Curriculum vitae Giacomo Roati

PERSONAL INFORMATION

Roati Giacomo - ID ORCID: orcid.org/0000-0001-8749-5621

Date of birth: 1/11/1974 - Nationality: Italian

URL for web site: http://quantumgases.lens.unifi.it/exp/li

EDUCATION

2003 PhD in Physics (*cum laude*), Department of Physics University of Trento, Italy
1999 Master in Physics (*cum laude*), Department of Physics University of Milan, Italy

CURRENT POSITION(S)

2018 – Director of Research at CNR-INO, Italy
2020 – Visiting scientist at Yale, New Haven USA (Prof. N. Navon)
2018 – Visiting scientist at UNAM, Mexico City (Prof. J. H. Seman)
2005 – Visiting scientist at University of Sao Carlos, Brazil (Prof. V. Bagnato)

PREVIOUS POSITIONS

2010 – 2018 Senior Researcher at CNR-INO
2005 – 2010 Fixed-term Researcher, University of Florence and Centro INFM- BEC of Trento, Italy
2010 Visiting research fellow (February-June), MIT, Cambridge USA (Prof. M. Zwierlein)
2006 Visiting scientist (January-March), JILA, Boulder USA (Prof. E. Cornell)
2003 – 2005 Post-Doc at the European Laboratory for Non-Linear Spectroscopy (LENS), Florence, Italy

FELLOWSHIPS AND AWARDS

2010 – Associated Fellow to LENS, University of Florence, Italy
2014 – National Scientific Qualification for Full Professor position (Condensed Matter Physics)
2012 – 2017 ERC-Consolidator Grant QuFerm2D, Quantum Simulation of Two-Dimensional Fermionic Systems (ERC-2012-StG)
2002 Award as best oral contribution at the SIF (Italian Physics Society) Conference
2000 Award as young researcher at Italian National Institute of Physics of Matter Meeting

SCIENTIFIC INTEREST

My scientific interests regard quantum simulation with strongly-correlated atomic Fermi systems. As Research Director, I have however the ambition of fostering the cooperation of the different scientific areas of CNR-INO, supporting and conducting cross-fertilisation actions and projects.

During my **ERC Consolidator Grant** (2012-2017), I have set up a new experimental machine that produces ultracold Fermi gases of 6-Lithium atoms. I have developed new cooling techniques that allow an efficient production of Fermi superfluids and ultracold Fermi spin mixtures (Phys. Rev. A 90, 043408 (2014)), and this scheme is now replicated in many experiments worldwide. Our machine exploits the most advanced optical diagnostic and manipulation tools. In particular it features a large optical access to detect the atomic cloud with high resolution (below 1 μm). We can measure not only global but also local quantities and we can extract the properties of the many-body wave functions. At the same time, we have the possibility to image topological defects and their dynamics even in-situ (see Nature 600, 64, (2021)), which is a fundamental diagnostic tool for this proposal. My group is pioneering, first in Italy and among the first in Europe, the **manipulation of ultracold matter through arbitrarily tailored optical potentials**. These are created using dynamical devices such as digital micromirror devices (DMD) and they are imprinted with similar sub-micron resolution through the microscope objective. We can produce ordered and disordered structures, mesoscopic channels, barriers, with sizes comparable with the correlation lengths of our atomic gases (~500 nm). This feature allows for

studying the onset of quantum dynamics in the transport of superfluids or spin. In the last years my research activity has been indeed focussed on the study of quantum transport phenomena in such strongly-correlated Fermi systems. In particular, with my group I have investigated the Josephson dynamics both in the AC (Science, 350, 1505, (2015)) and DC regimes (Science 369, 84 (2020)), disclosing the **effects of dissipation in the superfluid dynamics** (Phys. Rev. Lett. 120, 025302 (2018) and Phys. Rev. Lett. 126, 055301 (2021)). At the same time, we have investigated **spin transport in repulsive Fermi gases**, attacking with new approaches the long-sought and still debated Stoner ferromagnetic instability (Nature Physics 13, 704709 (2017), Phys. Rev. Lett. 118, 083602 (2017), Phys. Rev. Lett. 121, 253602 (2018)).

Since the last year, my group is exploring **the dynamics of topological defects** quasi-two dimensional homogenous Fermi gases, to study new and exciting phenomena in disparate systems in nature. In particular, in such layered Fermi superfluids, we have very recently realised a programmable quantum vortex collider platform (Nature 600, 64 (2021)). This experimental scheme is unique. It will allow the study of vortex dynamics with an unprecedented degree of controllability, giving the possibility of addressing collisions, trajectories and annihilation processes and vortex-sound interactions, comparing directly them with numeric.

Since 2005, I actively collaborate with **Prof. V. S. Bagnato** of the University of Sao Carlos (Brazil) in **studies of quantum turbulent regime** in atomic BEC. I have participated in the setting up of the experimental apparatus achieving the first Bose-Einstein condensate of Latin America. We have reported out the first observations of quantum turbulence phenomena in atomic Bose-Einstein condensates, which is considered a milestone in our field, followed by other publications in this topic.

I collaborate with Prof. Jorge Seman at the UNAM University in Mexico City. We have recently completed the realisation of the experimental apparatus, observing the first superfluid Fermi gas of Latin America. More recently, I have started a long-term collaboration with Prof. N. Navon at Yale University, USA, on the study of the out-of-equilibrium dynamics of homogeneous strongly-correlated Fermi systems.

I currently conduct individual research and lead an experimental group at CNR-INO laboratory at LENS, Florence. One of my main principles of team management is the development of the researchers' talents and the maximum valorisation of their contribution in the group's results. This has attracted in the past 10 years 2 Marie Skłodowska-Curie Fellows (F. Scazza, W.J. Kwon) and has lead three team members to obtain an ERC Starting Grant (W. Kwon, F. Scazza, M. Zaccanti).

Bibliometrics indices

ISI WoS: h-index 34, number of citations 6100 w/o self-citations
Google Scholar: h-index 45, number of citations 11200
Scopus: h-index 36, 7000 citations

I am co-author of more than 62 publications on peer-reviewed journals (excluding the Conference Proceedings), among which 19 Phys. Rev. Lett., 1 Phys. Rev. X, 4 Science, 3 Nature and 3 Nature Physics.

Five selected publications:

1) G. Del Pace, K. Xhani, A. Muzi Falconi, M. Fedrizzi, N. Grani, D. Hernandez Rajkov, M. Inguscio, F. Scazza, W. J. Kwon, **G. Roati**, Phys. Rev. X 12, 041037 (2022), *Imprinting persistent currents in tunable fermionic rings*

2) W. J. Kwon, G. Del Pace, K. Xhani, L. Galantucci, A. Muzi Falconi, M. Inguscio, F. Scazza and **G. Roati**, Nature 600, 64 (2021)*, Sound emission and annihilations in a programmable quantum vortex collider*

3) G. Del Pace, W.J. Kwon, M. Zaccanti, **G. Roati**, and F. Scazza, Phys. Rev. Lett. 126, 055301 (2021), *Tunneling Transport of Unitary Fermions across the Superfluid Transition*

4) W. J. Kwon, G. Del Pace, R. Panza, M. Inguscio, W. Zwerger, M. Zaccanti, F. Scazza and **G. Roati**, Science 369, 84 (2020), *Strongly correlated superfluid order parameters from dc Josephson supercurrents*

5) K. Xhani, E. Neri, L. Galantucci, F. Scazza, A. Burchianti, K.L. Lee, C. F. Barenghi, A. Trombettoni, M. Inguscio, M. Zaccanti, **G. Roati**, N. P. Proukakis, Phys. Rev. Lett. 124, 045301 (2020), *Critical transport and vortex dynamics in a thin atomic Josephson junction*

Curriculum vitae Andreas Trenkwalder

PERSONAL INFORMATION

Andreas Trenkwalder, ID ORCID: https://orcid.org/0000-0002-3066-5025

EDUCATION

2011	PhD in Physics, University of Innsbruck
2008	Master in Physics, University of Innsbruck

CURRENT POSITION

since 2012	Researcher at CNR-INO

PREVIOUS POSITIONS / OCCUPATIONS

2011-2012	Postdoc at FeLiKx experiment of Rudolf Grimm, IQOQI Innsbruck, Austria
2004	research technician at BioMEM group of Oliver Klett, Uppsala, Sweden
2003-2004	Erasmus year in Uppsala, Sweden
1994-2001	CD production engineer in Ötztal Bahnhof, Austria
1993-1994	construction engineer in Nütziders, Austria

SCIENTIFIC INTERESTS

- Experimental physics with ultracold quantum gases of Fermions and Bosons
- Experiment control system and technical devices to control quantum gases experiments

SELECTED PUBLICATIONS

1) A. Ciamei, S. Finelli, A. Trenkwalder, M. Inguscio, A. Simoni, and M. Zaccanti, Exploring Ultracold Collisions in 6Li−53Cr Fermi Mixtures: Feshbach Resonances and Scattering Properties of a Novel Alkali-Transition Metal System, Phys. Rev. Lett. 129, 093402 (2022), https://doi.org/10.1103/physrevlett.129.093402

2) A. Trenkwalder, M. Zaccanti, and N. Poli, A flexible system-on-a-chip control hardware for atomic, molecular, and optical physics experiments. Rev. Sci. Instrum 92 (10), 105103 (2021) https://doi.org/10.1063/5.0058986

3) A. Trenkwalder, G. Spagnolli, G. Semeghini, S. Coop, M. Landini, P. Castilho, L. Pezzè, G. Modugno, M. Inguscio, A. Smerzi, and M. Fattori, Quantum phase transitions with parity-symmetry breaking and hysteresis, Nature Physics 12, 826–829 (2016), https://doi.org/10.1038/nphys3743

4) G. Semeghini, M. Landini, P. Castilho, S. Roy, G. Spagnolli, A. Trenkwalder, M. Fattori, M. Inguscio and G. Modugno, Measurement of the mobility edge for 3D Anderson localization, Nature Physics 11, 554–559 (2015), https://doi.org/10.1038/nphys3339

5) C. Kohstall, M. Zaccanti, M. Jag, A. Trenkwalder, P. Massignan, G. M. Bruun, F. Schreck, and R. Grimm, Metastability and coherence of repulsive polarons in a strongly interacting Fermi mixture, Nature, 485, pages 615–618 (2012), https://doi.org/10.1038/nature11065

Curriculum Vitae Luca Tanzi

PERSONAL INFORMATION

Tanzi Luca - ORCID: 0000-0002-1933-5092 - Researcher ID: M-1809-2014

Date of birth: 09/08/1985

Nationality: Italian

URL for web site: http://quantumgases.lens.unifi.it/exp/dy

EDUCATION

Early 2014	PhD in "Atomic and Molecular Spectroscopy" Dipartimento di Fisica e Astronomia, Università di Firenze/LENS, Italy Supervisor: Giovanni Modugno
Early 2010	Master in Physics (cum laude) Dipartimento di Fisica e Astronomia, Università di Milano, Italia

CURRENT POSITION(S)

2023 –	Researcher (II livello) at CNR-INO

PREVIOUS POSITIONS

2019 – 2022	Researcher (III livello) at CNR-INO, Pisa Unit (Pisa, Italy)
2017 – 2019	Postdoc at Dipartimento di Fisica e Astronomia, Università di Firenze, Italy
2014 – 2017	Postdoc at ICFO – The Institute of Photonic Sciences, Barcelona, Spain
2014	Postdoc at Dipartimento di Fisica e Astronomia, Università di Firenze/LENS, Italy

FELLOWSHIPS AND AWARDS

2023	PRIN 2022 Grant, Dipolar Quantum Simulator of Topological Phases (DiQuT)
2020	"Giovani Ricercatori 2020" Award, Gruppo 2003 per la Ricerca Scientifica, Italy
2017 – 2019	Postdoc fellowship at Università di Firenze, Italy
2014 – 2017	Postdoc fellowship at ICFO, Barcelona, Spain
2014	Postdoc fellowship at LENS, Università di Firenze, Italy
2013	EPL Presentation Award at the "Disorder in Condensed Matter and Ultracold Atoms" conference, Varenna, Italy

RESEARCH INTERESTS

My research consists mainly of frontier experiments on quantum phenomena in ultracold gases. My current focus is twofold: the study of exotic quantum phases in dipolar systems and the realization of novel quantum computing schemes using Rydberg atoms in tweezer arrays.

Detailed research activities

2024 – present: **Quantum information with neutral atoms in optical tweezers**

I am currently leading the construction of a new experimental setup to trap Rydberg atoms in optical tweezers for quantum information purposes at the Università di Firenze/CNR-INO.

2016 – present: **Supersolids**

Since 2017, I have been working at the Università di Firenze/CNR-INO, as a post-doc (2017-2019) and as a permanent researcher (from 2019) in the group of Prof. Giovanni Modugno. In 2019, I discovered a new quantum phase of matter in a quantum gas of strongly magnetic atoms: the supersolid [Phys. Rev. Lett. 122, 130405 (2019)]. For sufficiently strong dipolar interactions, a Bose gas of trapped magnetic atoms enters a novel quantum phase, stabilized purely by quantum fluctuations, that simultaneously exhibits solid and superfluid properties. This work has attracted considerable interest from the scientific community (see for example the commentaries Physics 12, 38, Nature 569, 494 and Nature Physics 15, 986) and has been successfully replicated by competing groups. More recently, I have characterized the supersolid phase by testing its exotic properties in several ways [Nature 574, 382-385 (2019); Science 371, 1162-1165 (2021);

Phys. Rev. X 12, 021019 (2022), Nature (2024)]. Based on these results, I have been awarded the prestigious Italian "Giovani Ricercatori 2020" prize.

2013 – 2017: **Quantum liquids**
I did my first long-term postdoc at ICFO (Barcelona, Spain) in the ultracold quantum gases group of Prof. Leticia Tarruell. I played a crucial role in the discovery of a novel phase of matter: a liquid quantum droplet stabilized by pure quantum many-body effects in a mixture of two Bose-Einstein condensates with controllable interactions [Science 359, 301-304 (2018), Phys. Rev. Lett. 120, 135301 (2018)]. These experiments open a new exciting research topic on bulk systems stabilised by beyond mean field effects: our results have been highlighted in Science 359, 274-275 (2018), Nature Physics 14, 211-212 (2018) and Physics Today 72, 4, 46 (2019).

2010 – 2014: **Disordered quantum systems**
After graduating from the Università degli Studi di Milano (Italy), I did my Ph.D. in the "Quantum Gases" group at LENS (Firenze, Italy), in the potassium laboratory of Prof. Giovanni Modugno. I used a Bose-Einstein condensate with tunable interaction in a controllable disordered optical potential to study several key phenomena arising from the subtle interplay of disorder and interaction in quantum systems. My main results are the observation of interaction-induced anomalous diffusion in initially Anderson-localised wave packets [Phys. Rev. Lett. 106, 230403 (2011)] and the observation of a finite-temperature Bose-glass phase [Phys. Rev. Lett. 113, 095301 (2014), Phys. Rev. Lett. 111, 115301 (2013)].

Skills on quantum gases experiments
Since the beginning of my career, I have worked on three different cold atom experiments and contributed to the construction of two of them: the Bose mixing experiment of potassium atoms at ICFO Barcelona [Phys. Rev. A 98, 062712 (2018)], the dipolar dysprosium BEC experiment at CNR-INO Pisa [Phys. Rev. A 97, 060701(R) (2018)]. I have extensive experience in the construction of experimental apparatus to produce quantum degenerate gases of potassium and dysprosium isotopes. I have acquired skills in several topics: quantum gases, optical lattices, disordered systems, etc. on the scientific side, and optics, programming, electronics, etc. on the technical side.

PUBLICATION RECORD
Since 2011, I have co-authored 18 publications (7 as first author) in high-impact, peer-reviewed journals, including: 2 Nature, 2 Science, 1 Physical Review X, 5 Physical Review Letters.
Web of Science (May 2024): 1687 citations; H-index 16
Google Scholar (May 2024): 2611 citations, H-index 16

Five selected publications:

1. G. Biagioni, N. Antolini, B. Donelli, L. Pezzè, A. Smerzi, M. Fattori, A. Fioretti, C. Gabbanini, M. Inguscio, **L. Tanzi**, G. Modugno, *Measurement of the superfluid fraction of a supersolid by Josephson effect*, Nature 629, 773–777 (2024).
2. **L. Tanzi**, J. G. Maloberti, G. Biagioni, A. Fioretti, C. Gabbanini, and G. Modugno, *Evidence of superfluidity in a dipolar supersolid from non-classical rotational inertia*, Science 371, 1162-1165 (2021).
3. **L. Tanzi**, S. M. Roccuzzo, E. Lucioni, F. Famà, A. Fioretti, C. Gabbanini, G. Modugno, A. Recati, and S. Stringari, *Supersolid symmetry breaking from compressional oscillations in a dipolar quantum gas*, Nature 574, 382-385 (2019).
4. **L. Tanzi**, E. Lucioni, F. Famà, J. Catani, A. Fioretti, C. Gabbanini, G. Modugno, *Observation of a Dipolar Quantum Gas with Metastable Supersolid Properties*, Phys. Rev. Lett. 122, 130405 (2019).
5. C. R. Cabrera*, **L. Tanzi***, J. Sanz, B. Naylor, P. Thomas, P. Cheiney, L. Tarruell, *Quantum liquid droplets in a mixture of Bose-Einstein condensates*, Science 359, 301-304 (2018).

Luca Tanzi
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