PERSONAL INFORMATION

Andrew L. Miller

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APPOINTMENTS

Jan. 2023 – present — Postdoctoral Researcher

Nikhef - National Institute for Subatomic Physics/ Utrecht University, Amsterdam, Netherlands

Research Working on anomaly detection and machine learning methods to classify different types of glitches in GW detectors. Supervisors: Chris van den Broek and Sarah Caudill

Responsibilities Working with two PhD students, one Masters student and one Bachelors student on their implementations of anomaly detection methods and superradiance from vector boson clouds around rotating black holes

Jan. 2020 – Dec. 2022 — FSR Postdoctoral Fellow

Université catholique de Louvain, Louvain-la-Neuve, Belgium

Research Developing methods to detect dark matter interacting with gravitational-wave detectors; vector boson clouds around black holes, a stochastic background, and primordial black holes. Supervisor: Giacomo Bruno

Responsibilities Building up a Virgo group, organizing seminars, mentoring students, diversity and outreach.

First Belgian Fellowship In April 2021, awarded a fellowship from the Special Research Fund (FSR) to support research in any discipline; competitive: only 14 out of 74 applicants were awarded this fellowship

Second Belgian Fellowship In May 2022, awarded the prestigious Chargé de Recherches postdoctoral fellowship from the Belgian National Fund for Scientific Research (FNRS) in Belgium; extremely competitive

Aug. – Dec. 2019 — Institute for High Energy Physics and Astrophysics (IHEPA)

IHEPA, University of Florida, Gainesville, FL, USA

Fellowship Awarded to pursue my PhD research at the Institute for Cosmic Ray Research in Japan.

Nov. 2016 – Aug. 2019 — Graduate Student Mentor

University of Florida International Research Experience for Undergraduates (IREU) program

Mentored undergraduates who travel to Europe or Australia to do research each summer.

Aug. 2015 – Aug. 2019 — Graduate Student Fellow (GSF)

University of Florida (UF), Gainesville, FL, USA

Fellowship Awarded 4 years of funding to pursue any research direction from UF during my PhD.

FELLOWSHIPS

June 2022 — “Chargé de recherches” postdoctoral fellowship

3-year fellowship awarded by the Fonds de la Recherche Scientifique (FNRS), the National science funding agency in Belgium. Extremely competitive.

Jan. 2022 — Archival Research Fellowship

Awarded by the European Space Agency for two one-month visits to ESAC to support archival research of LISA Pathfinder data in Madrid, Spain. Very competitive.

April 2021 — FSR incoming postdoctoral fellowship

2-year fellowship awarded from the Special Research Fund (FSR) at the Université catholique de Louvain to support research in any discipline. Very competitive; only 14 out of 74 proposals selected.

August 2019 **IHEPA fellowship**

Semester-long fellowship awarded by the Institute for High Energy Physics and Astrophysics at the University of Florida to pursue my PhD research at the Institute for Cosmic Ray Research in Japan

March 2015 **Graduate student fellowship**

4-year fellowship Awarded by the University of Florida to pursue research for my PhD in any discipline. Only awarded to 3 out of about 30 incoming PhD students

RESEARCH VISITS

24 April –3 May 2024 **Indian Institute of Technology (IIT), Bombay**

Mumbai, India

12–16 Dec. 2023 **Inter-University Centre for Astronomy and Astrophysics (IUCAA)**

Pune, India

Research Invited to visit Debarati Chatterjee to consult on continuous gravitational-wave searches for dark matter and neutron stars

Sept. – Nov. 2023 **International Center for Theoretical Physics, Asia-Pacific (ICTP – AP)**

Beijing, China

Research Working on the synergy of dark-matter and gravitational-wave physics by developing methods to search for mini extreme-mass ratio inspirals systems with Huaike Guo

7 – 19 May 2023 **ICTP – South American Institute for Fundamental Research (SAIFR)**

São Paulo, Brasil

e

Oct. – Nov. 2022 **European Space Agency**

Madrid, Spain

Research Analyzing LISA Pathfinder data to look for signatures of ultralight dark matter that could have directly interacted with the test masses when this mission flew

Fellowship In January 2022, awarded a fellowship from the European Space Agency to visit the European Space Astronomy Centre to collaborate with Luis Mendes on searching LISA Pathfinder data for ultralight dark matter

12 – 18 June 2022 **Los Alamos National Laboratory**

New Mexico, USA

Research Collaborated with Grant Meadors, Jonah Miller, Soumi De and others on ways to improve searches for boson clouds around black holes, use atom interferometry, and constrain the neutron star equation of state

Oct. 2021 – Nov. 2021 **AMALDI Research Center, Sapienza Università di Roma**

Rome, Italy

Research Collaborated on projects related to using machine learning to detect long-lived gravitational waves from young neutron stars

Oct. 2020 – Dec. 2020 **Sapienza Università di Roma**

Rome, Italy

Research Collaborated on projects related to direct dark matter detection with gravitational-wave interferometers, and to detecting boson clouds around black holes

Aug. 2019 – Nov. 2019 **Institute for Cosmic Ray Research (ICRR)**

Kashiwa, Japan

Research Collaborated with KAGRA members on developing an estimation of significance for continuous-wave and stochastic gravitational-wave searches, and on establishing an interactive data analysis tool for plotting KAGRA data.

Fellowship Awarded a fellowship to pursue this research by the Institute for High Energy Physics and Astrophysics (IHEPA) at the University of Florida.

EDUCATION

Nov. 2016 – Nov. 2019 **PhD in Physics - Thesis Title: "Using machine learning and the Hough Transform to search for gravitational waves due to r-mode emission by isolated neutron stars"**

Joint PhD between Sapienza Università di Roma, Rome, Italy and University of Florida, Gainesville, FL, USA.

Grade Summa cum laude ("Ottimo con lode")

Supervisors Pia Astone and Bernard Whiting

Aug. 2015 – Dec. 2016 **Master's of Science in Physics**

University of Florida, Gainesville, FL, USA

Aug. 2011 – May 2015 **Bachelor's of Science in Physics**

The College of New Jersey, Ewing, NJ, USA

Honors Summa cum laude, Valedictorian of the Department of Physics

Scholarship Awarded a merit scholarship to attend this institution

TEACHING EXPERIENCE

20–26 Aug. 2023 **Lecturer, Astrocamp, [Link]**

CEIA Centro de Educação e Interpretação Ambiental, Portugal

Course Title: Gravitational-wave astrophysics: a new window into the universe

Invited one-week lecture series, consisting of 15 hours of lectures, 9 hours of practical/exercise classes, and 4 hours of written exams, targetting exceptionally bright high school students throughout Europe, the Middle East and the US

Aug. 2015 – Dec. 2016 **Teaching Assistant**

University of Florida, Gainesville, FL, USA

PHY2048: Physics with Calculus 1

Fall 2015, spring 2016 and fall 2016 semesters

Taught three classical mechanics labs or four mechanics problem solving sessions.

Aug. 2014 – May 2015 **Physics Tutor**

Department of Physics, The College of New Jersey, Ewing, NJ, USA

Tutored introductory classical mechanics, electrodynamics, modern physics, and mathematical physics.

Aug. 2013 – May 2014 **Physics and Math Tutor**

Tutoring Center, The College of New Jersey, Ewing, NJ, USA

Tutored introductory classical mechanics, electrodynamics, modern physics, mathematical physics, calculus, linear algebra and differential equations.

Aug. 2012 – May 2013 **Lab Assistant**

Department of Physics, The College of New Jersey, Ewing, NJ, USA

Set up and assisted with introductory classical mechanics and electrodynamics labs.

LEADERSHIP ROLES

May 2023 – Feb 2024 **Nikhef-wide "Junior Colloquim" co-organizer**

Nikhef

Coordinate approximately bimonthly seminar series at Nikhef designed for PhD students to practice giving conference talks in a safe, supportive environment.

Feb 2021 – May 2022 **Project manager, paper writing team chair and lead analyst**

LIGO/Virgo/KAGRA collaborations

Collaboration paper on a search for dark photon dark matter using data from LIGO/Virgo's third observing run. Responsible for the scientific output and the publication of this analysis.

May 2020 – May 2022 **Project manager, paper writing team chair and analyst**

LIGO/Virgo/KAGRA collaborations

Collaboration paper on a search for gravitational waves from boson clouds around black holes using data from LIGO/Virgo's third observing run. Responsible for the scientific output and the publication of this analysis.

Nov. 2020 – Mar. 2021 **Virgo Early Career Scientists (VECS) seminar series co-organizer**

Virgo collaboration

Co-organize a virtual seminar series that promotes the work of early career scientists in the Virgo collaboration.

Aug. 2020 – May 2021 **Project manager and paper writing team co-chair**

LIGO/Virgo/KAGRA collaborations

Collaboration paper titled "Diving below the spin-down limit: Constraints on gravitational waves from the energetic young pulsar PSR J0537-6910."

Co-managed the writing of the paper and the presentation/interpretation of results. Responsible for the scientific output and the publication of this analysis.

March 2020 – Dec. 2022 **Departmental seminar series co-organizer**

Université catholique de Louvain

Coordinate weekly seminar series at Université catholique de Louvain by inviting prominent gravitational-wave physicists.

Jan. 2020 – Oct. 2020 **Paper writing team co-chair**

LIGO/Virgo collaborations

Collaboration paper on a search for gravitational waves from three millisecond pulsars and two very young pulsars. Co-managed the writing of the paper and the presentation/interpretation of results. Paper: Gravitational-wave constraints on the equatorial ellipticity of millisecond pulsars.

CONFERENCE ORGANIZING

Co-organizer, LOC

6–10 May 2024 Einstein Telescope Symposium (link).

Conference dedicated to encouraging interactions in the Netherlands between gravitational-wave physicists working on machine learning.

Main organizer, SOC and LOC

11–13 July 2023 Multi-Messenger Continuous Gravitational Waves (link).

First conference dedicated to detecting continuous gravitational waves from neutron stars and dark matter, and interacting with the astronomy community for this purpose

Invited speakers, organized all logistical aspects of the conference, and set up tutorials to enable newcomers to enter the field of gravitational-wave astronomy

Co-organizer

14–15 June 2023 Gravitational-wave retreat (link).

Event meant to foster connections different people on the instrumentation, theory and computational sides of gravitational-wave physics

Main organizer

18 Nov. 2022 Second Virgo LGBTQ+ STEM Day virtual conference (link).

Seminar organizer

20 Jan. 2021 "When the M meets the P" (link).

Annual event meant to foster connections between mathematicians and physicists at UCLouvain; arranged for a seminar on diversity at this event

Co-organizer

18 Nov. 2020 First Virgo LGBTQ+ STEM Day virtual conference (link).

Member of the Organizing staff

19–21 Feb. 2019 First European Physical Society Conference on Gravitation, Rome, Italy.

20–31 Aug. 2018 International Astronomical Union (IAU) General Assembly, Vienna, Austria.

1–7 July 2018 Fifteenth Marcel Grossmann Meeting, Rome, Italy.

DIVERSITY EFFORTS

18 November 2022 Virgo LGBTQ+ STEM day

Co-organizer; Found speakers to discuss their research and experiences of LGBTQ+ advocacy in academia

7–11 November 2022 The importance of LGBTQ+ STEM day

Presented at the Virgo week diversity session about why this event matters to both LGBTQ+ and non-LGBTQ+ scientists, and our plans for the event

15–18 November 2021 Joining the Multi-messenger Diversity Network (MDN)

Presented at the November Virgo week, Cascina, Italy

19–22 April 2021 Updating the Virgo non-discrimination and anti-harassment policy

Presented (by Kevin Turbang) online to the April Virgo week, Cascina, Italy

15–18 March 2021 Mental health survey: Gauging the mental health within the LIGO/Virgo/KAGRA collaborations

Presented (by Kamiel Janssens) online to the LIGO/Virgo/KAGRA collaboration meeting, Milwaukee, WI, USA.

18 November 2020 Virgo LGBTQ+ STEM day

Co-organizer; Introduced the purpose of LGBTQ+ in STEM day, facilated discussions, and found speakers for the event

6–9 July 2020 Structural racism in academia

Invited presentation at the online July Virgo Week meeting, Cascina, Italy.

RESEARCH SUPERVISION

Aug. 2023–present Cooperating in directing the Masters thesis of Charchit Kumar Sethi at Cologne University.

Jan. 2023–present Helping with the Ph.D. thesis of Melissa Lopez at Utrecht University.

Jan. 2023–present Helping with the Ph.D. thesis of Stefano Schmidt at Utrecht University.

April 2021–Oct. 2022 Cooperating in directing the Masters thesis of Vincenzo Rella at Sapienza Università di Roma. Thesis project: "Simulating a tensor boson interaction with gravitational-wave interferometers".

Jan. 2020–present Cooperating in directing the Ph.D. thesis of Federico De Lillo at Université catholique de Louvain. Thesis project: "Searching for a stochastic gravitational-wave background".

Jan. 2020–present Cooperating in directing the Ph.D. thesis of Antoine Depasse at Université catholique de Louvain. Thesis project: "Searching for boson cloud signals in LIGO and Virgo data".

UNDERGRADUATE RESEARCH SUPERVISION

June – Aug. 2023 Lianys Feliciano, IREU student from City University of New York. Project: Separating overlapping gravitational-wave signals from long-lived binary neutron star inspirals in Einstein Telescope using the Hough Transform.

Jan.–July 2023 Sam Meije, Bachelors student at Utrecht University. Project Title: Searching for transient gravitational waves from vector boson clouds around rotating black holes.

Nov. 2021–May 2022	Arthur Rigaux, Bachelors student at UCLouvain. Project Title: Deriving new constraints on boson clouds around spinning black holes based on recent LIGO data.
Feb.–May 2021	Maxime Harvengt, Bachelors student at UCLouvain. Project Title: "Ondes gravitationnelles continues provenant d'étoiles à neutrons isolées" (Continuous gravitational waves from isolated neutron stars).
May–Aug. 2019	Teresita Ramirez, IREU student from California State University, Fullerton, CA, USA. Project Title: "Parameter estimation of power-law gravitational-wave signals using machine learning".
May–Aug. 2018	Jessica Leviton, IREU student from University of Michigan, MI, USA. Project title: "Inaccuracies in Correction Parameters and Long Duration Transient Source Recovery".
May–Aug. 2017	Avi Vajpeyi, IREU student from The College of Wooster, OH, USA. Project title: "Enhancing Long Transient Power Spectra with Filters".

OUTREACH EFFORTS

17–19 April 2024	Gravitational-wave Open Data Workshop, Taiwan I negotiated to have a tutorial given on continuous gravitational-wave science at this workshop aimed at educating undergraduate students about how the LIGO/Virgo collaborations conduct searches for long-lived signals, in contrast to the short-lived mergers of compact objects. Until this workshop, continuous-wave science had no representation to the public.
24 Mar. 2022	*Towards understanding neutron stars with continuous gravitational waves*, I moderated this LIGO/Virgo/KAGRA webinar to promote continuous-wave searches from known sources; over 100 participants
24 Feb. 2022	*Searching for continuous gravitational waves from unknown sources*, LIGO/Virgo/KAGRA webinar to promote continuous-wave searches; spoke about the search we performed for dark photon dark matter and primordial black hole binaries; over 75 participants
1 Dec. 2021	*Observations constraining dark matter clouds around spinning black holes in our galaxy*, science summary for an LVK collaboration paper "All-sky search for gravitational wave emission from scalar boson clouds around spinning black holes in LIGO O3 data".
27 May 2021	*Ultralight dark matter eludes detection*, science summary for an LVK collaboration paper "Constraints on dark photon dark matter using data from LIGO's and Virgo's third observing run".
20 Jan. 2021	Continuous gravitational waves from neutron stars Talk given to the Institute for Research and Mathematics at the annual "When the M meets the P" event that fosters collaborations between Mathematicians with Physicists at the Institute
31 Oct. 2020	*Halloween is Dark Matter Day!*, outreach article on how gravitational waves can be used to probe the existence of dark matter.
29 July 2020	*No mountains yet on millisecond pulsars*, science summary for the LVK collaboration paper "Gravitational-wave constraints on the equatorial ellipticity of millisecond pulsars".
June 2020 – Dec. 2022	Website manager for gravitational-wave activities in Belgium Manage virgo-gw.be and gravitatationalwaves.be, websites that highlight Belgium's contributions to Virgo and to gravitational-wave physics as a whole, respectively.
3 May 2016	Gravitational waves: Theory, Detection, and Prospects Outreach talk to The College of New Jersey.
22 May 2015	An overview of gravitational-wave physics: experiments and data analysis techniques Invited outreach talk to the Pascack Hills High School Research Symposium.

AWARDS

21 June 2022	Awarded the "Chargé de recherches" (postdoctoral) fellowship by the Fonds de la Recherche Scientifique (FNRS) National fellowship in Belgium to support research in any discipline. Extremely competitive.
February 2022	Awarded travel and Funding Early Career Scientists (FECS) grants to attend April APS meeting Support to attend the April 2022 APS meeting in New York and present my work on searching for boson clouds around spinning black holes
10 Jan. 2022	Selected to participate in the ESA Archival Research Vistor Program.

	Support to visit the European Space Science Center and develop methods to search LISA Pathfinder data for ultralight dark photon dark matter
26 July – 20 August 2021	Admitted to the Les Houches Summer School 2021: Dark Matter, Les Houches, France.
11–28 July 2021	National Science Foundation Simons Foundation Grant
	Support to attend the workshop “Exploring Extreme Matter in the Era of Multimessenger Astronomy: from the Cosmos to Quarks”, Aspen Center of Physics, Aspen, CO, USA.
14 June 2020	Honorable Mention, GWIC-Braccini Thesis Prize.
Aug. – Dec. 2019	IHEPA fellowship.
20 Oct. 2017	2nd place for presentation in Multiwavelength Astronomy and Astrophysics Section at the Young Scientists Forum in Lviv, Ukraine.
17–20 Oct. 2017	Awarded a €100 travel grant to attend the Young Scientists Forum in Lviv, Ukraine
3–12 July 2017	Awarded a €900 grant to attend International School of Physics "Enrico Fermi" - Varenna, Lake Como, Italy Course on: Gravitational Waves and Cosmology
22 May 2015	Fink-Moses-Pregger Physics Award for highest grade point average in the physics department at The College of New Jersey.
22 May 2015	Leadership and services award from The College of New Jersey physics department.
15 April 2015	Sigma Pi Sigma, Phi Beta Kappa, and Phi Kappa Phi honors society inductee
11-14 April 2015	Awarded $500 to present at the April APS meeting, Baltimore, MD, USA

SKILLS

Excellent communicator, independent and collaborative researcher, experienced data analyst with expertise in machine learning, signal processing, statistics, Matlab, and Python

SERVICE WORK

May. 2022 – present	Member, Speakers committee for the Virgo Scientific Collaboration
Sept. 2022 – present	Career Mentoring Fellow, American Physical Society
Jan.–Dec. 2022	Member, Continuous-wave first detection readiness committee for LIGO/Virgo/KAGRA
16–19 May 2022	Session Chair, Pharos conference on multi-messenger physics of neutron stars
Jan. 2020–present	Member, Virgo Diversity, Equity and Inclusion Committee
Jan. 2020–present	Referee for Physical Review D, Letters and Astrophysical Journal
Feb. 2019–present	Reviewer within the LIGO/Virgo/KAGRA collaboration for analyses that search for isolated neutron stars, gravitational-wave lensing, and electromagnetic counterparts

RESEARCH TRACK RECORD

Continuous gravitational waves from isolated neutron stars

2014-2016 I began my career in gravitational-wave physics by determining the detection efficiency of an all-sky search method (the Frequency-Hough) for quasi-monochromatic, quasi-infinite duration gravitational waves from asymmetrically rotating neutron stars. I also studied various follow-up techniques to cluster the billions of candidates we obtain in all-sky searches, and participated in a mock data challenge that compared different methods that search for isolated neutron stars.

Collaborators: Sinead Walsh, Pia Astone, Bernard Whiting, Cristiano Palomba.

Location: Sapienza University of Rome/ University of Florida, 2014-2016.

Transient continuous gravitational waves from newborn neutron stars

2017-2018 I developed one of the first methods that searches for intermediate duration ($\mathcal{O}(\text{hours} - \text{days})$) gravitational waves from newborn neutron stars. This method is a generalization of the Frequency-Hough transform that tries to find power-law signals, and was one of four that contributed to the first-ever search for a long-lived remnant of the binary neutron star merger GW170817.

Collaborators: Alicia Sintes, David Keitel, Lilli Sun, Sharan Banagiri, and Miguel Oliver

Location: Sapienza University of Rome/ University of Florida; remote collaborations, 2017-2018

2020-2021 I have recently managed searches for continuous gravitational waves from known pulsars using data from LIGO/Virgo's third observing run, and specifically, from J0537-6910, one of the most actively glitching pulsars known. Collaborators: Matt Pitkin, Simone Mastrogiovanni, Wynn Ho

Location: Catholic University of Louvain; remote collaborations, 2020-2021.

Machine learning

2018-2019 I used artificial and convolutional neural networks to detect transient continuous gravitational waves from newborn neutron stars. This method performed equally as well as the Generalized Frequency-Hough transform, and was computationally cheaper. It was also able to detect signals that deviate slightly from a power-law model, which was a major limitation of Generalized Frequency-Hough transform. We searched again for a remnant of GW170817, and provided a framework for assessing the sensitivity and usability of machine learning methods in gravitational-wave physics. I also worked studying the sensitivity of artificial neural networks and support vector machines towards r-mode gravitational-wave signals. We showed that we could see transient signals as far as a few megaparsecs away.

Collaborators: Pia Astone, Cristiano Palomba, Bernard Whiting, Antonis Mytidis

Location: Sapienza University of Rome/ University of Florida, 2018-2019.

2019 I was also involved in the development and review of a nearest-neighbor method, called EMBright, that aims to classify components of binary mergers, and their remnants, as having a neutron star or not. This method is able to quickly output a classification on the basis of parameters returned by binary merger searches that can aid astronomers in deciding whether to follow-up particular neutron star or neutron star/black hole mergers.

Collaborators: Deep Chatterjee, Shaon Ghosh, Patrick R. Brady, Shasvath J. Kapadia, Samaya Nissanke, and Francesco Pannarale.

Location: Sapienza University of Rome/ University of Florida; remote collaborations, 2019

2021 I am involved in a project that aims to apply machine learning to continuous gravitational-wave data analysis. We are applying convolutional neural networks to estimate the sky location of a neutron star, which has so far been successful in Gaussian noise. We are testing the network on non-Gaussian artifacts (lines, glitches, combs, etc.) to see if it can distinguish those from a continuous wave and subsequently estimate the sky location of the neutron star. We are performing this analysis after taking two Fourier transforms of the strain data, which localizes in a lot fewer bins in this domain compared to the frequency domain.

Collaborators: Takahiro S Yamamoto, Takahiro Tanaka, Magdalena Sieniawska

Location: Catholic University of Louvain; remote collaborations, 2021

Dark matter: dark photons

2020-present During my postdoctoral fellowship, I have shifted my field slightly to dark matter detection via gravitational-wave interferometers. I have led the first-ever LIGO, Virgo and KAGRA search for a candidate of dark mater, the dark photon, that could directly couple to the protons and neutrons in the interferometers. Additionally, I have developed an end-to-end pipeline to detect this signal, which closely resembles both continuous gravitational waves and noise disturbances. I am now working to distinguish among different types of dark matter interactions with gravitational-wave detectors.

Collaborators: Yue Zhao, Keith Riles, Huaike Guo.

Location: Catholic University of Louvain, remote collaborations, 2020-present

Primordial black holes

2020-present I have applied the Generalized Frequency-Hough transform to look for inspiraling planetary-mass primordial black holes. The signals that come from these inspirals resemble those of transient continuous gravitational waves (both have frequency evolutions that follow power laws). Based on the sensitivity of this method, and of current and future detectors, we projected constraints on the fraction of dark matter that primordial black holes could compose. Our method can investigate an interesting mass region for primordial black holes, and can be complementary to methods already developed to search for binary mergers.

Collaborators: Sébastien Clesse, Nancy Aggarwal, Huaike Guo, Kuver Sinha

Location: Catholic University of Louvain; remote collaborations, 2020-present

Dark matter: boson clouds around black holes

2018-present I was involved in the development of a method that searches for gravitational waves from depleting scalar boson clouds around black holes. Our group also set direct constraints on black hole/boson mass combinations using the results of all-sky searches in LIGO/Virgo's second observing run. I am now managing a search for scalar boson clouds using data from LIGO/Virgo's third observing run.

Collaborators: Paola Leaci, Cristiano Palomba, Lilli Sun, Sabrina D'Antonio

Location: Sapienza University of Rome/ Catholic University of Louvain; remote collaborations, 2018-present.

2020-present I have been mentoring a PhD student working to detect vector boson clouds that could form around black holes in binary systems, such as Cygnus x-1. Vector boson clouds could emit gravitational waves that are much stronger, but also much shorter, than those of scalar bosons. Furthermore, the search for a black hole in a binary system is much more computationally heavy than that of an isolated system. We are working on developing a computationally cheap method to probe this exotic source of gravitational waves.

Collaborators: Paola Leaci, Cristiano Palomba, Magdalena Sieniawska, Antoine Depasse

Location: Sapienza University of Rome/ Catholic University of Louvain; remote collaborations, 2018-present.

Stochastic gravitational-wave backgrounds

2020-present I have become involved in the stochastic gravitational-wave group within the LIGO/Virgo/KAGRA collaborations. I was an analyst in the search for an anisotropic gravitational-wave background using data from LIGO/Virgo/KAGRA's third observing run. I am also involved in efforts to detect an intermittent background of black hole mergers, to develop a robust, modular infrastructure for stochastic gravitational-wave data analysis for isotropic backgrounds, and to apply these techniques to search for a background of gravitational waves from isolated neutron stars. I am mentoring a PhD student in these projects.

Collaborators: Shivaraj Kandhasamy Jishnu Suresh, Federico De Lillo

Location: Catholic University of Louvain; remote collaborations, 2020-present.

2020-present I have become involved in the stochastic gravitational-wave group within the LIGO/Virgo/KAGRA collaborations. I was an analyst in the search for an anisotropic gravitational-wave background using data from LIGO/Virgo/KAGRA's third observing run. I am also involved in efforts to detect an intermittent background of black hole mergers, to develop a robust, modular infrastructure for stochastic gravitational-wave data analysis for isotropic backgrounds, and to apply these techniques to search for a background of gravitational waves from isolated neutron stars. I am mentoring a PhD student in these projects.

Collaborators: Shivaraj Kandhasamy Jishnu Suresh, Federico De Lillo

Location: Catholic University of Louvain; remote collaborations, 2020-present.

Probing the GeV excess with continuous waves

2022-present I used null results from an all-sky search for gravitational waves from deformed neutron stars to constrain the existence of millisecond pulsars at the galactic center that could explain the observed GeV excess. For the first time, GW searches were used to rule out certain model parameters that predict the number of millisecond pulsars needed to explain the GeV excess. Now, I am working to develop a more optimal method to search specifically the galactic center for millisecond pulsars in binary systems, where we expect many to lie, as well as to evaluate the computational cost of performing such a directed search for neutron stars in binaries by finely resolving the sky patch in the galactic center.

Collaborators: Yue Zhao

Location: Nikhef / Utrecht University.

Detecting binary neutron star inspirals in 3G detectors

2022-present I am a member of the Einstein Telescope consortium and am working on computationally efficient methods to search for binary neutron star inspirals and sub-solar mass primordial black holes by leveraging the low-frequency sensitivity of this future instrument. By doing so, I am getting involved in early warning efforts to ensure that astronomers will have ample time to potentially see a neutron star/neutron star merger.

Collaborators: Neha Singh, Cristiano Palomba

Location: Nikhef / Utrecht University.

Machine learning for glitch identification and mitigation

2022-present I am involved in various projects to use particular statistics, such as the fractal dimension, to identify different types of glitches in the detectors, and distinguish them from astrophysical signals, using machine learning (generative adversarial networks and autoencoders). With these techniques, we have been able to reveal potentially new glitch classes, and are working to determine which auxiliary channels in the detector are responsible for observed glitches.

Collaborators: Sarah Caudill, Melissa Lopez, Stefano Schmidt and others

Location: Nikhef / Utrecht University.

INVITED TALKS [8]

10–13 October 2023 Novel probes of dark matter with continuous gravitational waves

Presented online to the 42nd International Symposium on Physics in Collision (PIC 2023), Arica, Chile

18–25 March 2023 O3 Lessons – Continuous-wave sources

Presented to the 57th Rencontres de Moriond, Gravitation session, La Thuile, Italy

13-14 Jan. 2022 Determining the existence of primordial black holes and ultralight dark matter using gravitational-wave detectors

Presented online to the Mini-workshop on Theory for High Energy Physics, Hong Kong University of Science and Technology, Kowloon, Hong Kong

27-29 Sept. 2021	Dark photon dark matter searches using LIGO/Virgo data Presented to the virtual Workshop on Very Light Dark Matter 2021, University of Tokyo, Tokyo, Japan
6-9 Sept. 2021	Dark Photon Dark Matter searches in LIGO/Virgo's third observing run Presented to the virtual LIGO/Virgo/KAGRA collaboration meeting in a panel discussion on dark matter searches with gravitational-wave detectors, IJCLab, Orsay, France
22 June 2020	Continuous gravitational waves as probes of neutron stars and dark matter in the detection era Presented online to the Belgian High Energy Physics annual meeting, Belgium.
25–29 March 2019	Characterizing machine learning's capabilities to detect long duration transient gravitational-wave signals from isolated neutron stars Presented to the Congrès des doctorants (conference of Ph.D. students), Paris, France.
27–31 Jan. 2019	Searching for a remnant of GW170817 Presented to the 1st Punjab University International Conference on Gravitation and Cosmology, Lahore, Pakistan.

INVITED SEMINARS [32]

16 May 2024	Directly detecting dark matter with gravitational-wave interferometers Presented to the European Space Agency (ESA), European Space Astronomy Centre (ESAC), Villafranca del Castillo, Spain
25 April 2024	Using gravitational waves to search for dark matter Presented to the Indian Institute of Technology (IIT) Bombay, Mumbai, India
10 April 2024	Long-lived sources of gravitational waves from mini-EMRIs, PBHs and BNSs Presented to Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, São Paulo, Brasil
9 April 2024	Continuous waves: long-lived sources of gravitational waves from EMRIs, PBHs and BNSs Presented to INPE – Instituto Nacional de Pesquisas Espaciais, São José dos Campos, São Paulo, Brasil
27 March 2024	Long-lived sources of gravitational waves Presented to the University of Massachusetts-Dartmouth, North Dartmouth, MA, USA
1 March 2024	Probes of ultralight dark matter and primordial black holes with gravitational-wave detectors Presented to the Instituto de Física, Universidade de São Paulo (USP), São Paulo, Brasil
26 February 2024	Future first detections of black holes, dark matter and neutron stars with continuous gravitational waves Presented remotely to the Indian Institute of Technology (IIT), Bombay, Mumbai, India
24 January 2024	Future first detections of black holes, dark matter and neutron stars with continuous gravitational waves Presented to the université catholique de Louvain, Louvain-la-Neuve, Belgium
13 December 2023	Continuous gravitational waves: an overview Presented to the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, India
24 November 2023	Directly detecting dark matter and neutron stars with gravitational waves Presented to the Astronomy Department at Tsinghua University, Beijing, China
10 November 2023	Persistent gravitational-wave sources as probes of neutron-star and dark-matter physics Presented to the Hangzhou Institute for Advanced Study, University of Chinese Academy of Sciences (HIAS, UCAS), Hangzhou, China
17 October 2023	Exploring dark-matter candidates with continuous gravitational waves Presented to Peking University, Beijing, China
11 October 2023	Continuous gravitational-wave probes of neutron stars and dark matter Presented to the International Center for Theoretical Physics, Asia-Pacific, Beijing, China
30 Jun 2023	Inspiraling primordial black hole binaries as continuous gravitational-wave sources Presented to Univeristà di Roma, La Sapienza, Rome, Italy

28 June 2023	Continuous gravitational-wave searches for neutron stars and dark matter Presented to the Cittadella Universitaria di Monserrato, Cagliari, Italy
25 May 2023	Continuous gravitational-wave probes of neutron stars and dark matter Presented to The Center for Research and Advanced Studies (Centro de Investigación y de Estudios Avanzados, Unidad Mérida), Mérida, Yucatan, Mexico
8–19 May 2023	Probing neutron stars and dark matter with continuous gravitational waves Presented to the International Center for Theoretical Physics, South American Institute for Fundamental Research (ICTP-SAIFR), São Paulo, Brasil
21 Feb. 2023	Probing dark matter, black holes and neutron stars with gravitational-wave detectors Presented to the Indian Institute of Technology (IIT) Bombay, Mumbai, India
24 Jan. 2023	Detecting gravitational waves and dark matter using LIGO/Virgo/KAGRA Presented to the Instituto de Astronomía Universidad Nacional Autónoma de México (IA-UNAM), Mexico City, Mexico
10 Nov. 2022	Probes of dark matter with gravitational-wave detectors Presented to the Central European Institute for Cosmology and Fundamental Physics (CEICO) within the Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic
16 June 2022	Ultralight dark-matter searches with gravitational-wave detectors Presented to Los Alamos National Lab, Los Alamos, New Mexico, USA
4 Feb. 2022	Probing different types of dark matter with gravitational-wave detectors Presented online to Nikhef, National Institute for Subatomic Physics, Amsterdam, Netherlands
1 Feb. 2022	Constraining the existence of very light primordial black holes using results from continuous gravitational-wave searches Presented online to the Max Planck Institut f. Gravitationsphysik (AEI Hannover), Hannover, Germany
18 Nov. 2021	Using gravitational-wave interferometers to directly detect dark matter Presented to the AMALDI Research Center at the Sapienza University of Rome, Rome, Italy
12 Nov. 2021	Direct detection of dark matter with gravitational-wave interferometers Presented to Laboratoire d'Annecy De Physique Des Particules (LAAP), Annecy, France
21 June 2021	Continuous gravitational waves as probes of neutron stars and dark matter Presented online to Institut d'Astrophysique de Paris, GReCO seminar series, Paris, France.
26 Oct. 2020	Detecting dark matter with gravitational-wave detectors Presented to the Sapienza Università di Roma, Rome, Italy.
8 Oct. 2020	Using continuous gravitational waves to detect neutron stars, black holes, and dark matter Presented online to the University of Liège, Liège, Belgium.
27 Feb. 2020	Adapting gravitational-wave searches to detect dark photon dark matter Presented to the University of Maastricht, Maastricht, Netherlands.
20 Feb. 2020	Transient continuous-wave searches using machine learning and the Hough Transform Presented to the University of Liège, Liège, Belgium.
9 Jan. 2020	Using machine learning and the Hough Transform to detect gravitational waves from isolated neutron stars Presented to the Université catholique de Louvain, Louvain-la-Neuve, Belgium.
14 June 2018	Results of a Search for a Post-merger Remnant of Binary Neutron Merger GW170817 Presented to the University of Oslo, Institute of Theoretical Astrophysics, Oslo, Norway.

CONFERENCE TALKS [49]

6 – 10 May 2024	Localizing binary neutron star inspirals using continuous-wave methods in Einstein Telescope Presented to the XIV Einstein Telescope Symposium, Maastricht, Netherlands
6 – 9 Dec. 2023	Novel probes of dark matter with continuous gravitational waves Presented to the 10th International Conference on Gravitation and Cosmology (ICGC), Institute of Technology (IIT) Guwahati, India

11 – 14 Sep. 2023	Update on searching for long-lived binary neutron star inspirals in 3G GW detectors Presented remotely to the September LVK Collaboration meeting, Toyama, Japan
28 Aug – 1 Sep 2023	Probing neutron stars, (primordial) black holes and dark matter with continuous waves Presented to Gravitational Waves meet Amplitudes in Southern Hemisphere, São Paulo, Brasil
19–21 June 2023	Gravitational-wave probes of planetary-mass primordial black holes Presented to New Horizons in Primordial Black Hole Physics, Napoli, Italy
3–5 May 2023	Continuous gravitational-wave probes of dark matter Presented to the International Conference on Dark Matter and Stars (ICDMS), Lisboa, Portugal
24–28 April 2023	Gravitational-wave constraints on the pulsar explanation of the Galactic-Center GeV excess Presented to the Galactic Center Workshop, Granada, Spain
15–18 April 2023	Constraining asteroid-mass primordial black hole abundance using continuous waves Presented to the April American Physical Society (APS) meeting, Minneapolis, MN, USA
14–17 March 2023	Searching for long-lived binary neutron star inspirals in third-generation GW detectors Presented to the LIGO/Virgo/KAGRA March Collaboration meeting, Northwestern University, Evanston, Illinois, USA
7–11 November 2022	Can continuous waves tell us about the galactic-center GeV excess? Presented to the November Virgo Week, Cascina, Italy
22–26 August 2022	Ultralight dark-matter searches with gravitational-wave detectors Presented to the 25th annual International Conference on Particle Physics and Cosmology (COSMO'22) in Rio de Janeiro, Brasil
27 June–1 July	Searching for gravitational waves from mini-EMRIs in LIGO/Virgo Presented to the European Astronomical Society annual meeting, Valencia, Spain
16–19 May 2022	Reaching below the GW spin-down limit for "Big Glitcher" PSR J0537-6910 Presented as an e-poster to the Pharos conference: The multi-messenger physics and astrophysics of neutron stars, La Sapienza, Rome, Italy
21 Apr. 2022	Continuous gravitational waves as multi-messenger probes in third-generation gravitational-wave detectors Presented to the 12th CosPa Meeting: Multi-Messenger Sources and Observations, Louvain-la-Neuve, Belgium
9 – 12 Apr. 2022	Results of an all-sky search for boson clouds around spinning black holes using LIGO O3 data Presented to the American Physical Society April meeting, New York, New York, USA
15 – 18 Nov. 2021	Continuous gravitational-wave constraints on planetary- and asteroid-mass primordial black holes using O3a data Presented to the November Virgo Week meeting, Cascina, Italy
2 Nov. 2021	Direct constraints on planetary and asteroid-mass primordial black holes from continuous gravitational- wave searches Presented to the Belgian Gravitational-Wave Meeting, Brussels, Belgium
30 Aug. – 3 Sept. 2021	Continuous gravitational waves as probes of primordial black holes Presented to the Global meeting of the GWVerse COST action, Lisbon, Portugal
9 Aug. 2021	Gravitational-wave probes of dark matter Presented to the Les Houches summer school as a "gong talk", Les Houches, France
26–30 July 2021	Searching for dark photon dark matter in the third observing run of LIGO/Virgo Presented online to the European Physical Society Conference on High Energy Physics (EPS-HEP).
19–23 July 2021	Searching for dark photon dark matter in the third observing run of LIGO/Virgo Presented online to the 14th Edoardo Amaldi Conference on Gravitational Waves, Melbourne, Australia.
11–25 July 2021	How to detect continuous gravitational waves from isolated neutron stars Presented to the workshop "Exploring Extreme Matter in the Era of Multimessenger Astronomy: from the Cosmos to Quarks", Aspen Center of Physics, Aspen, CO, USA

17–18 June 2021	Constraints on dark photon dark matter using data from LIGO's and Virgo's third observing run Presented online to the 9th annual Belgian-Dutch Gravitational-Wave Meeting, Amsterdam, Netherlands.
27 Oct. 2020	Search for dark photons with continuous-wave methods Presented online to the Belgian Gravitational-Wave Meeting, Brussels, Belgium.
14–17 Sept. 2020	Detecting gravitational waves from planetary mass primordial black hole inspirals using the Generalized Frequency-Hough Transform Presented online to the fall 2020 LIGO/Virgo/KAGRA collaboration meeting.
2–6 Dec. 2019	First search for a remnant of GW170817 using convolutional neural networks Presented to the TeV Particle Astrophysics conference (TeVPA 2019), Sydney, Australia.
14–17 Oct. 2019	First search for a remnant of GW170817 using convolutional neural networks Presented to the Gravitational-Wave Physics and Astronomy Workshop (GWPAW), Tokyo, Japan.
18–21 June 2019	Using machine learning to detect gravitational waves from isolated neutron stars Presented to the 10th Young Researcher Meeting (YRM), Rome, Italy.
18–21 March 2019	Long-duration transient search on O3 data using machine learning and the Generalized Frequency-Hough Presented to the LIGO-Virgo March Meeting, Lake Geneva, WI, USA, 18–21 March 2019.
8–12 Oct. 2018	A method to search for a remnant of GW170817 with the Frequency-Hough Presented to the 3rd HEL.A.S. summer school and DAAD school "neutron stars and gravitational waves", Thessaloniki, Greece.
4–7 Sep. 2018	Update on Frequency-Hough post-merger search Presented to the LIGO-Virgo September Meeting, Maastricht, Netherlands.
12–21 July 2018	Searching for a remnant of GW170817 Presented to the ISAPP-Baikal Summer School "Exploring the Universe through multiple messengers", Bol'shie Koty, Russia.
16–20 April 2018	Searches for signals from unknown or poorly known sources Presented (by Alicia Sintes) to the Astro-Solids, Dense Matter, and Gravitational Waves workshop, Seattle, WA, USA.
16–18 April 2018	Update on post-merger remnant search using the Frequency-Hough Presented to the April Virgo Week meeting, Cascina, Italy.
19–22 March 2018	Frequency-Hough post-merger search update Presented to the LIGO-Virgo March Meeting, Sonoma, USA.
19–23 Feb. 2018	Search for a remnant of GW170817 using the Hough transform Presented to the YKIS2018a symposium: General Relativity – The Next Generation, Kyoto, Japan.
3–8 Dec. 2017	Post-merger remnant search for long gravitational-wave transients Presented to the 29th International Texas Symposium on Relativistic Astrophysics, Cape Town, South Africa.
29 Nov. – 1 Dec. 2017	Search for very long transient GW signals from the post-merger remnant of a binary neutron star merger Presented (by Cristiano Palomba) to: GW170817 - Italian contributions to the dawn of the multi-messenger astronomy, Gran Sasso Science Institute (GSSI), L'Aquila, Italy.
6–8 Nov. 2017	Post-merger remnant search for long GW transients Presented to the Nov. Virgo Week meeting, Cascina, Italy
17–20 Oct. 2017	Using Filtering to Find Long Duration Gravitational Waves from Neutron Stars Presented to the 2017 IEEE International Young Scientists Forum on Applied Physics and Engineering, Lviv, Ukraine.

13–14 Oct. 2017	Study of a method to detect r-mode signals in white noise Presented (by Avi Vajpeyi) to the Ohio-Region Section of the American Physical Society (OS/APS) Fall Meeting, Miami University, Oxford, Ohio.
28 Aug. – 1 Sep. 2017	Analyzing a machine learning algorithm to detect gravitational waves from r-modes Presented to the LIGO-Virgo Sep. Meeting, Geneva, Switzerland.
15–17 May 2017	Developing a machine learning-based method to detect long gravitational-wave transients Presented to the May Virgo Week meeting, Cascina, Italy.
21–26 June 2015	How beaming of gravitational radiation from gamma ray bursts impacts gravitational-wave detection Presented to the 11th Edoardo Amaldi Conference on Gravitational Waves, Gwangju, South Korea.
11–14 April 2015	An analysis of the Frequency-Hough method for an all-sky search for continuous waves Presented to the American Physical Society April Meeting, Baltimore, MD, USA.
9–13 Dec. 2013	How much do diurnal land-sea circulations contribute to coastal wind power? Presented to the American Geophysical Union (AGU) Fall Meeting, San Francisco, CA.
3–6 Oct. 2013	Contribution of the diurnal sea breeze to wind power potential at Crystal Cove Presented to the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference, San Antonio, TX, USA.
3–7 Dec. 2012	Nanoscale ice measured through in-situ ellipsometry and ESEM Presented to the AGU Fall Meeting, San Francisco, CA, USA.
3–7 Dec. 2012	Environmental scanning electron microscopy of ice crystal nucleation and growth: investigating the formation of a shadow behind nucleating ice crystals Presented (by Marco Amaral) to the AGU Fall Meeting, San Francisco, CA, USA.

OTHER WORKSHOPS ATTENDED

26 July – 20 Aug. 2021	Les Houches Summer School 2021: Dark Matter, Les Houches, France.
11–25 July 2021	Exploring Extreme Matter in the Era of Multimessenger Astronomy: from the Cosmos to Quarks. Aspen Center for Physics, Aspen, CO, USA.
15–19 July 2019	Physical and Mathematical Aspects of General Relativity, Domodossola, Italy.
21–23 May 2019	The International School on Gravity from Earth to Space, Urbino, Italy.
8–12 April 2019	Third ASTERICS-OBELICS International School on Computing for Astrophysics and Astroparticle Physics, Annecy, France.
12–14 Nov. 2018	Fundamental Physics with LISA, Arcetri, Florence, Italy.
5–7 Nov. 2018	Third LISA Consortium meeting, Marseilles, France.
3–12 July 2017	International School of Physics “Enrico Fermi”, Gravitational Waves and Cosmology, Varenna, Lake Como, Italy.

References

- Chris van den Broek, postdoc supervisor, professor, Nikhef (National Institute for Subatomic Physics) / Utrecht University, vdbroeck@nikhef.nl, +31 (0)20 592 2053
- Giacomo Bruno, postdoc supervisor, professor, Catholic University of Louvain, giacomo.bruno@uclouvain.be, +3210473215
- Keith Riles, collaborator, professor, University of Michigan, kriles@umich.edu, +17347644652
- Bernard Whiting, PhD supervisor, professor, University of Florida, bernard@phys.ufl.edu, +13523928746
- Pia Astone, PhD supervisor, senior INFN researcher, INFN Sezione di Roma Uno, pia.astone@roma1.infn.it, +390649914431

Notes about authorship conventions: Most of my research has been conducted within the LIGO/Virgo/KAGRA collaborations, and I am a co-author on many papers as a result. The standard practice in these collaborations is to list all active members as authors, strictly alphabetically in most cases, to represent the contributions that all of us have made to the assembly, testing, infrastructure, operation, data analysis and internal review for the experiments and results. I only list the collaboration papers below to which I have actively contributed, either through analysis, management, writing or review.

Select Publications

[52] Andrew L. Miller. "Gravitational waves from sub-solar mass primordial black holes". In: (Apr. 2024). arXiv: 2404.11601 [gr-qc].

This is an invited review for a book titled "Primordial Black Holes"', ed. Chris Byrnes, Gabriele Franciolini, Tomohiro Harada, Paolo Pani, and Misao Sasaki; Springer (2024).

[51] Quynh Lan Nguyen and Andrew L. Miller. "Dark Matter and its Effect on Gravitational Wave Signals". In: *PoS* EPS-HEP2023 (2024), p. 132.

I contributed to the this conference proceedings by describing the kinds of dark-matter searches that could be performed using data from LIGO, Virgo and KAGRA.

[50] Sulagna Bhattacharya, Andrew L. Miller, and Anupam Ray. "Continuous Gravitational Waves: A New Window to Look for Heavy Non-annihilating Dark Matter". In: (Mar. 2024). arXiv: 2403.13886 [hep-ph].

I contributed to the intellectual design of this project, and also to calculating the expected formation rate densities of sun-like planets detectable by future space-based gravitational-wave detectors that could transmute into black holes.

[49] Andrew L. Miller, Nancy Aggarwal, Sébastien Clesse, Federico De Lillo, et al. "Gravitational wave constraints on planetary-mass primordial black holes using LIGO O3a data". In: (Feb. 2024). arXiv: 2402.19468 [gr-qc].

I ran the first-ever search for planetary-mass primordial black holes and placed stringent constraints on the fraction of dark matter that primordial black holes could compose.

[48] Andrew L. Miller, Neha Singh, and Cristiano Palomba. "Enabling multimessenger astronomy with continuous gravitational waves: Early warning and sky localization of binary neutron stars in the Einstein Telescope". In: *Phys. Rev. D* 109 (4 Feb. 2024), p. 043021. arXiv: 2309.15808 [astro-ph.IM].

I designed a method to search for binary neutron star inspirals in third-generation detectors that is computationally efficient and robust against noise disturbances, that can also warn astronomers of imminent mergers.

[47] Paloma Laguarta et al. "Detection of anomalies amongst LIGO's glitch populations with autoencoders". In: *Class. Quant. Grav.* 41.5 (Feb. 2024), p. 055004. arXiv: 2310.03453 [astro-ph.IM].

I contributed to the ideas behind the machine learning techniques employed in this work , and the use of the fractal dimension as a statistic to encode information about various auxiliary channels to find the origin of glitches .

[46] Ish Gupta et al. "Characterizing Gravitational Wave Detector Networks: From A$^\sharp$ to Cosmic Explorer". In: (July 2023). arXiv: 2307.10421 [gr-qc].

This is a report with the details of the calculations to support the white paper [45]. Here, I computed the horizon distance reach to rotating black holes with dark matter clouds emitting gravitational waves through anniliation.

[45] Matthew Evans et al. "Cosmic Explorer: A Submission to the NSF MPSAC ngGW Subcommittee". In: (June 2023). arXiv: 2306.13745 [astro-ph.IM].

In this white paper, I computed the distance to which we could detect gravitational waves from ultralight scalar boson clouds around rotating black holes in Cosmic Explorer.

[44] Andrew L. Miller. "Recent results from continuous gravitational wave searches using data from LIGO, Virgo, and KAGRA's third observing run". In: *57th Rencontres de Moriond on Gravitation*. May 2023. arXiv: 2305.15185 [gr-qc].

I wrote a conference proceedings as a contribution to the 2023 Gravitation session of the 57th Rencontres de Moriond for an invited talk in which I gave an overview of the state-of-the-art continuous gravitational-wave searches in LIGO/Virgo/KAGRA's third observing run.

[43] Marica Branchesi et al. "Science with the Einstein Telescope: a comparison of different designs". In: *JCAP* 07 (2023), p. 068. arXiv: 2303.15923 [gr-qc].

I compared the impact of different possible designs of Einstein Telescope on the detection of post-merger gravitational waves from isolated neutron stars, and determined that two 2 L-shaped interferometers provided better sensitivity than a single triangle interferometer.

[42] Andrew L. Miller and Yue Zhao. "Probing the Pulsar Explanation of the Galactic-Center GeV Excess Using Continuous Gravitational-Wave Searches". In: *Phys. Rev. Lett.* 131.8 (2023), p. 081401. arXiv: 2301.10239 [astro-ph.HE].

I used null results from an all-sky search for gravitational waves from deformed neutron stars to constrain the existence of millisecond pulsars at the galactic center that could explain the observed GeV excess. For the first time, GW searches were used to rule out certain model parameters that predict the number of millisecond pulsars needed to explain the GeV excess.

[41] Magdalena Sieniawska, David Ian Jones, and Andrew Lawrence Miller. "Measuring neutron star distances and properties with gravitational-wave parallax". In: *Mon. Not. Roy. Astron. Soc.* 521.2 (2023), pp. 1924–1930. arXiv: 2212.07506 [astro-ph.HE].

I calculated the sky resolution necessary to resolve the GW parallax effect, and determined how sensitive our methods need to be to obtain that resolution.

[40] Andrew L. Miller and Luis Mendes. "First search for ultralight dark matter with a space-based gravitational-wave antenna: LISA Pathfinder". In: *Phys. Rev. D* 107.6 (2023), p. 063015. arXiv: 2301.08736 [gr-qc].

I ran a search on LISA pathfinder data, taken from March 2016 - May 2017, to look for any signatures of dark matter that could have coupled to the instrument. I set the first-ever upper limits on this coupling from a space-based GW antenna that was a precursor to LISA.

[39] Federico De Lillo, Jishnu Suresh, Antoine Depasse, Magdalena Sieniawska, Andrew L. Miller, and Giacomo Bruno. "Probing ensemble properties of vortex-avalanche pulsar glitches with a stochastic gravitational-wave background search". In: *Phys. Rev. D* 107.10 (2023), p. 102001. arXiv: 2211.16857 [gr-qc].

I provided insight into neutron star glitches, and helped to design the scope of the project to constrain the glitch sizes and rates.

[38] Takahiro S. Yamamoto, Andrew L. Miller, Magdalena Sieniawska, and Takahiro Tanaka. "Assessing the impact of non-Gaussian noise on convolutional neural networks that search for continuous gravitational waves". In: *Phys. Rev. D* 106.2 (2022), p. 024025. arXiv: 2206.00882 [gr-qc].

I provided insight into the non-Guassian nature of the noise in LIGO/Virgo, and expertise in how all-sky searches for neutron stars are performed in practice and convolutional neural networks.

[37] Huai-Ke Guo and Andrew L. Miller. "Searching for Mini Extreme Mass Ratio Inspirals with Gravitational-Wave Detectors". In: (May 2022). arXiv: 2205.10359 [astro-ph.IM].

I calculated the expected distance reach as a function of mass ratio to gravitational waves emitted by hypothetical binary systems composed of one ordinary object and one exotic compact object with a much smaller mass than its companion orbiting around the heavier object. I also helped to conceptualize this work and contributed to developing the method, based on the Hough Transform, to search for these signals.

[36] Andrew L. Miller, Francesca Badaracco, and Cristiano Palomba. "Distinguishing between dark-matter interactions with gravitational-wave detectors". In: *Phys. Rev. D* 105.10 (2022), p. 103035. arXiv: 2204.03814 [astro-ph.IM].

I showed that the Wiener filter can follow-up candidate dark-matter signals interacting with gravitational-wave detectors, confirming or rejecting thems. Also, I demonstrated the effectiveness of this method to distinguish between scalar and vector dark-matter interaction signals.

[35] Richard Brito, Sukanya Chakrabarti, Sebastien Clesse, Cora Dvorkin, Juan Garcia-Bellido, Joel Meyers, Ken K. Y. Ng, Andrew L. Miller, Sarah Shandera, and Ling Sun. "Snowmass2021 Cosmic Frontier White Paper: Probing dark matter with small-scale astrophysical observations". In: (Mar. 2022). arXiv: 2203.15954 [hep-ph].

I contributed to this white paper by writing a section on how we can probe dark matter via its interactions with gravitational-wave detectors, as well as generally how to probe dark matter via astrophysical observations of small-scale structure.

[34] Robert Caldwell et al. "Detection of early-universe gravitational-wave signatures and fundamental physics". In: *Gen. Rel. Grav.* 54.12 (2022), p. 156. arXiv: 2203.07972 [gr-qc].

I contributed to this white paper by describing different types of dark matter that could interact with GW detectors.

[33] Federico De Lillo, Jishnu Suresh, and Andrew L. Miller. "Stochastic gravitational-wave background searches and constraints on neutron-star ellipticity". In: *Monthly Notices of the Royal Astronomical Society* 513.1 (Apr. 2022), pp. 1105–1114. arXiv: 2203.03536 [gr-qc].

I contributed here by determining the frequency distribution of galactic neutron stars to use, and by advising the first author, a PhD student, on how to conduct the search, interpret the results, and write the paper.

[32] R. Abbott et al. "Search for gravitational waves from Scorpius X-1 with a hidden Markov model in O3 LIGO data". In: *Phys. Rev. D* 106.6 (2022), p. 062002. arXiv: 2201.10104 [gr-qc].

I reviewed the analysis method, codes, the paper and results for this search for gravitational waves from Sco X-1, and helped interpret the upper limits on gravitational-wave strain.

[31] R. Abbott et al. "All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO and Advanced Virgo O3 data". In: *Phys. Rev. D* 106.10 (2022), p. 102008. arXiv: 2201.00697 [gr-qc].

I placed constraints on the rates and abundance of planetary- and asteroid-mass primordial black hole binaries using upper limits obtained from these all-sky searches.

[30] R. Abbott et al. "All-sky search for gravitational wave emission from scalar boson clouds around spinning black holes in LIGO O3 data". In: *Phys. Rev. D* 105 (10 May 2022), p. 102001. arXiv: 2111.15507 [astro-ph.HE].

I led the first all-sky LIGO/Virgo/KAGRA search for gravitational waves from boson clouds around black holes. I coordinated the scientific analyses, managed the paper writing, handled the release of data, and wrote a science summary suitable for the public.

[29] Andrew L. Miller, Nancy Aggarwal, Sébastien Clesse, and Federico De Lillo. "Constraints on planetary and asteroid-mass primordial black holes from continuous gravitational-wave searches". In: *Phys. Rev. D* 105.6 (2022), p. 062008. arXiv: 2110.06188 [gr-qc].

I used upper limits from a continuous-wave search to put constraints on the rates and abundance of planetary- and asteroid- mass primordial black hole binary systems slowly inspiraling due to the emission of gravitational waves.

[28] R. Abbott et al. "Constraints on dark photon dark matter using data from LIGO's and Virgo's third observing run". In: *Phys. Rev. D* 105.6 (2022), p. 063030. arXiv: 2105.13085 [astro-ph.CO].

I led this LIGO/Virgo/KAGRA search for dark photon dark matter. I ran one of the two searches, coordinated the scientific analyses, managed the paper writing, handled the internal review of methods, and wrote a science summary suitable for the public.

[27] A. Addazi et al. "Quantum gravity phenomenology at the dawn of the multi-messenger era—A review". In: *Prog. Part. Nucl. Phys.* 125 (2022), p. 103948. arXiv: 2111.05659 [hep-ph].

I wrote a section in this white paper on searches for quasi-monochromatic, long-lasting gravitational-wave signals from neutron stars, primordial black hole binaries, and boson clouds around black holes.

[26] Iuri La Rosa, Pia Astone, Sabrina D'Antonio, Sergio Frasca, Paola Leaci, Andrew Lawrence Miller, Cristiano Palomba, Ornella Juliana Piccinni, Lorenzo Pierini, and Tania Regimbau. "Continuous Gravitational-Wave Data Analysis with General Purpose Computing on Graphic Processing Units". In: *Universe* 7.7 (2021), p. 218.

I contributed in discussions about understanding conceptually the Hough Transform, as well as how GPUs could be applied to the Generalized Frequency Hough Transform, which is a method that I developed to search for rapidly spinning down neutron stars.

[25] R. Abbott et al. "Search for anisotropic gravitational-wave backgrounds using data from Advanced LIGO and Advanced Virgo's first three observing runs". In: *Phys. Rev. D* 104.2 (2021), p. 022005. arXiv: 2103.08520 [gr-qc].

I co-ran the broadband radiometer analysis for this paper, which involved producing skymaps summed over all frequencies, analyzing outliers who had high signal-to-noise ratios, and producing upper limits.

[24] Andrew L. Miller, Sébastien Clesse, Federico De Lillo, Giacomo Bruno, Antoine Depasse, and Andres Tanasijczuk. "Probing planetary-mass primordial black holes with continuous gravitational waves". In: *Phys. Dark Univ.* 32 (2021), p. 100836. arXiv: 2012.12983 [astro-ph.HE].

I developed a method to detect primordial black hole inspirals with masses less than $10^{-3} M_{\odot}$ using the Hough Transform. I showed that advanced and future gravitational-wave detectors will be able to place physical constraints on the fraction of dark matter that primordial black holes could compose.

[23] R. Abbott et al. "Diving below the Spin-down Limit: Constraints on Gravitational Waves from the Energetic Young Pulsar PSR J0537-6910". In: *Astrophys. J. Lett.* 913 (2021), p. L27. arXiv: 2012.12926 [astro-ph.HE].

I managed the scientific analysis, led the writing of the paper, and contributed to discussions regarding the upper

limits produced in this paper.

[22] Andrew L. Miller et al. "Probing new light gauge bosons with gravitational-wave interferometers using an adapted semi-coherent method". In: *Phys. Rev. D* 103.10 (2021), p. 103002. arXiv: 2010.01925 [astro-ph.IM].

I developed a method to directly detect vector bosons that may interact with baryons in gravitational-wave interferometers by judiciously varying the Fast Fourier Transform length to match the expected frequency spread of the dark matter signal.

[21] Andrew L. Miller et al. "Using gravitational-wave interferometers as particle detectors to directly probe the existence of dark matter". In: *Letter of Intent for Snowmass 2021* (Aug. 2020).

I led the writing of this letter of intent that was aimed at arguing that Snowmass should support efforts to directly search for ultralight dark matter with interacting directly with gravitational-wave detectors.

[20] Ling Sun, Cristiano Palomba, and Andrew L. Miller. "Snowmass2021-Letter of Interest Search for gravitational waves from ultralight boson clouds around black holes". In: *Letter of Intent for Snowmass 2021* (Aug. 2020).

I was involved in discussions for what kind of arguments we wanted to make at the Snowmass meeting to support efforts to search for boson clouds around black holes.

[19] R. Abbott et al. "Gravitational-wave Constraints on the Equatorial Ellipticity of Millisecond Pulsars". In: *Astrophys. J. Lett.* 902.1 (2020), p. L21. arXiv: 2007.14251 [astro-ph.HE].

I managed the writing of this paper, and coordinated with astronomers and gravitational-wave physicists to ensure that the emphermides for the analyses were available.

[18] G. Intini, P. Leaci, P. Astone, S.D.' Antonio, S. Frasca, I. La Rosa, A. Miller, C. Palomba, and O. Piccinni. "A Doppler-modulation based veto to discard false continuous gravitational-wave candidates". In: *Class. Quant. Grav.* 37.22 (2020), p. 225007.

I contributed to many discussions of these vetoes that were meant to reduce the number of candidates that an all-sky search for neutron stars returned that followed a particular pattern in the sky.

[17] Deep Chatterjee, Shaon Ghosh, Patrick R. Brady, Shasvath J. Kapadia, Andrew L. Miller, Samaya Nissanke, and Francesco Pannarale. "A Machine Learning Based Source Property Inference for Compact Binary Mergers". In: *Astrophys. J.* 896.1 (2020), p. 54. arXiv: 1911.00116 [astro-ph.IM].

I was an internal reviewer within LIGO for the pipeline described in this work, and contributed by suggesting many tests of the nearest neighbor machine learning algorithm that were then placed in the paper.

[16] Ornella J. Piccinni, P. Astone, S. D'Antonio, S. Frasca, G. Intini, I. La Rosa, P. Leaci, S. Mastrogiovanni, A. Miller, and C. Palomba. "Directed search for continuous gravitational-wave signals from the Galactic Center in the Advanced LIGO second observing run". In: *Phys. Rev. D* 101.8 (2020), p. 082004. arXiv: 1910.05097 [gr-qc].

I had done tests with the methodology used in this paper in the follow-up of the search for GW170817, and also read and gave comments on the paper.

[15] Andrew L. Miller. "Using machine learning and the Hough Transform to search for gravitational waves due to r-mode emission by isolated neutron stars". PhD thesis. Sapienza University of Rome and University of Florida., 2019.

I developed methods to detect long-lived remnants of neutron star mergers or supernovae using machine learning and the Hough Transform.

[14] Cristiano Palomba et al. "Direct constraints on ultra-light boson mass from searches for continuous gravitational waves". In: *Phys. Rev. Lett.* 123 (2019), p. 171101. arXiv: 1909.08854 [astro-ph.HE].

I contributed to discussions regarding how to best map the upper limits from the second observing run to constraints on boson/black hole mass pairs.

[13] Andrew L. Miller et al. "How effective is machine learning to detect long transient gravitational waves from neutron stars in a real search?" In: *Phys. Rev. D* 100.6 (2019), p. 062005. arXiv: 1909.02262 [astro-ph.IM].

I used a convolutional neural network to search for transient gravitational waves, signals lasting of $\mathcal{O}$(hours-days) from a remnant of the first-detected binary neutron star merger GW170817, and characterized the use and sensitivity of this machine learning method in gravitational-wave searches.

[12] A. Singhal et al. "A resampling algorithm to detect continuous gravitational-wave signals from neutron stars in binary systems". In: *Class. Quant. Grav.* 36.20 (2019), p. 205015.

I contributed to discussions about how to perform sensitivity studies to test the resampling algorithm.

[11] Miquel Oliver, David Keitel, Andrew L. Miller, Hector Estelles, and Alicia M. Sintes. "Matched-filter study and energy budget suggest no detectable gravitational-wave 'extended emission' from GW170817". In: (Dec. 2018). arXiv: 1812.06724 [astro-ph.HE].

I contributed to discussions about how to respond to the claim of "extended emission" to GW170817, and ran an independent analysis that also showed that no signal could have been detected.

[10] Antonis Mytidis, Athanasios Aris Panagopoulos, Orestis P. Panagopoulos, Andrew L. Miller, and Bernard Whiting. "Sensitivity study using machine learning algorithms on simulated r-mode gravitational wave signals from newborn neutron stars". In: *Phys. Rev. D* 99.2 (2019), p. 024024. arXiv: 1508.02064 [astro-ph.IM].

I finalized the paper by producing the figures demonstrating the sensitivty of the machine learning algorithm, and dealt with the round of referee comments that had been put off for years.

[9] B.P. Abbott et al. "Search for gravitational waves from a long-lived remnant of the binary neutron star merger GW170817". In: *Astrophys. J.* 875.2 (2019), p. 160. arXiv: 1810.02581 [gr-qc].

I ran the Generalized Frequency-Hough algorithm to search for a long-lived remnant of GW170817. This was one of four analyses in the paper, and I also contributed to writing the sections regarding the description and results of my analysis.

[8] S. D'Antonio et al. "Semicoherent analysis method to search for continuous gravitational waves emitted by ultralight boson clouds around spinning black holes". In: *Phys. Rev. D* 98.10 (2018), p. 103017. arXiv: 1809.07202 [gr-qc].

I tested this method on simulated boson cloud signals, and later adapted it to detect dark photon dark matter signals.

[7] S. Mastrogiovanni et al. "Phase decomposition of the template metric for continuous gravitational-wave searches". In: *Phys. Rev. D* 98.10 (2018), p. 102003. arXiv: 1808.01532 [gr-qc].

I contributed to discussions about the paper.

[6] Andrew L. Miller et al. “Method to search for long duration gravitational wave transients from isolated neutron stars using the generalized frequency-Hough transform”. In: *Phys. Rev. D* 98.10 (2018), p. 102004. arXiv: 1810.09784 [astro-ph.IM].

I developed a method to search for long-lived gravitational-wave signals from remnants of neutron star mergers or supernovae explosions that follow power-law frequency evolutions.

[5] O.J. Piccinni, P. Astone, S. D’Antonio, S. Frasca, G. Intini, P. Leaci, S. Mastrogiovanni, A. Miller, C. Palomba, and A. Singhal. “A new data analysis framework for the search of continuous gravitational wave signals”. In: *Class. Quant. Grav.* 36.1 (2019), p. 015008. arXiv: 1811.04730 [gr-qc].

I tested the data structures that were designed in this paper in a search for a long-lived remnant of GW170817. I also contributed to discussions about the benefits and feasibility of this approach.

[4] S. Mastrogiovanni, P. Astone, S. D’Antonio, S. Frasca, G. Intini, P. Leaci, A. Miller, C. Palomba, O.J. Piccinni, and A. Singhal. “An improved algorithm for narrow-band searches of continuous gravitational waves”. In: *Class. Quant. Grav.* 34.13 (2017), p. 135007. arXiv: 1703.03493 [gr-qc].

I contributed to discussions about the paper.

[3] Sinead Walsh et al. “Comparison of methods for the detection of gravitational waves from unknown neutron stars”. In: *Phys. Rev. D* 94.12 (2016), p. 124010. arXiv: 1606.00660 [gr-qc].

I quantified the sensitivity of the Frequency-Hough method to simulated neutron star signals in gravitational-wave data.

[2] Andrew L. Miller and Thulsi Wickramasinghe. “How beaming of gravitational waves compares to the beaming of electromagnetic waves: impacts to gravitational wave detection”. In: *J. Phys. Conf. Ser.* 716.1 (2016). Ed. by Hyung Mok Lee and John Oh, p. 012006. arXiv: 1609.09832 [astro-ph.HE].

I determined how beaming of gravitational waves would affect the detection of gravitational waves, and compared this to the beaming of electromagnetic waves.

[1] NB Magee, A Miller, M Amaral, and A Cumiskey. “Mesoscopic surface roughness of ice crystals pervasive across a wide range of ice crystal conditions.” In: *Atmospheric Chemistry & Physics* 14.22 (2014).

I designed a diffusion chamber to hold ice crystals that we studied, and also took images of ice crystals with a scanning electron microscope at Princeton.