Matteo Folcarelli

2° year PhD Student · Astroparticle physics

matteo.folcarelli@uniroma1.it

I am a second-year PhD student with a long-standing interest in particle physics and the mechanisms underlying our universe. This passion has shaped my academic career, which has focused on the study of theoretical physics of fundamental interactions throughout my master's degree. Starting from my master's thesis and continuing into my PhD, my interest in the direct detection of dark matter has led me to collaborate with experiments in this field aimed at detecting this elusive form of matter. Alongside my academic career, I am actively involved in tutoring activities offered by my university for undergraduate and graduate students. In my free time, I volunteer as a scout leader, promoting civic engagement and outdoor activities among young people aged 16 to 21.

About me

Nationality

Italian

Education

Sapienza University of Rome

Piazzale Aldo Moro, 5, 00185
Roma RM
2023 - today

PhD student

- Data analysis and commissioning of the BULLKID-DM experiment
- Advisor: Prof. Marco Vignati
- Thesis topic:
  BULLKID-DM in a direct dark matter experiment sensible to the particle mass range O(GeV) and below. Its innovative detector consists of a fully-active array of silicon wafers to form a monolithic structure without inert materials. The wafers are carved in dice sensed by phono-mediated cryogenic kinetic inductance detectors (KIDs). During my first year of PhD I was mainly involved in the evaluation of the future sensitivity of the experiment to the WIMP-like particles and I guided the choice of the shielding system against particle backgrounds of natural radioactivity. In this second year, I'm mainly interested in the energy calibration of the demonstrator of the experiment through the use of external radioactive sources. The scope is both to validate the standard energy calibration of the experiment, based on optical photons, and to characterize the detector response to particle signals.
- Supplementary studies: Probabilistic inference and forecasting in sciences. Underground physics: theory and experiments. Introduction to cryogenic detectors and characterization of kinetic inductance detectors

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MASTER DEGREE *2023*

- Graduated with honors
- Thesis title: Characterization of the CYGNO experiment prototype during the underground campaign at LNGS
- Advisor: Prof. Andrea Messina
- Thesis topic:
  The CYGNO collaboration is a dedicated research group with the primary focus on establishing a high-resolution Time Projection Chamber (TPC) employing optical readout through gas electron multipliers (GEMs) at the INFN Gran Sasso Laboratories (LNGS). The goal is to achieve a 3D tracking, with head tail capability, and background rejection down to O(keV) energy, in order to explore the O(GeV) mass range both for SI and SD coupling. During my thesis project, I actively participated in the underground commissioning of the LIME prototype of the CYGNO experiment at LNGS. Throughout my thesis work, I had the privilege of gaining hands-on experience across various research aspects, encompassing technical aspects of the prototype and extensive data analysis. My main contributions included conducting an initial assessment of the diffusion coefficient of ionized electrons in the gas mixture and a comprehensive 3D reconstruction of particle tracks within the detector. In addition, I engaged in the critical challenge of distinguishing between the signatures of electronic recoil (ER) and nuclear recoil (NR) events. Specifically, I conducted a comparative analysis between two dataset, one of which had a high rate of nuclear scattering events through the use of an external source of Americium-Beryllium.
- Main studies: Quantum field theory. Standard model of particle physics: phenomenology and BSM models. Neutrinos and dark matter physics.

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BACHELOR DEGREE *2021*

- Graduated with honors
- Thesis title: Semiclassical Approximation and Supersymmetric formulation
- Advisor: Prof. Carlo Presilla
- Thesis topic:
  The semiclassical approximation is a well-known method for solving the Schrödinger equation perturbatively. Supersymmetry, on the other hand, is an analytical technique used to solve the same equation for a specific class of Hamiltonians. My thesis describes a novel and promising approach to combine these two techniques, aiming to develop a more powerful method for solving the Schrödinger equation.
- Supplementary studies: Asymptotic methods for differential equations. Advanced Electromagnetism Course within the Excellence Program.

Liceo Scientifico Francesco Severi

Viale Europa, 36, 03100
Frosinone FR

HIGH SCHOOL DEGREE *2018*

- Graduated with honors
- Thesis topic: Why physics makes us free?

Publications

PUBLISHED

Cygno collab. 2024. The CYGNO project for directional Dark Matter searches. PoS TAUP2023

D.Delicato et al. 2024. Germanium target sensed by phonon-mediated kinetic inductance detectors. `https://arxiv.org/pdf/2412.07379`

IN PREPARATION

M.Folcarelli for the Cygno collaboration. Cygno 3D reconstruction

M.Folcarelli for the BuLLKID-DM collaboration. Physics reach of the BULLKID experiment: background and sensitivity limits

M.Folcarelli for the BuLLKID-DM collaboration. Calibration of bulk events in the BULLKID-DM experiment

Presentations

INVITED TALKS

Matteo Folcarelli. Summer 2024. *Below threshold events in BULLKID*. Invited talk: EXCESS Workshop 2024, Sapienza University of Rome

Poster sessions

Matteo Folcarelli. Autumn 2024. *Physics reach of the BULLKID-DM experiment: background and sensitivity limits*. Poster: Third INFN school of underground Physics, Bertinoro(FC), Italy

Outreach & Professional Development

Outreach

2018-today	**FSE scout leader**,	*Frosinone (FR), Italy*

Tutor activities & scholarships

2019-2021	**Scholarship at the physics department library**,	*Sapienza University of Rome, Italy*
2021-2022	**Scholarship at the physics department laboratory of electronics**,	*Sapienza University of Rome, Italy*
2022-2023	**Tutor for the circuit laboratory course in the Bachelor's Degree in Physics**, Prof. A. Di Domenico	*Sapienza University of Rome, Italy*
2025	**Tutor for the Mechanics course in the Bachelor's Degree in Physics**, Prof. F. Bellini	*Sapienza University of Rome, Italy*

Development

INFN School of Statistics, 2024, Paestum (CE)
Advanced PhD School with the aim of providing an overview of statistical methods and tools used in particle, astroparticle and nuclear physics.

INFN School of Underground Physics, 2024, Bertinoro (FC), Italy.
Advanced PhD school with the aim of deeply investigate, both theorethically and experimentally, the topics related to underground physics.

PhD course in "Probabilistic inference and forecasting in sciences", 2024, Prof. Giulio D'Agostini, Sapienza University of Rome, Italy.

Skills & hobbies

Amateur astrophotographer

Programmer in Python, C++, Arduino, Raspberry Pi

English level: B2

F.to
Matteo Folcarelli
Ai fini della pubblicazione