

## Curriculum vitae of Cinzia DI GIORGIO

Born in Cagliari (Italy) on June 5th, 1988.

*Researcher ID: AAC-2549-2021; ORCID: 0000-0003-2127-3991*

Since December 2022: Staff Researcher at the CNR-IOM, Trieste, Italy.

### Past Positions

August 2019 - July 2022: P.O.N. – AIM Research Fellow (Ricercatore a tempo determinato di tipo A - Programma Operativo Nazionale - Attraction and International Mobility - Ricerca ed Innovazione 2014-2020), with the benefit of 12-month international mobility.

January 2021 – March 2022: PI of the *University of Salerno/University of Sannio* working unit in the *ET\_Italia* project.

January/February 2020: Adjunct Research Assistant Professor, Physics Department, Temple University, Philadelphia (USA).

August 2017 - July 2019: Post-doc Researcher, Physics Department, University of Salerno. Project title: *Scanning Probe Microscopy studies of orbital and exchange interaction in S/F junctions.*

August 2016 – July 2017: Post-doc Researcher, Physics Department, University of Salerno. Project title: *Scanning Probe Microscopy and application to nanotechnology.*

### Academic education

2016: Ph.D. degree in Physics, Phys. Dept., University of Salerno, Italy. Thesis title: *Superconductivity in S/F hybrids: a scanning probe microscopy study of orbital interaction.*

October 2014 - November 2015: Visitor Student, Phys. Dept., Temple University, Philadelphia (PA, USA).

2012: MSc degree in Physics (110/110 *cum laude*), Phys. Dept., University of Salerno, Italy. Thesis title: *Studio della dinamica dei vortici in ibridi Superconduttore/Ferromagnete attraverso l'uso della Magnetic Force Microscopy.*

2010: Bachelor's degree (110/110 *cum laude*), Phys. Dept., University of Salerno, Italy. Thesis title: *Applicazioni del metodo tight binding ad orbitali di tipo p.*

### Research track record

I started my research activity during the MSc internship at the Physics Department of University of Salerno, by investigating the conditions of spontaneous superconducting vortex pairs nucleation, in magnetically coupled superconductor/ferromagnet hybrids, by employing low temperature magnetic force microscopy (LT-MFM). As a follow-up, in 2013 I started my Ph.D. in Physics focusing on the effect of magnetic topology on the confinement of superconducting vortices, and on technical advances toward the exploitation of *quantitative* LT-MFM. During my Ph.D., I joined the Scanning Probe Microscopy (SPM) laboratory, led by Prof. M. Iavarone, at the Physics Department of Temple University (Philadelphia, USA) for 14 months. There, I focused my interests on two main subjects: study of superconductivity and vortex matter in new generation Fe-based superconductors, and study of the electronic properties of mono and few-layers MoS<sub>2</sub>, both by means of scanning probe microscopy techniques (low temperature scanning tunnelling microscopy and spectroscopy and Kelvin probe force microscopy).

As a post-doc researcher, from 2016 to 2019, my scientific interests spanned from the study of unconventional symmetries of superconducting vortex cores, to the investigation of the electronic properties in nano-structured semiconductors. In particular, I focused on the effects of cobalt substitution on surface reactivity, chemistry and electronic band-structure of nanostructured ZnO-thin films, by performing light-assisted scanning probe microscopies.

In 2017, I was invited to join the European *Virgo* project, on the detection of gravitational waves, being involved, as material scientist, in the modelling, fabrication and characterization of innovative nanolayered coatings, for the gravitational waves interferometer's mirrors. In 2018, I also joined the Italian *ET\_Italia* project, for the forthcoming setting up of a possibly cryogenic gravitational wave interferometer, thus requiring the development of cryo-friendly material for mirror's coatings. From January 2021 to March 2022, I led the University of Salerno-University of Sannio working unit in *ET\_Italia*.

From August 2019 to July 2022, I was appointed as a 3-year research fellow (Ricercatore a tempo determinato di tipo A) at the Phys. Dept. of University of Salerno, under the project PON-AIM (Programma Operativo Nazionale - Attraction and International Mobility), with the benefit of 12-month international mobility. During this time, I carried on a study on the elasto-mechanical properties of strained 2D materials, by means of quantitative atomic force microscopy nano-indentation. The correlation between mechanical strain and tunability of the electronic properties of 2D materials is, to date, the core of my research activity. During the time abroad, I strengthened my collaboration with the SPM group in Temple University, and I built a new collaboration with the *Nanostructures@Nanosecond* laboratory, at the Laboratoire de Physiques des Solides, in Orsay (Fr), led by Dr. Marco Aprili.

During my career, I've gained knowledge of (light-assisted) scanning probe microscopy techniques, such as atomic force, conductive-atomic force, piezo force, kelvin probe, and scanning tunnelling microscopies, at ambient pressure and temperature, as well as in ultra-high vacuum and low temperature. I've dealt with cryogenics, ultra-high vacuum equipment, X-ray diffraction, and Raman microscopy and spectroscopy techniques, as well as I've contributed to the setting up of custom-built apparatuses for condensed matter experiments.

I've joined many international conferences and workshops, with several oral and poster contributions.

## **Awards**

2017: First Europhysics Letters prize for the best poster presented at "Superstripes 2017" International Conference.

## **Professional activities**

March 2021: member of the technical committee for the purchase of a mechanical interface for cryogenic test of a superconducting quadrupole for INFN-Sezione di Napoli (C.I.G. 8385462E23)

December 2019: member of the technical committee for the purchase of a cryogenic pipeline for INFN-Sezione di Napoli (C.I.G. ZC92A2D0F6)

October 2018: Supporting staff for *Tunneling Through Nanoscience 2018* International Conference.

July 2018: Member of the scientific committee for *9Th Young Researcher Meeting* International Conference.

## **Teaching activities**

2022: Experimental part of "Solid States Physics" - bachelor's degree in Physics, University of Salerno.

2020-2021: Experimental part of "Mechanics and Thermodynamics with experimentations" - bachelor's degree in Mathematics, University of Salerno.

2019: Teaching Assistant for Laboratory of Electromagnetism - bachelor's degree in Mathematics, University of Salerno.

2014: Teaching Assistant for Calculus I - bachelor's degree in Physics, University of Salerno.

2013-2014: Teaching Assistant for Physics I - bachelor's degree in Biology, University of Salerno.

## **Student supervision**

2022: Co-tutor of a MSc thesis. Title: *Nanoscale study of strain effects and electrical properties of MoS<sub>2</sub>*.

2021: Co-tutor of a Ph.D. thesis. Title: *Tailoring the structural and surface properties of TiO<sub>2</sub> thin films and TiO<sub>2</sub>-based nanolayers, with heat treatments layer thickness, and oxide mixtures*.

## Visits in research laboratories

- Several short- and long-term visits at the *Nanostructures@Nanoseconds* laboratory (contact person: Dr. M. Aprili) at Laboratoire de Physique des Solides (LPS, Solid State Laboratory) – to carry on scanning probe microscopy and spectroscopy experiments on 2D materials.
- Several long- and short-term visits at the *Scanning Probe Microscopy* laboratory (contact person: Prof. M. Iavarone) at the Phys. Dept. of Temple University (Philadelphia, USA) – to carry on ultra-high vacuum, low temperature scanning tunneling microscopy and spectroscopy experiments on superconductor/ferromagnet hybrids, Fe-based superconductors, and novel topological magnets.
- Short-term visit at the *Nanoscience* laboratory (contact person: Prof. Oleg Kolosov), Lancaster University (UK) – to investigate the thermal conduction of 2D materials at the nanoscale, through scanning thermal force microscopy.
- Short-term visit at the *HYBRID – Hybrid systems at low dimension* laboratory (Grenoble, Fr) (contact person: Nedjma Bendiab) to begin new collaborations on optical and electronic properties of 2D materials.

## Selected Publications

1. Di Giorgio C., et al. Visualizing the quantum capacitance of strained MoS<sub>2</sub> Monolayer by Electrostatic Force Microscopy, in preparation
2. O. Durante, V. Granata, R. Fittipaldi, J. Neilson, G. Carapella, F. Chiadini, R. DeSalvo, R. De Simone, F. Dinelli, V. Fiumara, V. Pierro, I.M. Pinto, A. Vecchione, F. Bobba, and C. Di Giorgio. Structural phase transformations in TiO<sub>2</sub> thin films upon thermal treatments, submitted to *Surfaces and Interfaces* (under review)
3. Di Giorgio C., et al. Mechanical, elastic, and adhesive properties of two-dimensional materials, *Advanced Materials Interfaces, Invited Review, Adv. Mater. Interfaces* 9, 2102220, 2022.
4. O. Durante, J. Neilson, C. Di Giorgio. The influence of plasma on the morphological and structural properties of TiO<sub>2</sub> thin films. *Il nuovo cemento C* 45 168, 2022
5. Di Giorgio C., et al. Exceptional Elasticity of Microscale Constrained MoS<sub>2</sub> Domes, *ACS Appl. Mater. Interfaces* 13, 40, 2021.
6. Blundo E., Di Giorgio C., Pettinari G., Bubble formation in van der Waals crystals: A platform for fundamental studies, *Il nuovo cemento C* 44 (4-5), 2021.
7. Durante O., Di Giorgio C., et al. Emergence and Evolution of Crystallization in TiO<sub>2</sub> Thin Films: A Structural and Morphological Study, *Nanomaterials* 11, 1409, 2021.
8. Prías-Barragan, J.J., Gross, K., Ariza-Calderon, H., Prieto, P. Di Giorgio, C., et al. Room-temperature ferromagnetism in oxidized-graphenic nanoplatelets induced by topographic defects. *Journal of Magnetism and Magnetic Materials* 524, 167664, 2021.
9. Di Giorgio C., et al. Nanoscale Measurements of Elastic Properties and Hydrostatic Pressure in H<sub>2</sub>-Bulged MoS<sub>2</sub> Membranes, *Adv. Mater. Interfaces* 7, 2001024, 2020.
10. Blundo E., Di Giorgio C., et al. Engineered Creation of Periodic Giant, Nonuniform Strains in MoS<sub>2</sub> Monolayers, *Adv. Mater. Interfaces* 7, 2000621, 2020.
11. Di Giorgio C., et al. Quantitative magnetic force microscopy using calibration on superconducting flux quanta. *Nanotechnology* 30, 314004, 2019.
12. D'Agostino D., Di Giorgio C., et al. Effects of cobalt substitution on ZnO surface reactivity and electronic structure. *Journal of materials chemistry C* 7, 8364, 2019.
13. Putilov, A. V., Di Giorgio, C., et al. Vortex-core properties and vortex-lattice transformation in FeSe. *Phys. Rev. B.* 99, 144514, 2019.
14. Pierro, V., Fiumara, V., Chiadini, F., Bobba, F., Carapella, G., Di Giorgio, C., et al. On the performance limits of coatings for gravitational wave detectors made of alternating layers of two materials, *Optical Materials* 96, 1092691, 2019.
15. Precner, M., Polaković, T., Qiao, Qiao, Trainer, D. J., Putilov, A. V., Di Giorgio, C., et al. Evolution of Metastable Defects and Its Effect on the Electronic Properties of MoS<sub>2</sub> Films. *Scientific Reports* 8, 1, 2018.
16. Precner, M., Polaković, T., Trainer, D. J., Putilov, A. V., Di Giorgio, C., et al. Metastable defects in monolayer and few-layer films of MoS<sub>2</sub>. *Advanced Materials: Proceedings of the International Workshop on Advanced Materials (IWAM-2017)*, AIP Conference Proceedings 2005, 020004, 2018.
17. Di Giorgio, C., et al. Anisotropic Superconducting Gaps and Boson Mode in FeSe<sub>1-x</sub>S<sub>x</sub> Single Crystals. *Journal of Superconductivity and Novel Magnetism* 30, 763, 2017.
18. Di Giorgio C., et al. Superconducting Vortex-Antivortex Pairs: Nucleation and Confinement in Magnetically Coupled Superconductor-Ferromagnet Hybrids. Book chapter in: "*Vortex Dynamics and Optical Vortices*", p. 83-106, Intechopen, ISBN: 978-953-51-2929-5, doi: 10.5772/65954, 2017.

19. D'Agostino D., Di Giorgio C., et al. Piezoelectricity and charge trapping in ZnO and Co-doped ZnO thin films. *AIP Advances* 7, 055010, 2017.
20. Trainer D.J., Putilov, A.V., Di Giorgio, C., et al. Inter-Layer Coupling Induced Valence Band Edge Shift in Mono- to Few-Layer MoS<sub>2</sub>. *Scientific Reports* 7, 1, 2017.
21. Di Giorgio C., et al. Observation of superconducting vortex clusters in S/F hybrids. *Scientific Reports* 6, 1, 2016.
22. Di Trolio, A., Alippi, P., Bauer, E. M., Ciatto, G., Chu, M. H., Varvaro, G., Polimeni, A., Capizzi, M., Valentini, M., Bobba, F., Di Giorgio, C. Ferromagnetism and Conductivity in Hydrogen Irradiated Co-Doped ZnO Thin Films. *ACS Applied Materials and Interfaces* 8, 12925, 2016.
23. Moore, S. A., Curtis, J. L., Di Giorgio C., et al. Evolution of the superconducting properties in FeSe<sub>1-x</sub>S<sub>x</sub>. *Phys. Rev. B* 92, 235113, 2015.
24. Bobba F., Di Giorgio C., et al. Vortex-antivortex coexistence in Nb-based superconductor/ferromagnet heterostructures. *Phys. Rev. B* 89, 1, 2014
25. Mancusi D., Di Giorgio, C., et al. Magnetic pinning in a superconducting film by a ferromagnetic layer with stripe domains. *Superconductor Science and Technology* 27, 125002, 2014.

### Conference Contributions:

1. APS March Meeting 2015, San Antonio, Texas (USA) – Oral Contribution: Vortex-Antivortex coexistence in Nb based Superconductor/Ferromagnet heterostructures
2. APS March Meeting 2016, Baltimore, Maryland (USA) – Oral Contribution: Nanoscale investigation of mesoscopic phenomena in S/F hybrid structures using Scanning Probe Microscopy techniques
3. Science through Scanning Probe Microscopy 2016 (StSPM'16), Bologna, Italia – Oral Contribution: Scanning Probe Microscopy observation of superconducting vortex clusters in S/F hybrids
4. APS March Meeting 2017, New Orleans, Louisiana (USA) – Oral Contribution: Low Temperature Scanning Tunneling Microscopy investigation of FeSe and FeSe<sub>1-x</sub>S<sub>x</sub> single crystals
5. Superstripes 2017 - Quantum in complex matter, Ischia, Napoli, Poster: Low temperature Scanning Tunneling Microscopy investigation of FeSe single crystal
6. APS March Meeting 2018", Los Angeles, California, USA – Oral Contribution: Confinement of superconducting vortices in Superconductor/Ferromagnet heterostructures
7. Properties, Fabrication and Applications of Nano-Materials and Nano-Devices (Nano-M&D 2019)", Paestum, Salerno, Italia – Oral Contribution: Elasto-mechanical study of MoS<sub>2</sub> domes by Atomic Force Microscopy and Spectroscopy"
8. DSEC VI - Directionally Solidified Eutectics Conference, Fisciano, Salerno, Italia – Poster: Nanoscale investigation of metal-insulator transition in Ca<sub>2</sub>RuO<sub>4</sub> layered perovskite
9. CARRIER DOPING IN TWO-DIMENSIONAL LAYERED MATERIALS: TOWARD NOVEL PHYSICAL PROPERTIES AND ELECTRONIC DEVICE APPLICATIONS (CA2D), Napoli, Italia – Poster: Elasto-mechanical study of MoS<sub>2</sub> domes by Atomic Force Microscopy and Spectroscopy
10. Science through Scanning Probe Microscopy 2019 – Extended Version (StSPM19EV)" – Oral Contribution: Elasto-mechanical study of MoS<sub>2</sub> domes by Atomic Force Microscopy and Spectroscopy
11. NINE2021 the 4th INTERNATIONAL CONFERENCE ON NANOTECHNOLOGY BASED INNOVATIVE APPLICATIONS FOR THE ENVIRONMENT – Oral Contribution: H<sub>2</sub>-bulged membranes made of transition metal dichalcogenides: an AFM study
12. 2Day Physics, Sapienza Universita di Roma, Roma, Italia – Oral Contribution: On the tunability of MoS<sub>2</sub> properties: a scanning probe microscopy study
13. 14th Edoardo Amaldi Conference on Gravitational Waves (Amaldi 14)" – Oral Contribution: Study of TiO<sub>2</sub>-based nanolayered optical coatings.

### Contributions to Collaboration Meetings:

1. Virgo Week July 2021, Coating Workshop, virtual event – Oral Contribution: Status of fabrication/characterization of Coating prototypes down-selected from #LIGO-G1902307"
2. LIGO-Virgo-KAGRA (LVK) Collaboration Meeting March 2021 – Oral Contribution: Deposition and characterization of nanolayered prototype films
3. Virgo Week January 2021, Coating Workshop, virtual event – Oral Contribution: Status of fabrication/characterization of Coating prototypes down-selected from #LIGO-G1902307

4. Virgo Week January 2019, Coating Workshop, Pisa, Italia – Oral Contribution: Progress on fabrication and characterization of dielectric oxides at UniSannio/USalerno

**Seminars:**

1. Participation to the event “Ciclo di Seminari per Studenti a.a. 2021/2022”, organized by the Physics Department of University of Salerno. Oral Contribution: La materia alle nanoscale.
2. Participation to the “Journal club sur les matériaux 2D 2021”, organized by the Laboratoire de Physiques des Solides, Orsay (Fr). Oral Contribution: Twist Angle-Dependent Atomic Reconstruction and Moiré Patterns in Transition Metal Dichalcogenide Heterostructures.
3. Invited seminar to the HYBRID (Hybrid systems at low dimension) group (Grenoble, Fr, 2019): Electronic and Elasto-Mechanical properties of chalcogenides by Scanning Probe Microscopy and Spectroscopy.