



Professor Stefano Fantoni

Curriculum Vitae

Stefano Fantoni is an Italian theoretical physicist, now retired from the International School for Advanced Studies in Trieste (SISSA), still working in the fields of nuclear physics and low temperature physics.

He is considered among the top three Italian scientists in the field of theoretical nuclear physics.

The common denominator of his research was to go beyond the mean-field models in solving the many-body problems that occurs in quantum Bose or/and Fermi systems, characterized by the presence of strong correlations among their components. In that he has given significative improvements to **the many-body theory and in the numerical simulations for quantum fluids**. In the seventies he has been the author, together with Sergio Rosati, of the Power Series cluster theory for strongly interacting fermions, known as FR cluster expansion, and later, of the Fermion Hyper Netted Chain (FHNC) integral equations to compute the FR expansion terms at all orders. Such theories have opened up the modern many-body studies on strongly interacting Fermi systems, such as nuclear matter and Quantum fluids. It is due to him and to V. R. Pandharipande and O. Benhar, the extension at all perturbative orders of the so called Correlated Basis Function (CBF) theory, originally developed by E. Feenberg, and the proof of its renormalizability, as well as the first realistic calculation of the one-body Green's Function and the Response functions of Nuclear matter, largely used to explain the experimental results of electron and neutrino scattering on heavy nuclei. Also of great importance are his studies done together with Kevin Schmidt on Quantum Monte Carlo methods for nuclear systems, and particularly the development of the Auxiliary Field Diffusion Monte Carlo (AFDMC) method, heavily used in nuclear and neutron matter calculations.

He was born in Taranto on 4 June 1945 and attended the high school in Livorno and the university studies in Pisa. He graduated in Physics in 1968 from the Pisa University, and received his PhD degree in 1970 from the **Scuola Normale Superiore**. He first worked as an assistant lecturer at the University of Pisa from the first of November 1970 and then as Associate Professor since 1972. In 1986 he became full professor and three-month later he was given the chair of Nuclear Physics at the University of Lecce.

From 1991 to 2000 he acted as **Director of the Interdisciplinary Laboratory of the International School for Advanced Studies, SISSA** in Trieste. In 2004 he was elected and nominated as **SISSA Director**, duty that he has covered until November 2010. In 2011 **He was nominated as President of ANVUR (the Italian Agency for the evaluation of the university and of the research)** duty that he has covered until 2016. In 2016 he was nominated as **President of the International Foundation for the Development of Freedom of Science (FIT)** in Trieste, duty that he is still covering. In 2022 he has been nominated as **Secretary General for the Administrative affairs of the International Union of Physics and Applied Physics (IUPAP)**

Research Activity

His research activity **has been mainly devoted to quantum liquids** of interest of nuclear and condensed matter phenomena typical of low temperature physics. He started doing research during his graduation thesis in light nuclei with his first article in 1970 on ${}^6\text{Li}$. In the same year he started his studies in many-body theory for strongly interacting quantum Bose and Fermi systems, a field of research that he never abandoned.

In this context he has given four major contributions: (i) the development cluster expansion techniques, known in the literature as the Fantoni-Rosati (FR) cluster expansion, (ii) the derivation of the Fermi Hyper Netted Chain (FHNC) equations, to sum up series of cluster terms (iii) the development of Correlated Basis Function theory (CBF) and, more recently, (iv) the development of a new numerical simulation Monte Carlo method for nuclear systems, known as Auxiliary Field Diffusion Monte Carlo (AFDMC). He has led four research groups: one in Pisa, a second one in Lecce and a third one in Urbana, Illinois, all in the field of nuclear physics and a fourth one in Trieste in Condensed matter physics. He also coordinated a research group made of few Italian and foreign universities and research laboratories in the field of nuclear astrophysics. He has conducted dozens of research projects funded by Italian public institutes (INFN, MIUR, CNR) and American ones (NSF, DOE). **At present he is responsible, together with Prof. Nicola Casagli, President of OGS, of the National Research Project *Trieste Laboratory on Quantitative sustainability***

He has been the Italian representative of nuclear physics in several international bodies dealing with future perspectives in nuclear physics and electron scattering off nuclei at intermediate energies. He has also given contributions to science communication and popularization. His research group at the SISSA Interdisciplinary Laboratory has developed a new communication model based on the existing interconnections and inter-relations amongst communicating agents. The SISSA model has been designed to overcome some of the deficiencies of the traditional top-down model in which communication simply flows from those who know to those who do not know. In connections with this kind of research he founded in 2005 the first PhD school in Science and Society supported by both SISSA and the University of Milan.

He has been co-editor of the series Tessere (Cuen editing company, Naples) (1994–1998); publisher of the e-journal JCOM from its foundation in 2004 and author of various articles in newspapers and books and of a dozen research articles on science communication.

He has published nearly 400 papers, books and invited talks, journal articles, with more than ten thousands citations, an index factor of 48 and an i10-factor of 114.

International experience

He spent several stays abroad as visiting professor: in 1977 at the Niels Bohr Institute of Copenhagen where he developed his theory on momentum distribution in a strongly interacting fermionic system; in 1979 at the Institute für Physik in Köln where he extended his FR and FHNC theory to fluid in the superfluid phase; from 1980 to 1982 and in 1984 at the **Department of Physics, University of Illinois at Urbana–Champaign**, where he worked as a staff member of the physics department and developed the CBF theory; in 1990 at the Jefferson Laboratory (CEBAF) in **Newport News, Virginia**, where he worked on the Green's Function of nuclear matter; in 2000 at the **Theory Center Seattle (Washington)** where he started the studies in astronuclear physics.

He has also been a consultant of the **National Science Foundation and of the European Commission** in the framework of INTAS program; Italian delegate to the OECD Committee Megaforum Science in Nuclear Physics in 1997 and 1998; member of the **Program Advisory Committee for the Jefferson Laboratory at Newport News in Virginia** from 1989 to 1993, when the accelerator was still under construction and the center began to outline its strategic lines of experimental research; member

and then chairman of the Program Advisory Committee of INFN laboratories in Legnaro (Padova) in the period 1991–1996; member of the board of directors of the European Center for Theoretical Studies in Nuclear Physics and related areas (ECT*) in 1993, when it was founded in Villazzano (Trento), until 1995; during the period 2003/2009 he was member of the International Advisory Committee of the Institute for Advanced Studies, Collegium Budapest. Stefano Fantoni has been one of the members in several editorial boards, such as Nuclear Physics A (Elsevier), Advances in Quantum Many-Body Theories (World Scientific) and Recent Progress in Many-Body Theories (Plenum). He organized several international conferences, both in Italy and abroad, and has been referee of several international physics journals. Moreover, his activity on science communication led him to make part of several European committees aimed at this important area, like for instance the VII European Framework Program, Science in Society (2008).

Evaluation and management experience

He was the founder of the Elba International Physics Center (EIPC) which he directed from 1985 to 1992. During this period EIPC acted as the Italian counterpart of the Aspen Center for Physics in Colorado, organizing conferences and workshops funded by local administration and some international research centers. In the period 1992–1993 he took part, as Italian member, together with the Danish nobelist Ben Mottelson and the French scientist Oriol Bohigas, in the Committee nominated to establish the European Centre for Theoretical Physics, ECT*. The center is still in operation in the fields of nuclear physics, astrophysics and condensed matter. From 1991 to 2000 he directed the Interdisciplinary Laboratory of SISSA, a laboratory having the mission of developing and promoting new research areas to be endorsed in SISSA. Within such activity, he founded the Neuroscience sector. In 1994 he founded the School in Science Communication which he directed until 2004. This school has received numerous international awards and has been the first examples in our country of an educational activity on science diffusion. He was also President of FEST, the Trieste Festival of Scientific books and journals in the years 2007 and 2008. He has been the **Director of SISSA from 2004 to 2010** and member of **CRUI, the association of the Rectors of the Italian universities**, in the same period. His direction has been characterized not only by the opening up of SISSA activities to the dialogue with the society but also by the identification, design and construction of the new SISSA location, a building of almost 25000mq, 150000mq in a park dominating the whole Trieste bay, that is able to host the whole educational and research activity of SISSA. He has been nominated as the **President of the International Foundation for the Development of Freedom of Science (FIT)** in Trieste in 2008. In the same year he was nominated from the regional administration of Friuli Venezia Giulia as delegate to the Commission Coordination of universities and research institutions of the Friuli Venezia Giulia. He has also been nominated as the president of the Trieste section of Alliance Française in 2009. Stefano Fantoni has a well-recognized experience on scientific assessment gained during all his career. He was also member of the national committee for the evaluation of the basic research projects (FIRB committee) from 2007 to 2010 and member of the national committee to evaluate scientific museums and projects on popularization of science from 1995 to 1997 and from 2009 to 2010.

He has been the first President of ANVUR (the Italian Agency for the evaluation of the university and of the research) (2011–2016).

He has also been the **Champion of EuroScience Open Forum (ESOF)**, in occasion of the nomination of **Trieste as European City of Science for the year 2020**. He is at present on the board of the EuroScience ESOF committee.

In 2022 he became Secretary General for the Administrative affairs of the International Union of Physics and Applied Physics (IUPAP).

Prizes and awards

The research activity on nuclear physics and, more in general, on the physics of quantum fluids earned him numerous invitations to plenary talks at international conferences. For his contributions to theoretical nuclear physics and for the development of FHNC theory he has awarded the prestigious **international recognition Eugene Feenberg Memorial Medal 2007**, which includes a couple of nobelist in its award list Stefano Fantoni, for his work in science communication has received various awards and recognitions. Among these, he got the **prestigious 2001 Kalinga Prize, awarded by UNESCO**. He also received the Award Piazzano in 2002, to have founded and directed the Master in Science communication; in 2006, the Pirelli International prize for the multimedia initiative Ulysses in the net of science; in 2007, the Capo d'Orlando prize for his activities in science communication.

Finally, Stefano Fantoni has received important awards for his activities in promoting the city of Trieste and Friuli Venezia Giulia, as a center of science and technology. Among these the most important was the Silver Rose Prize from the Merchants Association of Trieste (2008) and **Barcola Prize from the city of Trieste (2010)**.

20 Selected works

- *Fantoni, S.; Rosati, S. (1974). "Jastrow correlations and an irreducible cluster expansion for infinite boson or fermion systems". *Il Nuovo Cimento A.* **20** (1): 179–193.*
- *Fantoni, S.; Rosati, S. (1975). "The hypernetted-chain approximation for a fermion system". *Il Nuovo Cimento A.* **25** (4): 593–615.*
- *Fantoni, S. (1978). "Momentum distribution of Boson and Fermion systems in Jastrow theory". *Il Nuovo Cimento, 44A* (2): 191.*
- *Fantoni, S.; Friman, B.L.; Pandharipande, V.R. (1981). "The imaginary part of the nucleon optical potential in nuclear matter". *Physics Letters B.* **104** (2): 89–91.*
- *Manousakis, E.; Fantoni, S.; Pandharipande, V.R.; Usmani, Q.N. (1983). "Comparative study of three-nucleon potentials in nuclear matter". *Physical Review B.* **28** (7): 3770.*
- *Fantoni, S.; Pandharipande, V.R. (1984). "Momentum distribution of nucleons in nuclear matter". *Nuclear Physics A.* **427** (3): 473–492.*
- *Fantoni, S. (1984). "Linked cluster perturbative expansion in correlated basis theory". *Phys. Rev B* 29(5):2544.*
- *Benhar, O.; Fabrocini, A.; Fantoni, S. (1989). "The nucleon spectral function in nuclear matter". *Nuclear Physics A.* **505** (2): 267–299.*
- *Wang, X.Q.; Fantoni, S.; Tosatti, E.; Yu, Lu; Viviani, M. (1990). "Correlated-basis-function method for fermions on a lattice: The one-dimensional Hubbard model". *Physical Review B.* **41** (16): 11479.*
- *Pederiva, F.; Ferrante, A.; Fantoni, S.; Reatto, L. (1994). "Quantum theory of solid-liquid coexistence and interface in He 4". *Physical Review Letters.* **72** (16): 2589.*
- *Pederiva, F.; Chester, G.V.; Fantoni, S.; Reatto, L. (1997). "Variational study of vacancies in solid 4 He with shadow wave functions". *Physical Review B.* **56** (10): 5909.*
- *Smerzi, A.; Fantoni, S.; Giovanazzi, S.; Shenoy, S.R. (1997). "Quantum coherent atomic tunneling between two trapped Bose-Einstein condensates". *Physical Review Letters.* **79** (25): 4950.*
- *Ciftja, O.; Fantoni, S. (1998). "Fermi-hypernetted-chain study of unprojected wave functions to describe the half-filled state of the fractional quantum Hall effect". *Physical Review B.* **58** (12): 7898.*
- *Schmidt, K.E.; Fantoni, S. (1999). "A quantum Monte Carlo method for nucleon systems". *Physics Letters B.* **446** (2): 99–103.*
- *Moroni, S.; Sarsa, A.; Fantoni, S.; Schmidt, K.E.; Baroni, S. (2003). "Structure, rotational dynamics, and superfluidity of small OCS-doped He clusters". *Physical Review Letters.* **90** (14): 143401.*
- *Gandolfi, F.; Pederiva, F.; Fantoni, S.; Schmidt, K.E. (2007). "Quantum Monte Carlo calculations of symmetric nuclear matter". *Physical Review Letters.* **98** (10): 102503.*

- *Gandolfi, S.; Illarionov, A.Y.; Fantoni, S.; Schmidt, K.E. (2008). "Equation of State of Superfluid Neutron Matter and the Calculation of the S 0 1 Pairing Gap". Physical Review Letters. **101** (13): 132501.*
- *Lovato, A.; Benhar, O.; Fantoni, S.; Illarionov, A.Y.; Schmidt, K.E. (2011). "Density-dependent nucleon-nucleon interaction from three-nucleon forces". Physical Review C. **83** (5): 054003.*
- *Lovato, A.; Benhar, O.; Fantoni, S.; Schmidt, K.E. (2012). "Comparative study of three-nucleon potentials in nuclear matter". Physical Review C. **85** (2): 024003.*
- *Bonaccorsi, A.; Daraio, C.; Fantoni, S.; Folli, V.; Leonetti, M.; Ruocco, G. (2017). " Do social sciences and humanity behave like life and hard sciences?" Scientometrix 112:607.*