

# Giacomo Bighin

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## Curriculum vitæ

### Personal information

Date of birth 19th June, 1987  
Address Institut für Theoretische Physik, Universität Heidelberg  
Philosophenweg 19, 69120 Heidelberg, Germany  
E-mail [bighin@thphys.uni-heidelberg.de](mailto:bighin@thphys.uni-heidelberg.de)  
Nationality Italian  
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### Employment

November 2020-  
-present **Postdoctoral researcher**, *Institute for Theoretical Physics (ITP) and STRUCTURES Excellence Cluster, University of Heidelberg, Germany.*  
In November 2020, I joined the group of Prof. Tilman Enns at the Institute for Theoretical Physics (ITP) of University of Heidelberg as a postdoctoral researcher.

September 2016-  
-October 2020 **Postdoctoral researcher**, *IST Austria, Klosterneuburg, Austria.*  
In September 2016 I joined the Theoretical Atomic, Molecular, and Optical Physics group at IST Austria, led by Prof. Mikhail Lemeshko, supported by a Lise Meitner Fellowship of the Austrian Science Fund (FWF), project nr. M2641-N27.

### Education

April 2016 **Ph.D. in Physics**, *University of Padua, Padua, Italy.*  
Adviser: Prof. Luca Salasnich.  
Thesis title: “*Mean field and fluctuations for fermionic systems: from ultracold Fermi gases to cuprates*”.

September 2012 **Master’s Degree in Physics**, *University of Padua, Padua, Italy.*  
Adviser: Prof. Pieralberto Marchetti.  
Thesis title: “*A gauge approach to superfluid density in high- $T_c$  cuprates*”, graduation score 110/110 *cum laude* (full marks with honors, the highest score in the Italian system).

July 2009 **Bachelor’s Degree in Physics**, *University of Padua, Padua, Italy.*  
Adviser: Prof. Enzo Orlandini.  
Thesis title: “*Relaxation dynamics for a polymer subjected to extensive forces*”.

July 2006 **High school diploma (maturità classica)**, *Liceo “G. Veronese”, Chioggia, Italy.*

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## Other research and work experience

- April-June 2014 **TQC Group, University of Antwerp, Antwerp, Belgium.**  
Research visit in the group of Prof. Jacques Tempere.
- July-September 2011 **U.S. Department of Energy — Fermilab, Batavia, IL, U.S.A.**  
Intern, Particle Physics Division.

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## Honors, awards and grants

- January 2019 Lise Meitner Fellowship of the Austrian Science Fund (FWF), ~170,000€, for the project “*A path-integral approach to composite impurities*”, project nr. M2641-N27.
- Summer 2016 FFG (Austria Research Promotion Agency) Career Grant, ~2,000€.
- January 2013 Full Ph.D. scholarship from INFN (Istituto Nazionale di Fisica Nucleare), ~40,000€.

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## Publications

Pre-prints, under review and in preparation:

- **G. Bighin**, Q.P. Ho, M. Lemeshko, T.V. Tscherbul, “*Diagrammatic Monte Carlo for electronic correlation in molecules: high-order many-body perturbation theory with low scaling*”, *arXiv:2203.12666*, submitted to Phys. Rev. Lett.
- **G. Bighin**, and T. Macrì, “*A polaron on the surface of a sphere*”, in preparation.
- **G. Bighin**, A. Volosniev, L.A. Peña Ardila, “*Non-equilibrium dynamics of dipolar polarons*”, in preparation.

Published in peer-reviewed journals:

21. I.N. Cherepanov, **G. Bighin**, C.A. Schouder, A.S. Chatterley, H. Stapelfeldt, M. Lemeshko, “*A simple model for high rotational excitations of molecules in a superfluid*”, *arXiv:2201.13030*, accepted for publication in New J. Phys.
20. **G. Bighin**, A. Burchianti, F. Minardi, T. Macrì, “*An impurity in a heteronuclear two-component Bose mixture*”, accepted for publication in Phys. Rev. A.
19. **G. Bighin**, A. Cappellaro and L. Salasnich, “*Unitary Fermi superfluid near the critical temperature: thermodynamics and sound modes from elementary excitations*”, Phys. Rev. A **105**, 063329 (2022).
18. I.N. Cherepanov, **G. Bighin**, C.A. Schouder, A.S. Chatterley, S.H. Albrechtsen, A. Viñas Muñoz, L. Christiansen, H. Stapelfeldt, M. Lemeshko, “*Excited rotational states of molecules in a superfluid*”, Phys. Rev. A **104**, L061303 (2021).
17. A. Tonomi\*, A. Cappellaro\*, **G. Bighin**\* and L. Salasnich, “*Propagation of first and second sound in a two-dimensional Fermi superfluid*”, Phys. Rev. A **103**, L061303 (2021).
16. W. Rządkowski, N. Defenu, S. Chiacchiera, A. Trombettoni, **G. Bighin**, “*Detecting hidden and composite orders in layered models via machine learning*”, New J. Phys. **22**, 093026 (2020).

15. A.S. Chatterley, L. Christiansen, C.A. Schouder, A.V. Jørgensen, B. Shepperson, I.N. Cherepanov, **G. Bighin**, R.E. Zillich, M. Lemeshko, H. Stapelfeldt, “*Rotational coherence spectroscopy of molecules in helium nanodroplets: Reconciling the time and the frequency domains*”, Phys. Rev. Lett. **125**, 013001 (2020).
14. X. Li, E. Yakaboylu, **G. Bighin**, R. Schmidt, M. Lemeshko, A. Deuchert, “*Inter-molecular forces and correlations mediated by a phonon bath*”, J. Chem. Phys. **152**, 164302 (2020).
13. **G. Bighin**\*, N. Defenu\*, I. Nándori, L. Salasnich, A. Trombettoni, “*BKT-paired phase in coupled XY models*”, Phys. Rev. Lett. **123**, 100601 (2019).
12. X. Li, **G. Bighin**, E. Yakaboylu and M. Lemeshko, “*Variational approaches to quantum impurities: from the Fröhlich polaron to the angulon*”, Mol. Phys. **119**, 1981 (2019).
11. **G. Bighin**, T. V. Tscherbul and M. Lemeshko, “*Diagrammatic Monte Carlo approach to angular momentum in quantum many-particle systems*”, Phys. Rev. Lett. **121**, 165301 (2018).
10. **G. Bighin** and M. Lemeshko, “*Diagrammatic approach to orbital quantum impurities interacting with a many-particle environment*”, Phys. Rev. B **96**, 085410 (2017) (Selected as Editors’ Suggestion).
9. **G. Bighin** and L. Salasnich, “*Vortices and antivortices in two-dimensional ultracold Fermi gases*”, Sci. Rep. **7**, 45702 (2017).
8. P.A. Marchetti and **G. Bighin**, “*Superfluid Density in Cuprates: Hints on Gauge Compositeness of the Holes*”, J. Supercond. Nov. Magn. **30**, 721 (2017).
7. L. Salasnich and **G. Bighin**, “*Quantum Fluctuations and Vortex-Antivortex Unbinding in the 2D BCS-BEC Crossover*”, J. Supercond. Nov. Magn. **29**, 3103 (2016).
6. P.A. Marchetti and **G. Bighin**, “*Universality in cuprates: a gauge approach*”, J. Low Temp. Phys. **185**, 87 (2016).
5. **G. Bighin** and L. Salasnich, “*Finite-temperature quantum fluctuations in two-dimensional Fermi superfluids*”, Phys. Rev. B **93**, 014519 (2016)
4. **G. Bighin**, L. Salasnich, P.A. Marchetti and F. Toigo, “*Beliaev damping of the Goldstone mode in atomic Fermi superfluids*”, Phys. Rev. A **92**, 023638 (2015)
3. P.A. Marchetti and **G. Bighin**, “*Gauge approach to superfluid density in underdoped cuprates*”, Europhys. Lett. **110**, 37001 (2015) (Selected as Editor’s Choice)
2. L. Salasnich and **G. Bighin**, “*Scattering length of composite bosons in the three-dimensional BCS-BEC crossover*”, Phys. Rev. A **91**, 033610 (2015)
1. **G. Bighin**, L. Salasnich, G. Mazarella, and L. Dell’Anna, “*Pair condensation of polarized fermions in the BCS-BEC crossover*”, J. Phys. B **47**, 195302 (2014)

\* denotes equal contribution.

Proceedings:

- L. Salasnich and **G. Bighin**, “*Renormalization of the superfluid density in the two-dimensional BCS-BEC crossover*”, in the proceedings of the International Conference “Electron correlation in superconductors and nanostructures”, 17-20 August 2017, Odessa (Ukraine). International Journal of Modern Physics B **32**, 1840022 (2018).
- **G. Bighin** and L. Salasnich, “*Gaussian fluctuations in the two-dimensional BCS-BEC crossover: finite temperature properties*”, in the proceedings of the 24th Annual International Laser Physics Workshop, J. Phys.: Conf. Ser. **691**, 012018 (2016).

## Invited talks

- July 2022 “*Title TBD*”  
Invited talk at the SuperFluctuations 2022 conference, Padova, Italy.
- May 3rd, 2022 “*Detecting composite orders in layered models via machine learning*”  
Contributed talk the Quantum Magnetism and Statistical Mechanics of Lattice Models conference. Yerevan, Armenia.
- March 3rd, 2022 “*An impurity in a heteronuclear two-component Bose-Bose mixture*”  
Invited talk at University of Padua, Italy.
- July 30th, 2020 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”.  
Invited talk at ETH Zürich, Switzerland.
- June 23rd, 2020 “*Rotational coherence spectroscopy and far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets*”  
Invited talk at the SuperFluctuations 2020 conference, Padova, Italy. Delivered online due to the COVID-19 crisis.
- June 4th, 2020 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Invited talk at the ‘Spring Meeting on Ultracold Quantum Matter’, University of Padova, Italy. Delivered online due to the COVID-19 crisis.
- April 16th, 2020 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Invited talk at Universidade Federal do Rio Grande do Norte – Natal, Brazil. Delivered online due to the COVID-19 crisis.
- March 17th, 2020 Invited talk at Leibniz Universität Hannover, Germany. Canceled due to the COVID-19 crisis.
- February 17th, 2020 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Invited talk at Max Planck Institute of Quantum Optics, Garching, Germany.
- December 19th, 2019 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Contributed talk at the 1st Workshop on Molecular Quantum Technology (MQT2019), Puerto Natales, Chile.

- December 10th, 2019 “*Diagrammatic Monte Carlo approach to angular momentum in quantum many-body systems*”  
Contributed talk at the “Polarons in the 21st Century” workshop, Erwin Schrödinger Institute, Vienna.
- September 2019 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Universitat Politècnica de Catalunya, Barcelona, Spain.
- September 3rd, 2019 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
SuperFluctuations 2019 conference, Padova, Italy.
- May 23th, 2019 “*Far-from-equilibrium dynamics of molecules in  $^4\text{He}$  nanodroplets: a quasiparticle perspective*”  
Universität Heidelberg, Germany.
- October 31st, 2018 “*Composite, rotating impurities interacting with a many-body environment: analytical and numerical approaches*”  
Physics Colloquium, University of Nevada, Reno, U.S.A.
- September 6th, 2018 “*Molecular impurities interacting with a many-body environment: dynamics in Helium nanodroplets*”  
SuperFluctuations 2018 conference, San Benedetto del Tronto, Italy.
- July 19th, 2018 “*Composite, rotating impurities interacting with a many-body environment: analytical and numerical approaches*”,  
CQD Special Colloquium, Universität Heidelberg, July 19th, 2018
- September 7th, 2017 “*A diagrammatic approach to composite, rotating impurities*”  
SuperFluctuations 2017 conference, San Benedetto del Tronto, Italy.
- July 4th, 2017 “*A diagrammatic approach to composite, rotating impurities*”  
Contributed talk at the Workshop on Understanding Quantum Phenomena with Path Integrals: From Chemical Systems to Quantum fluids and Solids, ICTP, Trieste, Italy.
- June 14th, 2017 “*A diagrammatic approach to composite, rotating impurities.*”  
University of Padua, Italy.
- April 6th, 2016 “*Gaussian fluctuations in the two-dimensional BCS-BEC crossover*”  
IST Austria, Klosterneuburg, Austria.
- January 11th, 2016 “*Gaussian fluctuations in the two-dimensional BCS-BEC crossover*”  
Winter Workshop on Ultracold Quantum Matter, University of Padua, Italy
- June 5th, 2014 “*Condensate fraction for a polarized Fermi gas*”  
University of Antwerp, Belgium

## Refereeing

Referee for Physical Review Letters, Physical Review X, Physical Review A, Physical Review B, Physical Review Research, New Journal of Physics, SciPost Physics, Journal of Physics B: Atomic, Molecular and Optical Physics, Journal of Superconductivity and Novel Magnetism, MDPI Condensed Matter, MDPI Symmetry, MPDI Mathematics, and MDPI Applied Sciences.

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## Teaching experience

- Winter semester 2021-2022 Teaching assistantship for the course “*Condensed Matter Theory*” by professor M. Haverkort, University of Heidelberg.
- Summer semester 2021 Teaching assistantship for the seminar course “*Statistical Physics*” by professor A. Mielke, University of Heidelberg.
- March 2017 and March 2018 Three guest lectures on the path integral formalism, as a part of Prof. Mikhail Lemeshko’s course “*Modern Atomic, Molecular, and Optical Physics*” at IST Austria.
- Spring 2016 Teaching assistantship, Physics Laboratory course, Biology Department, University of Padova.
- Fall 2015 Teaching assistantship for the Electromagnetism course for 3rd year students, B.D. in Mathematics, University of Padova.

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## Outreach and other activities

- July 2019 I taught at a ‘Maths Camp’, designed to expose high-school students of developing countries to new mathematical ideas, inspiring them outside the classroom. The activity is run by NGO ‘African Maths Initiative’ (AMI) and hosted by the African Institute for Mathematical Sciences, Kigali, Rwanda.
- April 2017-April 2018 President, PostDoc Association, IST Austria, Klosterneuburg, Austria.
- October 2014-April 2016 Ph.D. students’ representative, Department of Physics and Astronomy, University of Padua.

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## Languages

- Italian Native.
- English Full professional proficiency. In 2011, I have taken the TOEFL® IBT standardized test, achieving a total score of 102/120 (R:30, L:25, S:18, W:29).
- German I am currently attending a B1 German course.
- Serbo-Croatian Basic knowledge.
- Ancient Greek Fair reading comprehension.
- Latin Fair reading comprehension.

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## Computer skills

- Advanced experience: Excellent knowledge of the C programming language and very good knowledge of the C++ programming language, which I use extensively for research-related programming and for hobby projects. Very good knowledge of parallel computing interfaces (OpenMP and MPI), of workload managers for high-performance clusters (SLURM) and of standard scientific computing libraries. Very high familiarity with UNIX-like operating systems, especially Linux and macOS. Numerical methods and applications to data analysis: Wolfram Mathematica, ROOT data analysis framework.
- Intermediate experience:  $\LaTeX$ , Python, Tensorflow.

Beginner experience: Haskell.