Francesco Carenini

Curriculum Vitae

Personal data

Place of birth	Seriate, Bergamo (BG)
Nationality	Italian
Date of birth	15/11/1998

Contacts

email	francesco.carenini2@unibo.it

Driving license

11/2017	Achievement of driving license, category B

Education

from 11/2022 to present	**International PhD College (selection procedure winner)**, Collegio Superiore of Alma Mater Studiorum-Università di Bologna, Italy. Full member of the International PhD College in Bologna. The International PhD College is an institution of excellence offering an interdisciplinary education to PhD students enrolled in a PhD program of Bologna University.
from 11/2022 to present	**Ph.D. in Astroparticle Physics (scholarship winner)**, Alma Mater Studiorum-Università di Bologna, Italy. PhD student in Physics: Nuclear and Subnuclear Physics Curriculum.
from 09/2020 to 10/2022	**Master Degree in Physics**, Università degli studi di Roma, La Sapienza, Italy. Particle and Astroparticle physics curriculum. Final grade: 110/110 cum laude
from 09/2017 to 09/2020	**Bachelor Degree in Physics**, Università degli studi di Trieste, Italy. Final grade: 109/110
2012-2017	**High School Diploma in classical studies**, Liceo Classico Paolo Sarpi, Bergamo. Final grade: 91/100

Networks and affiliations

from 06/2023 to present — **Partner PhD of RIASISSU**.
The Italian Network of Students of Schools and Institutes of Advanced University Studies (RIASISSU) is the association that brings together all students of the Italian Schools of Advanced Studies.

Membership of International Scientific Collaborations

from 10/2021 to present — **Full member of the KM3NeT Collaboration**.
Developing a neutrino flares search in a time-dependent likelihood framework with the KM3NeT/ARCA detector and characterising the time-dependent variation of the synchronisation latencies between the KM3NeT/ARCA Base-Modules. Member of both the regular and multimessenger online KM3NeT shift groups, responsible for the monitoring of the detector. Run Coordinator of data acquisition in 2023. Member of the Outreach Committee.

Activities within the KM3NeT Collaboration

from 11/2022 to present — **Doctoral Thesis in Astroparticle Physics**.
Supervisor: Prof. Annarita Margiotta
Cosupervisor: Dr. Giulia Illuminati

from 10/2021 to 10/2022 — **Master thesis in Astroparticle Physics**.
Defended on : October 21^{st}, 2022
Title: *On the sensitivity of KM3NeT/ARCA towards high-energy neutrinos from Gamma-Ray bursts*
Supervisor: Prof. Silvia Celli
External-supervisor: Dr. Angela Zegarelli

Membership of other Scientific Societies

from 10/2021 to present — **Associate member of the National Institute for Nuclear Physics (INFN)**.
Firstly as a Master Student, then as a Ph.D. Student.

Roles of responsibilities

from 10/2023 to 12/2023 — **Run coordinator for the KM3NeT data acquisition**.

Awards and honors

Bourses du Gouvernement Français 2024, Institut Francais Italia.
Winner of the French Government 2024-2025 research grant, supporting a 3-month research period at the Paris Cité University-AstroParticle and Cosmology laboratory (APC).

Student supervision activities

A.Y. 2023/24 — **Co-advisor for Bachelor thesis in Physics at Alma Mater Studiorum-Università di Bologna**.
Co-advisor for the candidate Camilla Benedetti with a thesis titled *"Studio dell'area efficace del telescopio KM3NeT/ARCA"*, discussed in July 2024.

A.Y. 2023/24 **Supervision of Internship in Astronomy at Alma Mater Studiorum - Università di Bologna**.
Co-supervisor for the internship project of the student Irene Borghesi, classified as professional activity during the bachelor's degree in Astronomy.

A.Y. 2022/23 **Supervision of Internship in Astronomy at Alma Mater Studiorum - Università di Bologna**.
Co-supervisor for the internship project of the student Giulia Fadini, classified as professional activity during the bachelor's degree in Astronomy.

Teaching experiences

A.Y. 2024/25 **Teaching assistant for the course of General Physics T-B**, Alma Mater Studiorum-Università di Bologna, Italy.
30 hours of teaching support to be given during the academic year 2024/2025, for the students of the first cycle degree program in Energy Engineering, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

A.Y. 2024/25 **Teaching assistant for the course of General Physics T-B (A-K)**, Alma Mater Studiorum-Università di Bologna, Italy.
25 hours of teaching support to be given during the academic year 2024/2025, for the students of the first cycle degree program in Engineering Management, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

A.Y. 2023/24 **Teaching assistant for the course of General Physics T-B**, Alma Mater Studiorum-Università di Bologna, Italy.
30 hours of teaching support to be given during the academic year 2023/2024, for the students of the first cycle degree program in Energy Engineering, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

A.Y. 2023/24 **Teaching assistant for the course of General Physics T-B (A-K)**, Alma Mater Studiorum-Università di Bologna, Italy.
25 hours of teaching support to be given during the academic year 2023/2024, for the students of the first cycle degree program in Engineering Management, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

A.Y. 2022/23 **Teaching assistant for the course of General Physics T-B**, Alma Mater Studiorum-Università di Bologna, Italy.
30 hours of teaching support to be given during the academic year 2022/2023, for the students of the first cycle degree program in Energy Engineering, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

A.Y. 2022/23 **Teaching assistant for the course of General Physics T-B (A-K)**, Alma Mater Studiorum-Università di Bologna, Italy.
25 hours of teaching support to be given during the academic year 2022/2023, for the students of the first cycle degree program in Engineering Management, Department of Industrial Engineering. Tasks include frontal teaching lessons, reception and preparation of written exam tests.

International Schools, Masterclasses and Workshops

September 2024 — **Masterclass "Generative AI for everyday life and academic research"**, Bologna, Italy.
Exploring the challenges and opportunities related to Generative Artificial Intelligence: technical, social and legal impacts of large-scale language models and AI in everyday life.

June 2024 — **15th International Neutrino Summer School 2024**, Bologna, Italy.
Poster: "Search for time-dependent emissions of cosmic neutrinos with the KM3NeT/ARCA telescope".

February 2024 — **Workshop on Numerical Multi-messenger Modeling**, Paris, France.
Workshop on numerical codes to simulate multi-messenger (photon/neutrino/cosmic-ray) emission from astrophysical sources.

Jan. 2024 - Feb. 2024 — **1st RESTART Camp on Soft Skills**, Bologna, Italy.
Leadership, Team Working and Public Speaking for a Research Career. The program also included elements of emotional intelligence, human communication and other fundamental relational/social skills. All participants from RESTART presented in a public event their research result, with the scope to make the presentation understandable also by the non experts.

September 2023 — **ONSCI-Officina di Narrazione della Scienza Summer School**, Bologna, Italy.
Theoretical lessons, laboratory activities and testimonies on the use of storytelling in scientific, informative or specialized seminars, in educational activities and public engagement.

from 06/2023 to 07/2023 — **International School in AstroParticle Physics 2023: Neutrino physics, astrophysics and cosmology**, Varenna, Lake Como, Italy.
Poster: "Untriggered flares search with the KM3NeT/ARCA neutrino telescope".

Talks and poster presentations

Poster — **Workshop on Numerical Multi-messenger Modeling 2025**, Desy, Zeuthen, Germany.
Main author of the poster "Stacking search for KM3NeT/ARCA neutrinos using theoretical blazar models"

Talk — **Cosmic Rays and Neutrinos in the Multi-Messenger Era Conference 2024**, Paris Cité University-AstroParticle and Cosmology laboratory, Paris, France.
Selected to deliver the talk titled "Incorporating theoretical blazar models into neutrino stacking analyses with KM3NeT/ARCA".

Poster — **Cosmic Rays and Neutrinos in the Multi-Messenger Era Conference 2024**, Paris Cité University-AstroParticle and Cosmology laboratory, Paris, France.
Main author of the poster: "Incorporating theoretical blazar models into neutrino stacking analyses with KM3NeT/ARCA" selected for presentation at the conference.

Poster — **9th Rome International Conference on AstroParticle Physics (RICAP) 2024**, Hotel Villa Tuscolana, Rome, Italy.
Co-author of the poster: "Methods for a time-dependent neutrino flare search with the KM3NeT/ARCA telescope".

Third mission

Scientific and Cultural dissemination

01/2025 Invited to deliver a Ph.D. Seminar at the Paris Cité University-AstroParticle and Cosmology laboratory (APC), in Paris, with a contribution titled "Deep-sea telescopes: a new window to our Universe".

09/2024 Invited speaker at the dissemination event "Think&Drink: Exploring the Invisible Universe" organized by the Ph.D. students of the Collegio Superiore, in Bologna, with a contribution titled:"Deep-sea telescopes: a new window on our Universe".

02/2024 Participating to the Student Café 2024, orientation days dedicated to undergraduates who want to enroll in a degree program in physics at Bologna University.

from 02/2024 to present Member of the Outreach Committee of the KM3NeT Collaboration, in charge of dissemination and communication of the KM3NeT science and technical progress.

from 06/2023 to 01/2024 Leader of the Physics&Technology section within the Antropia project.

from 11/2022 to present Author of the dissemination podcast "It's Not Rocket Science", with the support of Collegio Superiore of Bologna University. Available on major streaming platforms.

from 11/2022 to present Member of the International PhD College in Bologna, developing co-working activities and attending selected seminars and lectures, in order to realize a multi-disciplinary dissemination project.

from 12/2020 to 04/2024 Writing scientific articles for dissemination and publishing videos for the educational project Antropia (www.antropia.it).

Organization of schools, conferences and meetings

Member of the Local Organizing Committee for the 15th International Neutrino Summer School 2024, 3-14 June 2024, Bologna, Italy.

Member of the Local Organizing Committee for the ANTARES-KM3NeT Collaboration Meeting, 12-16 February 2024, Bologna, Italy.

Member of the Local Organizing Committee for the #1 WP7 Meeting: Implementation of multi-messenger liaisons, 24-25 May 2023, Bologna, Italy.

Publications

[1] O. Adriani et al. "On the Potential Galactic Origin of the Ultra-High-Energy Event KM3-230213A". In: (Feb. 2025). arXiv: 2502.08387 [astro-ph.HE].

[2] O. Adriani et al. "The ultra-high-energy event KM3-230213A within the global neutrino landscape". In: (Feb. 2025). arXiv: 2502.08173 [astro-ph.HE].

[3] S. Aiello et al. "Astronomy potential of KM3NeT/ARCA". In: *Eur. Phys. J. C* 84.9 (2024), p. 885. DOI: 10.1140/epjc/s10052-024-13137-2. arXiv: 2402.08363 [astro-ph.HE].

[4] S. Aiello et al. "Atmospheric muons measured with the KM3NeT detectors in comparison with updated numeric predictions". In: *Eur. Phys. J. C* 84.7 (2024), p. 696. DOI: 10.1140/epjc/s10052-024-13018-8. arXiv: 2403.11946 [astro-ph.HE].

[5] S. Aiello et al. "Differential Sensitivity of the KM3NeT/ARCA detector to a diffuse neutrino flux and to point-like source emission: Exploring the case of the Starburst Galaxies". In: *Astropart. Phys.* 162 (2024), p. 102990. DOI: 10.1016/j.astropartphys.2024.102990. arXiv: 2402.09088 [astro-ph.HE].

[6] S. Aiello et al. "Embedded software of the KM3NeT central logic board". In: *Comput. Phys. Commun.* 296 (2024), p. 109036. DOI: 10.1016/j.cpc.2023.109036. arXiv: 2308.01032 [astro-ph.IM].

[7] S. Aiello et al. "First observation of the cosmic ray shadow of the Moon and the Sun with KM3NeT/ORCA". In: *Eur. Phys. J. C* 83.4 (2023), p. 344. DOI: 10.1140/epjc/s10052-023-11401-5. arXiv: 2211.08977 [astro-ph.IM].

[8] S. Aiello et al. "First Searches for Dark Matter with the KM3NeT Neutrino Telescopes". In: (Nov. 2024). arXiv: 2411.10092 [astro-ph.HE].

[9] S. Aiello et al. "gSeaGen code by KM3NeT: an efficient tool to propagate muons simulated with CORSIKA". In: (Oct. 2024). arXiv: 2410.24115 [hep-ex].

[10] S. Aiello et al. "KM3NeT broadcast optical data transport system". In: *JINST* 18.02 (2023), T02001. DOI: 10.1088/1748-0221/18/02/T02001. arXiv: 2210.13328 [astro-ph.IM].

[11] S. Aiello et al. "Measurement of neutrino oscillation parameters with the first six detection units of KM3NeT/ORCA". In: *JHEP* 10 (2024), p. 206. DOI: 10.1007/JHEP10(2024)206. arXiv: 2408.07015 [hep-ex].

[12] S. Aiello et al. "Observation of an ultra-high-energy cosmic neutrino with KM3NeT". In: *Nature* 638.8050 (2025), pp. 376–382. DOI: 10.1038/s41586-024-08543-1.

[13] S. Aiello et al. "Probing invisible neutrino decay with KM3NeT/ORCA". In: *JHEP* 04 (2023), p. 090. DOI: 10.1007/JHEP04(2023)090. arXiv: 2302.02717 [hep-ex].

[14] S. Aiello et al. "Probing invisible neutrino decay with the first six detection units of KM3NeT/ORCA". In: (Jan. 2025). arXiv: 2501.11336 [hep-ex].

[15] S. Aiello et al. "Search for neutrino emission from GRB 221009A using the KM3NeT ARCA and ORCA detectors". In: *JCAP* 08 (2024), p. 006. DOI: 10.1088/1475-7516/2024/08/006. arXiv: 2404.05354 [astro-ph.HE].

[16] S. Aiello et al. "Search for non-standard neutrino interactions with the first six detection units of KM3NeT/ORCA". In: *JCAP* 02 (2025), p. 073. DOI: 10.1088/1475-7516/2025/02/073. arXiv: 2411.19078 [hep-ex].

[17] S. Aiello et al. "Search for quantum decoherence in neutrino oscillations with six detection units of KM3NeT/ORCA". In: (Oct. 2024). arXiv: 2410.01388 [hep-ex].

[18] S. Aiello et al. "Searches for neutrino counterparts of gravitational waves from the LIGO/Virgo third observing run with KM3NeT". In: *JCAP* 04 (2024), p. 026. DOI: 10.1088/1475-7516/2024/04/026. arXiv: 2311.03804 [astro-ph.HE].

[19] S. Aiello et al. "Study of tau neutrinos and non-unitary neutrino mixing with the first six detection units of KM3NeT/ORCA". In: (Feb. 2025). arXiv: 2502.01443 [hep-ex].

[20] S. Aiello et al. "The Power Board of the KM3NeT Digital Optical Module: design, upgrade, and production". In: *Electronics* 13.11 (2024), p. 2044. DOI: 10.3390/electronics13112044. arXiv: 2311.14872 [astro-ph.IM].

[21] A. Albert et al. "Acoustic positioning for deep sea neutrino telescopes with a system of piezo sensors integrated into glass spheres". In: *Exper. Astron.* 59.1 (2025), p. 6. DOI: 10.1007/s10686-024-09971-7. arXiv: 2405.07230 [astro-ph.IM].

[22] A. Albert et al. "Constraints on the energy spectrum of the diffuse cosmic neutrino flux from the ANTARES neutrino telescope". In: *JCAP* 08 (2024), p. 038. DOI: 10.1088/1475-7516/2024/08/038. arXiv: 2407.00328 [astro-ph.HE].

[23] A. Albert et al. "Hint for a TeV neutrino emission from the Galactic Ridge with ANTARES". In: *Phys. Lett. B* 841 (2023), p. 137951. DOI: 10.1016/j.physletb.2023.137951. arXiv: 2212.11876 [astro-ph.HE].

[24] A. Albert et al. "Results of the follow-up of ANTARES neutrino alerts". In: *JCAP* 09 (2024), p. 042. DOI: 10.1088/1475-7516/2024/09/042. arXiv: 2402.16498 [astro-ph.HE].

[25] A. Albert et al. "Search for neutrino counterparts to the gravitational wave sources from LIGO/Virgo O3 run with the ANTARES detector". In: *JCAP* 04 (2023), p. 004. DOI: 10.1088/1475-7516/2023/04/004. arXiv: 2302.07723 [astro-ph.HE].

[26] A. Albert et al. "Searches for Neutrinos in the Direction of Radio-bright Blazars with the ANTARES Telescope". In: *Astrophys. J.* 964.1 (2024), p. 3. DOI: 10.3847/1538-4357/ad1f5b. arXiv: 2309.06874 [astro-ph.HE].

[27] F. Carenini et al. "KM3NeT Online Multi-Messenger Results". In: *EPJ Web Conf.* 319 (2025), p. 08004. DOI: 10.1051/epjconf/202531908004.

[28] Emilio Jesús Pastor Gómez and Francesco Carenini. "Methods for a time-dependent neutrino flare search with the KM3NeT/ARCA telescope". In: *EPJ Web Conf.* 319 (2025), p. 13011. DOI: 10.1051/epjconf/202531913011.

[29] Mathieu Lamoureux et al. "Follow-up of O3 gravitational wave events with neutrinos in ANTARES and KM3NeT telescopes". In: *PoS* ICRC2023 (2023), p. 1506. DOI: 10.22323/1.444.1506.

[30] Mathieu Lamoureux et al. "Hint for a TeV neutrino emission from the Galactic Ridge with the ANTARES telescope". In: *PoS* ICRC2023 (2023), p. 1103. DOI: 10.22323/1.444.1103.

[31] Massimo Mastrodicasa et al. "KM3NeT real-time analysis framework". In: *PoS* TAUP2023 (2024), p. 273. DOI: 10.22323/1.441.0273.

[32] T. Unbehaun et al. "Prospects for combined analyses of hadronic emission from γ-ray sources in the Milky Way with CTA and KM3NeT". In: *Eur. Phys. J. C* 84.2 (2024), p. 112. DOI: 10.1140/epjc/s10052-023-12279-z. arXiv: 2309.03007 [astro-ph.HE].

Other research activities

from 03/2021 to 07/2021 **SFERA project**.
Institute: Sapienza University, Rome, Italy.

Description: In the context of "Physics Laboratory II" master course, I have worked in a group of 4 people on the SFERA electromagnetic calorimeter. Main goal of our work has been the calibration of the apparatus, exploiting a ^{137}Cs radioactive source and studying the response of PMTs in terms of total collected charge. After that, we analyzed spectra of several sources (^{22}Na,^{133}Ba,^{60}Co) with the goal of analyzing the linearity of the response in terms of energy, focusing also on the correlation of signals coming from adjacent channels of the calorimeter. Finally we have estimated the time resolution of our detector fitting the pulse shapes provided by the digitizer.

from 12/2019 to 04/2020 **Internship for students of Bachelor degree**.
Institute: International Centre for Theoretical Physics (ICTP), Trieste, Italy.

Description: I wrote from scratch a genetic algorithm for the study of optimization problems, critically analyzing the results obtained and working with the Fortran programming language. In particular, I dealt with the problem of maximizing 1 in a binary string of 0 and 1 and I conducted a study on the parameters that appear in a genetic algorithm, namely the probability of reproduction, the probability of mutation, the length of the strings themselves and the number of individuals who are selected from time to time as being better than their population. The study has led to a choice of parameters that allows to approach an optimal solution, identified using a function, called fitness, that evaluates the goodness of individuals (binary strings) generated by the algorithm.

Master thesis

title: On the sensitivity of KM3NeT/ARCA towards high-energy neutrinos from Gamma-Ray bursts

supervisor: Prof. Silvia Celli

external-supervisor: Dr. Angela Zegarelli

description: KM3NeT/ARCA neutrino telescope is located in the Mediterranean sea, 100 km off-shore Portopalo di Capo Passero in Sicily. It consists of several vertical string-like structures equipped with optical sensors, namely each string is made of eighteen Digital Optical Modules (DOMs), with in turn 31 photomultipliers (PMTs) each. Those PMTs measure Cherenkov radiation emitted by charged particles produced by neutrino passage in seawater and their subsequent interactions. Muons produced by charged current interactions travel through the volume of the detector and leave a track-like signature. KM3NeT reconstruction algorithms are able to infer the energy and direction of the incoming neutrino, starting from PMT information. In this context, the identification of neutrinos from Gamma-Ray Bursts (GRBs) would provide new insights into the physics of processes happening inside those sources, which are still poorly understood. The goal of this thesis project is to perform a statistical analysis, to determine which are the ideal parameters that optimize the discovery capability of ARCA to GRBs neutrinos. The analysis, conducted on track-like events, exploits Monte Carlo neutrino simulations performed for a transient point source, like a GRB, for ARCA in a 115-lines configuration, i.e. one instrumented Building Block (BB). Then, the detector response functions, as the effective area and the point spread function, are studied, in order to know how many signal and background events we may expect, given a certain flux, and with which angular resolution. As a final goal, the sensitivity of the ARCA detector, with 1 BB, to a point-like cosmic neutrino flux from GRBs is investigated in the muonic flavour.

Bachelor thesis

title: The mass-metallicity relation in galaxies and its interpretation

supervisor: Prof. Maria Francesca Matteucci

co-supervisor: Dr. Emanuele Spitoni

description The aim of this thesis poject is to study the mass-metallicity relation in galaxies. This relation relates the mass of stars in galaxies to the relative abundance of oxygen in the interstellar medium, called metallicity, and has been studied taking into account the observational relation found by Curti et al.(2020). I've done a computational work, in which I studied different galactic evolution models and put constrains on them in order to reproduce the observational data. The results can be summarized as follows: it is necessary to assume that galaxies undergo phenomena of infalls and outflows of gas from the galactic system and that the parameters describing them change with stellar mass in galaxies; the comparison between these data and our theoretical models suggests that galactic winds must be more intense compared to what has been previously predicted in other studies; this new difference can be due to the more robust calibration method used in the observation of metallicity in galaxies by Curti et al. (2020). Then, has been confirmed that models which include galactic flows can put constrains on the parameters, like infall and galactic winds, provided that the hypothesis of instantaneous recycling is still a valid approximation.

Communication skills

Italian, mother tongue.

English, Level B2.

- From March 2024 to June 2024: **AcES Academic English Course** (50 hours).
Production of written papers and oral presentations, practice of academic writing and speaking, complemented by listening and reading activities, principles and praxis of academic literacy and proficiency, improving students' skills about academic texts in English, from syntax to style.

-2020-2022 Master course at the University of Rome, La Sapienza, completely English taught
-04/2016: Cambridge Certificate
-2011: Summer stage in Winchester

Latin, as a written language.

-2012-2017: studied translation from Latin to Italian

Greek, as a written language.

-2012-2017: studied translation from Greek to Italian

Computing skills

Operating systems	macOS,Linux
Tools	ROOT,Numpy,Jupyter,GitHub,GitLab
Languages	C,C++,Python,Fortran,MATLAB
Document	LaTeX, Microsoft Office packages
Content Management	Wikipedia Editing, WordPress

Other skills

Writing.

-2015-2017: Taking part to the course of editorial writing at the association "Il Paese che non c'e'" in Bergamo.

-2014-2015: Taking part to base and advanced creative writing course of the association "Il Paese che non c'e'" in Bergamo.

Experiences

From April 2021: Plastic Free volunteer

From March 2021 to October 2022: Student Representative in Physics Department Council at the University of Rome, La Sapienza

11/2015-12/2015: Guide at the art exhibit "Lo Specchio attraversato" for the association "The Blank Contemporary Art", in Bergamo.

2015: Taking part to the regional selection of the International Philosophy Olympiads with a dissertation about Immanuel Kant.