtain the solutions by simple rearrangement. For most equations, however it is necessary to use approximation.