

Candidate: Elena Pinetti

Tutor: Prof. Nicolao Fornengo

Title of the Thesis: From gamma rays to radio waves: dark matter searches across the spectrum

PhD Cycle: XXXIV

Co-tutored: Sorbonne University (Paris, France) - Tutor: Prof. Marco Cirelli

Research activity

The research activity of Elena Pinetti covers a wide spectrum of studies toward the identification of a solution to the dark matter problem.

She explored, in a seminal study, the potentiality of a new method based on the statistical cross correlation between a particle physics signal due to dark matter (specifically, gamma rays, relevant for heavy dark matter) and the distribution in the Universe of neutral hydrogen (observed through the HI line emission, observed at radio telescopes) as a proxy of dark matter distribution. This paper determined the capabilities of this new method to explore dark matter with current and future observational facilities.

A second analysis investigated a different frequency where a dark matter signal can be looked for, namely X rays, which are relevant for lighter dark matter particles. In this case, relevant bounds on the dark matter particle physics properties were obtained, by looking at the galactic dark matter signal.

Elena then participated to the analysis where filamentary structures in the Universe were discovered. These filaments connect galaxies and are expected as a consequence of cosmological structure formation. This is the first time they are identified in radio, and Elena investigated the hypothesis that the radio signal is originated by dark matter particles decaying into electrons, which in turn produce the radio emission through synchrotron emission. She derived under which circumstances (concerning the dark matter content of the filament, the environmental properties of the magnetic confinement and the particle physics properties of the dark matter particles) the observed signal can be due to dark matter.

Elena is currently working on two further projects. In the first, the particle dark matter gamma ray emission is studied at the fluctuation level, due to its inhomogeneous distribution in the Galaxy and in the Universe. In the second, fluctuations are again the main tool of investigation, in this case studies through the cross-correlation of galaxies distribution with the high-energy gamma rays. The study aims at forecasting the cross-correlation signal in view of the future observational campaigns of the Cerenkov Telescope Array (CTA). This study is in a more preliminary phase.

More recently she started to investigate primordial black holes as a solution to the dark matter problem, as an alternative to a particle physics solution.

Assessment of the candidate

During her research activity, Elena Pinetti showed excellent analytical skills, great work autonomy and strong determination, not separated from a strong sense of collaboration appreciated by all the people she worked with.

Her level of competence in understanding the physical phenomena at stake and in mastering the theoretical and computational tools necessary for the analysis is excellent, as well as her ability to personally manage a complex and technically demanding research program. She also exhibits strong leadership abilities and diverse interests

It is significant to point out the lively and broad nature of Elena Pinetti's scientific interests, as evidenced by her diversified activities, which span from cosmological to astrophysical to particle physics aspects. Starting from a common denominator represented by dark matter, she branches out in different directions covering the whole multimessenger and multiwavelength spectrum of astroparticle physics investigation and various types of dark matter candidates.

The overall judgment of Elena Pinetti's work and capabilities is therefore excellent.

Torino, 31 May 2021



PAPERS

Pinetti, Camera, Fornengo , Regis

SYNERGIES ACROSS THE SPECTRUM FOR PARTICLE DARK MATTER INDIRECT DETECTION: HOW HI INTENSITY MAPPING MEETS GAMMA RAYS

Published in: JCAP 07 (2020), 044, JCAP07(2020)044

e-Print: 1911.04989 [astro-ph.CO]

Cirelli, Fornengo, Kavanagh, Pinetti

INTEGRAL X-RAY CONSTRAINTS ON SUB-GEV DARK MATTER

Published in: Phys.Rev.D 103 (2021) 6, 063022

e-Print: 2007.11493 [hep-ph]

Vernstrom, Heald, Vazza, Galvin, West, Locatelli, Fornengo, Pinetti

DISCOVERY OF MAGNETIC FIELDS ALONG STACKED COSMIC FILAMENTS AS REVEALED BY RADIO AND X-RAY EMISSION

Published in: Mon.Not.Roy.Astron.Soc. (2021)

e-Print: 2101.09331 [astro-ph.CO]

Korsmeier, Fornengo, Negro, Pinetti, Regis

BOUNDS ON UNRESOLVED GAMMA RAYS SOURCES AND ON DARK MATTER FROM 1 AND 2 POINTS STATISTICS OF FERMI-LAT MAPS

in preparation

Camera, Cuoco, Fornengo, Pinetti, Vodeb, Zaharijas

CTA PROSPECTS FOR DARK MATTER SEARCHES THROUGH ANGULAR CORRELATIONS

in preparation

Petrakj, Pinetti, Silk, Wu

THE COSMIC COINCIDENCES OF PRIMORDIAL-BLACK-HOLE DARK MATTER

in preparation

INVITED SPEAKER AND SEMINARS

LABORATOIRE D'ANNECY-LE-VIEUX DE PHYSIQUE THÉORIQUE
Seminar: Constraining sub-GeV dark matter with indirect detection
2020, Annecy-le-Vieux (France)

BSM PANDEMIC DOUBLE FEATURE
Talk: Integral X-ray constraints on sub-GeV dark matter
2020, Virtual talk

INITIATIVE FOR COSMOLOGY AND ASTROPARTICLE PHYSICS (ICAP)
Talk: Integral X-ray constraints on sub-GeV dark matter
2020, Virtual talk

PERIMETER INSTITUTE
Talk: Cross-correlation between 21cm intensity mapping and gamma rays: a new path for particle dark matter searches Waterloo (Canada)
2020, Virtual talk

INITIATIVE FOR COSMOLOGY AND ASTROPARTICLE PHYSICS (ICAP)
Talk: Cross-correlation between 21cm intensity mapping and gamma rays: a new path for particle dark matter searches
2020, Institut d'Astrophysique de Paris (France)

UNIVERSITY OF WESTERN CAPE
Seminar: Particle Dark Matter indirect detection: how 21cm intensity mapping meets gamma rays
2010, Cape Town (South Africa)

CONFERENCE SPEAKER

PPC2021
Talk: Integral X-ray constraints on sub-GeV Dark Matter
2021, University of Oklahoma (online)

PONT 2020
Talk: Integral X-ray constraints on sub-GeV dark matter
2020, Virtual conference

3RD SOUTH AMERICAN DARK MATTER WORKSHOP
Talk: Integral X-ray constraints on sub-GeV dark matter
2020, Virtual conference

KASHIWA DARK MATTER SYMPOSIUM 2020
Talk: Integral X-ray constraints on sub-GeV Dark Matter

2020, Virtual conference

COSMOLOGY FROM HOME 2020

Talk: Cross-correlation between 21cm intensity mapping and gamma rays: a new path for particle dark matter searches

2020, Virtual conference

RENCONTRES DE PHYSIQUE DES PARTICULES 2020

Talk: Particle dark matter searches through cross-correlations between gamma-rays and neutral hydrogen intensity mapping

2020, Palaiseau (France)

SKA COSMOLOGY SWG

Talk: Cross-correlation between 21cm intensity mapping and gamma rays: a new path for particle dark matter searches

2020, Paris (France)

TAUP 2019 - International Conference on Topics in Astroparticle and Underground Physics

Talk: Dark Matter and Cosmology through cross-correlations with intensity mapping of neutral hydrogen

2019, Toyama (Japan)

COSMO2019

Talk: Dark Matter and Cosmology through cross-correlations with intensity mapping of neutral hydrogen

2019, Aachen (Germany)

Talks to be delivered after this report but before the end of the PhD:

Cortona Young, GGI

Talk: Integral X-ray constraints on sub-GeV Dark Matter

2021, Galileo Galilei Institute (online)

ICRC 2021

Talk: Integral X-ray constraints on sub-GeV Dark Matter

2021, DESY (online)

VISITING SCIENTIST

UNIVERSITY OF WESTERN CAPE
2019, Cape Town (South Africa)

SCHOOLS

INTERNATIONAL SCHOOL ON ASTROPARTICLE PHYSICS
2019, Max Planck Institute, Heidelberg (Germany)

THEORETICAL ASPECTS OF ASTROPARTICLE PHYSICS, COSMOLOGY AND GRAVITATION
2019, Galileo Galilei Institute, Arcetri (Italy)

XII TONALE WINTER SCHOOL IN COSMOLOGY
2018, Heidelberg University, Passo del Tonale (Italy)

SUMMER SCHOOL ON LARGE-SCALE STRUCTURE
2018, Max Planck Institute for Astrophysics, Berlin (Germany)

PHD COURSES

Title: Introduction to large N-limit

Title: Standard Model Effective Field Theory and its applications in Flavour Physics

Title: Dark Matter and Neutrino Physics

Title: Non perturbative aspects of classical and quantum field theory

Title: Liaisons with the corporate and business world (Sorbonne and Boston Consulting Group)