Giorgio Parisi Biography

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Giorgio Parisi (August 4, 1948—) was born in Rome, the son of a rentier who later became a civil servant, and of a homemaker. He spent his childhood in Rome, where he completed a scientific *liceo* (1966) at Istituto San Gabriele, a private catholic school.

Parisi then studied physics at La Sapienza – Università di Roma, obtaining a *laurea* (1970) for a thesis on the Higgs boson, under the supervision of Nicola Cabibbo. He has then held a series of appointments as researcher at the Laboratori Nazionali di Frascati (1971-1981), interspersed with extended stays at Columbia University, in New York (1976-1977), Institut des Hautes Etudes Scientifiques, in Bures-sur-Yvette (1976-1977), and Ecole normale supérieure, in Paris (1977-1978). In 1981, he took the chair of theoretical physics at the Università degli Studi di Roma "Tor Vergata", and in 1992 the chair of quantum theories at La Sapienza, where he turned emeritus in 2018. He then served as president of Accademia Nazionale dei Lincei (2018-2021).

Parisi trained as a high-energy physicist, and in the early 1970s was introduced to the theory of critical phenomena through his university friends, Luca Peliti and Marco d'Eramo. However, he did not dwell on the study of statistical mechanics, and spent most of the 1970s instead pursuing questions in quantum field theory—notably formulating the Altarelli-Parisi equations. In 1978, he stumbled upon the failings of the replica trick in the Sherrington-Kirkpatrick (SK) model of spin glasses, and hence embarked on an effort to resolve the associated discrepancy, culminating in a series of seminal works (1979-1980) about replica symmetry breaking. He came back to the physical interpretation of the solution a couple of years later (1983), and in collaboration with Marc Mézard, Miguel Virasoro, Nicolas Sourlas and Gérard Toulouse, later published a description of ultrametric structure of the low-temperature phase of the SK model (1984). With Mézard, he applied the concept of replica symmetry breaking to solve complex optimization problems, and with both Mézard and Virasoro, he summarized a decade of theoretical advances in the book *Spin Glass Theory and Beyond* (1987). Parisi then spent a few years collaboratively developing the APE series of supercomputers to study lattice gauge theories, before diving back into the study of spin glasses. In the early 2000s, he notably helped formulate the cavity approach to Bethe lattices, which led Riccardo Zecchina, Mézard and him to solve the random *k*-SAT problem. Since the mid-1990s, Parisi has also been working on the description of structural glasses, a problem he pursues to this day as part of Simons Collaboration "Cracking the Glass Problem", and has led him to co-author the book *Theory of Simple Glasses* (2020) with Francesco Zamponi and Pierfrancesco Urbani.

Parisi is a fellow of Accademia dei Lincei (1988) as well as a foreign member of the French Académie des sciences (1992), the United States National Academy of Sciences (2003)

and the American Philosophical Society (2013). He also been awarded various prizes, including the following.

- Feltrinelli Prize of Accademia dei Lincei (1986).
- Boltzmann Medal (1992) “for his fundamental contributions to statistical physics, and particularly for his solution of the mean field theory of spin glasses.”
- Italgas prize (1993) “for his relevant contributions given to the development of fundamental and applied physics in several research fields.”
- Dirac Medal of the ICTP (1999) “for his original and deep contributions to many areas of physics ranging from the study of scaling violations in deep inelastic processes (Altarelli–Parisi equations), the proposal of the superconductor's flux confinement model as a mechanism for quark confinement, the use of supersymmetry in statistical classical systems, the introduction of multifractals in turbulence, the stochastic differential equation for growth models for random aggregation (the Kardar–Parisi–Zhang equation) and his groundbreaking analysis of the replica method that has permitted an important breakthrough in our understanding of glassy systems and has proved to be instrumental in the whole subject of Disordered Systems."
- Enrico Fermi Prize (2002) "for his contributions to field theory and statistical mechanics, and in particular for his fundamental results concerning the statistical properties of disordered systems."
- Dannie Heineman Prize for Mathematical Physics (2005) "for fundamental theoretical discoveries in broad areas of elementary particle physics, quantum field theory, and statistical mechanics; especially for work on spin glasses and disordered systems."
- Nonino Prize “An Italian Master of our Time” (2005) for his pioneering work “on complexity, his research of rules and balances inside chaotic systems hypothesizing mathematical instruments, may take to great discoveries in all the fields of human knowledge, from immunology to cosmology.”
- Microsoft Award (2007) for his "outstanding contributions to elementary particle physics, quantum field theory and statistical mechanics, in particular to the theory of phase transitions and replica symmetry breaking for spin glasses. His approach of using computers to corroborate the conclusions of analytical proofs and to actively motivate further research has been of fundamental importance in his field."
- Lagrange Prize (2009) for “the development of the science of complexity in various areas of knowledge.”
- Max Planck Medal (2011) “for his significant contributions in theoretical elementary particle physics and quantum field theory and statistical physics, especially of systems with frozen disorder, especially spin glasses."
- Prix des trois physiciens of Ecole normale supérieure (2011).
- High Energy and Particle Physics Prize – EPS HEPP Prize (2015) “for developing a probabilistic field theory framework for the dynamics of quarks and gluons,

enabling a quantitative understanding of high-energy collisions involving hadrons."

- Lars Onsager Prize (2016) "for groundbreaking work applying spin glass ideas to ensembles of computational problems, yielding both new classes of efficient algorithms and new perspectives on phase transitions in their structure and complexity."
- Pomeranchuk Prize (2018) "for outstanding results in quantum field theory, statistical mechanics and particle theory."
- Wolf Prize (2021) "for being one of the most creative and influential theoretical physicists in recent decades. His work has a large impact on diverse branches of physical sciences, spanning the areas of particle physics, critical phenomena, disordered systems as well as optimization theory and mathematical physics."
- Nobel Prize in Physics (2021) "for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales."

He gave the Loeb Lectures at Harvard (1986), the Fermi lectures at Scuola Normale Superiore de Pisa (1987) and the Celsius lectures at Uppsala university (1993). He has further received a honoris causa doctorate in philosophy from the University of Urbino (2005) and one of science from the University of Extremadura (2019).