

Gianluca Colò

CURRICULUM VITAE

Brief overview

I am currently appointed as a Full Professor at the Department of Physics, University of Milano.

My research activity has been focused on nuclear structure physics, yet with interests in nuclear reactions and the application of nuclear theory methods to atomic and molecular physics: in this respect, I am the author of a monograph on molecular clusters. I have more than 250 publications in refereed journals and conference and school proceedings, with about 7000 citations and a resulting *h*-index equal to 48 (source: Web of Science, January 2023).

My leadership in the field is testified by the fact that I was invited to give an overview of all theoretical activities within nuclear structure in Italy, already in 2002. In 2014, I was invited as a plenary speaker to the yearly conference of the Italian Physical Society (SIF) to give a general talk on low-energy nuclear physics, both experimental and theoretical. I have been invited as well to a large number of international conferences and workshops; in particular, I have been a key speaker at conferences on Collective Motion in Nuclei and on Nuclear Symmetry Energy, I have given review talks and concluding talks in various meetings, and I have been a lecturer in International Summer Schools.

I have served in Scientific and Program Advisory Committees of different laboratories, as detailed below, and in panels to evaluate research proposals.

I am one of the editors of the International Journal of Modern Physics E (World Scientific, Singapore).

I have been invited as an examiner in thesis discussions and also participated in committees for higher qualifications (“HDR, Habilitation à Diriger des Recherches” in France). I have been on advisory committees of several international meetings; in particular, I have been appointed as a principal organiser of a long-term workshop at the Kavli Institute for Theoretical Physics in Beijing, China.

I have many international collaborations in Europe, the USA, and Asia. I lead a group of a few students and post-docs. In 2012, I started to give a new boost to the nuclear theory group. The group includes, besides me, two associate professors (Prof. C. Barbieri and Prof. X. Roca-Maza).

In general, I consider myself committed to promoting nuclear structure research in several manners. I have a strong collaboration with experimental groups, with whom I have co-authored several papers. I have participated in working groups to propose new experimental facilities like IRIDE (for the production of high intensity polarised photon beams) and SPES (a radioactive beam facility now fully financed by INFN).

I regularly teach both at the level of B.Sc. and M.Sc.; lately, I have regularly delivered the course of Nuclear Physics (42 hours in one semester). I consider teaching extremely important, and I am gratified by the high scores students have often given to my lectures. I also provide classes to PhD students, and recently these have been incorporated into a course in common between the PhD schools of Milano and Padova Universities.

Last but not least, I have been involved in continuous collaboration with our Department's direction and helped manage in different ways. In particular, I have contributed to defining the criteria for the evaluation of the Department research; I have been carrying out a project to encourage access to Physics for students with jobs; I have been one of the webmasters and Department seminar coordinator before becoming deputy Director from Oct. 1st, 2017 to Sep. 30th, 2020. I am also a committee member that plans the recruitment of new faculty staff and upgrades of employed staff.

Research interests and main achievements

I am a theoretical physicist, and my focus is on the quantum theory of many-body systems, particularly those composed of nucleons (atomic nuclei, nuclear matter and neutron stars). Nonetheless, I have also been working on electronic systems like molecules, clusters, and solids for some time.

As is well known, nuclei are amenable to an effective theory description in which the effective interaction is related to the specific many-body framework and not immediately transferable to other frameworks. My expertise is in effective forces for self-consistent mean-field and Density Functional Theory. I have contributed to developing new, increasingly accurate functionals. I am the main author of a published computer code for linear response theory (Hartree-Fock plus Random Phase Approximation or RPA) based on Skyrme forces or functionals. I am also the author of the first fully self-consistent charge-exchange RPA formalism.

I have been intensively studying the properties of collective nuclear vibrations and the extraction of the parameters for the nuclear equation of state. Among my main achievements, the determination of accurate values for the nuclear incompressibility from the giant monopole resonance and the density dependence on the symmetry energy from the dipole response should be highlighted.

In general, I have a strong background in the study of isovector nuclear properties: isospin symmetry in nuclei with its breaking and restoration at finite temperature, isospin mixing due to Coulomb and other forces, charge-changing transitions, including those which are relevant for particle physics and astrophysics (β -decay, electron capture and neutrino reactions). Controlling the isovector properties of nuclear models is of paramount importance for the study of exotic nuclei and compact objects like neutron stars. These systems have also been an object of my interest. In most cases, the goal has been to achieve a consistent description of the observed phenomena based on as few free parameters as possible.

I am the author of two review papers on compressional modes and exotic modes of excitation of the atomic nuclei and two review papers on the status of our understanding of specific terms of the nuclear functionals, that is, on tensor terms and isovector vs isoscalar nuclear pairing.

I have worked on pairing properties of nuclei in different manners, e.g. using fully self-consistent quasi-particle RPA calculations. I am the author of the paper that demonstrates for the first time the validity of the dielectric theorem in this case.

I have been the first to develop a fully microscopic model based on Skyrme forces beyond the mean-field, or DFT, description of nuclear properties. This model is based on the particle-vibration coupling (PVC) idea. With various refinements along the years, it has been eventually shown to be able to account satisfactorily for several diverse phenomena related to the fragmentation of single-particle and collective strength; it has been

employed to calculate the nucleon states around an even-even core (low-lying spectroscopy of odd nuclei), the particle-phonon multiplets, the width of giant resonances and their particle- and γ -decay.

I have also worked on simple models for nuclear reactions. However, most of my efforts have been to coupling microscopic nuclear structure models with realistic descriptions of the reaction mechanism (for instance, adapting the RPA input for Distorted Wave Born Approximation calculations).

Higher education

- M.Sc. in Physics (it. Laurea in Fisica), 1989, Università degli Studi di Milano, 110/110 *cum laude* (thesis: "Neutron direct decay from the nuclear giant resonances", advisors: R.A. Broglia, P.F. Bortignon, A. Bracco)
- PhD in Physics, 1992, Università degli Studi di Milano (thesis: "Microscopic structure of the nuclear giant resonances", supervisor: R.A. Broglia)

Professional record

- Post-doctoral position, 10-12/1993, ECT* (European Center for Theoretical Nuclear Physics and Related Areas), Trento, Italy
- Post-doctoral position, 1994, IPN (Institut de Physique Nucléaire), Orsay, France. Contract within the CEE-supported network "Many-Body Theory of correlated fermion systems."
- Post-doctoral position, 01-06/1995, Università degli Studi di Milano
- Assistant Professor, 06/1995-09/2006, Università degli Studi di Milano
- Associate Professor, 10/2006-02/2017, Università degli Studi di Milano
- Full Professor, 03/2017-present, Università degli Studi di Milano

Bibliometric data

I am the author of more than 250 scientific publications and one book, having about 7000 citations and an h -index equal to 48 (source: ISI Web of Science, January 2023).

The complete list of papers is available at: www0.mi.infn.it/~colo/listapub.pdf

Talks

More than 130 invited talks and seminars in 2004-2022, including summary talks in large conferences.

Visiting positions

- Visiting researcher, 2000, RIKEN (Wako-City), University of Aizu-Wakamatsu, Tohoku University (Sendai) and Yukawa Institute (Kyoto), Japan.
- Visiting professor (fr. Professeur invité), 2015, Université Claude Bernard, Lyon (France)
- Visiting professor at Yukawa Institute for Theoretical Physics (YITP), Kyoto University (Japan), 2022-23.

Teaching experience

Because of my strong research background, I have been assigned the Nuclear Physics course of the M.Sc. program. Nonetheless, I have been teaching all aspects of general physics, both in general and laboratory courses. I am currently teaching the general electromagnetism course (compulsory for B.Sc. students in Physics in their second year).

- General Physics II, 1995-2001, Exercises and exams (B.Sc. students in Physics)
- Experimental Physics I, 1999-2001, 50 hours course (B.Sc. students in Physics)
- Physics Laboratory I, 2001-2006, 50 hours course (B.Sc. students in Physics)
- Nuclei under extreme conditions, 2004-2009, 40 hours course (M.Sc. students in Physics)
- General Physics, 2007-2010, 48 hours course (B.Sc. students in Computer Science)
- Nuclear Physics, 2010-present, 48 hours course (M.Sc. students in Physics)
- Electromagnetism, 2011-present, 80 hours course (B.Sc. students in Physics)

I have been the supervisor of many B.Sc. and M.Sc. works and several PhD students.

Institutional roles in the University

- Project Coordinator, 2001-2002, Teaching project “Appropriate teaching conditions for working students.”
- Member of the Direction Board of the Department, 2001-2004
- Member of the Direction Board of the Department, 2010-2017 (special delegate of the Director for informatics systems, web pages, and seminars)
- Deputy Director, 10/2017-9/2020.

Serving in National and International Committees

- Member of the Program Advisory Committee (B-PAC) for the Ring Cyclotron, RCNP, Osaka, Japan during 2008-2010
- Member of the Study Group for the special project INFN-SPES (Selective Production of Exotic Species, i.e. a new Radioactive Beam Facility to be complete at Legnaro, Italy) from May 2008 to December 2018
- Member of the Program Advisory Committee (PAC) of LNL (Laboratori Nazionali di Legnaro, Italy) from January 2012 to 2017
- Member and Chair of the NCN panel of evaluators (National Science Center, Poland)

- Member of the Editorial Board of International Journal of Modern Physics E

Referee and evaluator

- Referee for many international journals: Nature, Reviews of Modern Physics, Physical Review C, Physical Review Letters, Physical Review B, Journal of Physics G, Nuclear Physics A, Physics Letters B, Computer Physics Communications, European Physical Journal A, European Physics Letters, Progress in Theoretical Physics, Acta Physica Polonica, International Journal of Physics E, Physica Scripta, Classical and Quantum Gravity, Canadian Journal of Physics.
- Project evaluator for the European Commission, Italian Ministry for Education and Research (MIUR), Japan Society for the Promotion of Science (JSPS), Agence National de la Recherche (ANR, France), National Science Center (NCN, Poland), Croatian Science Foundation (HRZZ), NAFOSTED (Vietnam).

Research Project coordination

- Local coordinator of the network “Asia Link in Nuclear Physics and Astrophysics”, involving eight institutions in Italy, France, Germany, P.R. China and Vietnam, granted by the EU.
- Deputy general coordinator of the network “Many-body theory of nuclear systems and implications on the physics of neutron stars”, granted by the Italian Ministry for Education and Research.
- Local coordinator of the network “ENSAR2”, granted by the EU.
- Local coordinator of the network “EUROLABS”, granted by the EU.

Conference and workshop organisation

- “Topical Conference on Giant Resonances”, Varenna, May 11th-16th, 1998
- “ISGDR mini-workshop”, Milano, March 16th, 2002
- “Nuclear Response Under Extreme Conditions”, Trento, October 20th-24th, 2003
- Long-term workshop “Dynamics and Correlations in Exotic Nuclei (DCEN2011)”, Kyoto (Japan), September 20th-October 28th, 2011
- “From nucleon structure to nuclear structure and compact astrophysical objects”, Beijing, June 11th-July 20th, 2012 (Chair)
- International Nuclear Physics Conference INPC2013, Florence (Italy), June 2nd-7th, 2013
- Topical Workshop on Modern Aspects in Nuclear Structure, Bormio (Italy), February 19th-22nd, 2014
- Second SPES International Workshop, Legnaro (Italy), May 26th-28th, 2014
- Topical Workshop on Modern Aspects in Nuclear Structure, Bormio (Italy), February 22nd-26th, 2016
- Third SPES International Workshop, Legnaro (Italy), October 10th-12th, 2016
- Topical Workshop on Modern Aspects in Nuclear Structure, Bormio (Italy), February 19th-25th, 2018

- 9th International Symposium on Nuclear Symmetry Energy (NuSYM2019), Sep. 30th-Oct. 4th, 2019, Da Nang City (Vietnam).
- Vth Topical Workshop on Modern Aspects in Nuclear Structure, February 4th-9th, 2020, Bormio (Italy).
- YIPQS long-term workshop on Mean-field and Cluster Dynamics in Nuclear Systems (MCD2022), Kyoto (Japan), May 9th-June 17th, 2022.
- Quinto incontro nazionale di Fisica Nucleare INFN2022, May 9th-11th, 2022, Lab. Nazionali del Gran Sasso (Italy).
- Shapes and Symmetries in Nuclei: from Experiment to Theory (SSNET'22), Orsay (France), May 30th-June 3rd, 2022.
- Domestic Molecule Type Workshop "Fundamentals in density functional theory" 9th-20th December 2022, YITP Kyoto (Japan).
- Topical Workshop on Modern Aspects in Nuclear Structure, Bormio (Italy), February 6th-11th, 2023