

Chris Karwin



Title

Gamma Rays from Fast Black-Hole Winds

Abstract

Massive black holes at the centers of galaxies can launch powerful wide-angle winds, which if sustained over time, can unbind the gas from the stellar bulges of galaxies. These winds, also known as ultra-fast outflows (UFOs), may be responsible for the observed scaling relation between the masses of the central black holes and the velocity dispersions of stars in galactic bulges. Propagating through the galaxy, the wind should interact with the interstellar medium creating a strong shock, similar to those observed in supernovae explosions, which is able to accelerate charged particles to high energies. In this talk I'll present the Fermi Large Area Telescope detection of gamma-ray emission from these shocks in a small sample of galaxies exhibiting energetic winds. The detection implies that energetic black-hole winds transfer $\sim 0.04\%$ of their mechanical power to gamma rays and that the gamma-ray emission represents the onset of the wind-host interaction.

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Postdoctoral Fellow

CONTACT

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PROFESSIONAL APPOINTMENTS

Postdoctoral Fellow

Clemson University

Aug 2019 – Present

- Focus: high-energy gamma-ray astronomy; multi-wavelength analysis
- Advisor: Prof. Marco Ajello

EDUCATION

University of California, Irvine

- Ph.D., Physics 2019
 - Focus: observational astroparticle physics
 - Dissertation: *Fermi*-LAT Observations of γ -Ray Emission Towards the Galactic Center and the Outer Halo of M31
 - Adviser: Prof. Simona Murgia

University of California, Irvine

- M.S., Physics 2017

University of Colorado at Colorado Springs

- B.S., Physics 2013
 - Cum Laude, with highest distinction

PUBLICATIONS

Summary: first/corresponding author: 7; contributing author: 3

10. **Deep Learning to Reconstruct Gas Skymaps for Dark Matter Detection**
Shmakov, A. et al. In prep.
9. **Gamma Rays from Fast Black-Hole Winds**
Ajello, M., et al. Submitted to Science Advances.
8. **Dark Matter Explanations of the Gamma-Ray Excesses from the Galactic Center and M31** ([link](#))
Burns, K., et al. Physical Review D 103.6 (2021): 063023
7. **Dark Matter Interpretation of the *Fermi*-LAT Observations Toward the Outer Halo of M31** ([link](#))
Karwin, C.M., et al. Physical Review D 103.2 (2021): 023027
6. **Search for Gamma-ray Emission from P-Wave Dark Matter Annihilation in the Galactic Center** ([link](#))
Johnson, C., et al. Physical Review D 99 (2019): 103007.
5. ***Fermi*-LAT Observations of γ -Ray Emission Towards the Outer Halo of M31** ([link](#))
Karwin, C.M., et al. The Astrophysical Journal 880.2 (2019): 95.
4. **Dark Matter Interpretation of the *Fermi*-LAT Observation Toward the Galactic Center** ([link](#))
Karwin, C.M., et al. Physical Review D 95.10 (2017): 103005.
3. ***Fermi*-LAT Observations of High-Energy γ -Ray Emission Toward the Galactic Center** ([link](#))
Ajello, M., et al. The Astrophysical Journal 819.1 (2016): 44.
2. **Microwave Properties of Twisted and Supertwisted Nematic Liquid Crystals with Weak Anchoring** ([link](#))
Karwin, C. M., and Livesey, K. L. Liquid Crystals 41.5 (2014): 707-716.
1. **Liquid Crystal Phase Shifters with a Twist** ([link](#))
Karwin, C. M., and Livesey, K. L. Applied Physics Letters 103.6 (2013): 063508.

PRESENTATIONS

ESO Hypatia Colloquium, April 20, 2021

- talk: Gamma Rays from Fast Black-Hole Winds ([link](#))

American Physical Society (APS) April Meeting, April 17, 2021

- talk: Gamma Rays from Fast Black-Hole Winds

9th International Fermi Symposium, April 12-17, 2021

- talk: A Legacy Analysis of the Milky Way Dwarfs

Fermi-LAT Collaboration Meeting, March 15-19, 2021

- plenary talk: Gamma Rays from AGN Outflows

237th Meeting of the American Astronomical Society (AAS), January 10-15, 2021

- talk: Detecting Cosmic Neutrino Counterparts with Next-Generation Gamma-Ray Telescopes

Fermi-LAT Collaboration Meeting, August 31-September 4, 2020

- talk: Dark Matter Interpretation of the *Fermi*-LAT Observations Toward the Outer Halo of M31

Fermi-LAT Collaboration Meeting, August 31-September 4, 2020

- talk: Optimizing the Sensitivity of Source Stacking Using Cuts Based on the Background Counts

Fermi-LAT Collaboration Meeting, March 23-27, 2020

- talk: The Gamma-Ray Emission of Ultra-Fast Outflows

36th International Cosmic Ray Conference, July 24-August 1, 2019, Madison, WI

- talk: *Fermi*-LAT Observations of Gamma-Ray Emission Towards the Outer Halo of M31 ([link](#))

University of California Irvine, March 25, 2019

- talk: *Fermi*-LAT Observations of Gamma-Ray Emission Towards the Galactic Center and the Outer Halo of M31

Los Alamos National Laboratory, January 8, 2019

- invited talk: *Fermi*-LAT Observations of Gamma-Ray Emission Towards the Outer Halo of M31

8th International Fermi Symposium, Oct. 14-19, 2018, Baltimore, MD

- poster ([link](#))

UCLA Dark Matter, Feb. 18-23, 2018

- poster ([link](#))

SERVICE

- Dark Matter New Physics (DMNP) group coordinator for *Fermi*-LAT collaboration Mar 2020 – Present
- Referee for Physical Review D and The Astrophysical Journal May 2019 – Present

OBSERVING EXPERIENCE

SARA Observatory

Sep 2019 – Dec 2020

- SARA is a consortium of optical telescope, operated remotely with Radmin Viewer
- Telescopes: Kitt Peak, Arizona (SARA-KP, 0.9 m); Cerro Tololo, Chile (SARA-CT; 0.6 m); Roque de los Muchachos, Spain (SARA-RM, 1 m)
- Observed on average 2 full nights per month

AWARDS

- **Graduate Dean Dissertation Year Fellowship**, UC Irvine, summer 2018
- **Regents Fellowship**, UC Irvine, 2013-2014

SKILLS

Physics

- Fermi Gamma-ray Space Telescope, γ -ray astronomy, SARA Observatory, active galactic nuclei, black-hole winds, dark matter, the Local Group, cosmic rays, the Galactic interstellar medium, multi-wavelength analysis, galaxy evolution, history of physics

Data Analysis

- data modeling, data visualization, data analysis pipeline development, probability and statistics, maximum likelihood estimation, hypothesis testing, uncertainty quantification, Monte Carlo simulation, machine learning

Programming and Computing

- Python (packages: pandas, astropy, numpy, scipy, xml.etree.ElementTree, os, sys, yaml, matplotlib, aplpy, PySimpleGUI, email, smtplib, ssl, etc.), Mathematica, SQL, Java, R, Octave, Mac OS X, Linux, Ubuntu, high performance computing clusters, GitHub, Jupyter, Mode, VirtualBox, LaTeX, Fermi Science Tools, Fermipy, GALPROP, CLUMPY, TOPCAT, MEGAlib

Teaching

- Extensive experience in teaching math and physics as a tutor, teaching assistant, and instructor. Passion for communicating complex ideas in clear and simple ways. Experience with active learning methodology and courses.

PAST WORK EXPERIENCE

Graduate Research Assistant

Jan 2014 – Jul 2019

University of California, Irvine

- Dissertation: *Fermi*-LAT Observations of γ -Ray Emission Towards the Galactic Center and the Outer Halo of M31
- Adviser: Prof. Simona Murgia

Teaching Associate

Jun 2017 – Sep 2017

University of California, Irvine

- Instructor for undergraduate physics
- Courses:
 - Physics 7D, Classical Electromagnetism
 - Physics 7LD, Classical Electromagnetism Lab

Teaching Assistant

Sep 2013 – Mar 2019

University of California, Irvine

- Courses:
 - Physics 113B, Quantum Physics, Discussion; Physics 50, Mathematical Methods for Physics, Fall 2018
Active learning course with an emphasis on coding in Mathematica.
 - Physics 52C, Fundamentals of Experimental Physics, Lab, Spring 2018
Experiments: Frank-Hertz, radioactive counting, gamma absorption, photoelectric effect, Rydberg constant
 - Physics 125A, Mathematical Methods for Physics; Physics 121W, Advanced Physics Lab, Winter 2018
Experiments: superconductors, plasma, Faraday effect, Millikan oil drop, muon decay, Mossbauer effect.
 - Physics 7LC, Classical Physics, Lab, Fall 2017
 - Physics 3LC, Basic Physics, Lab, Summer 2015
 - Physics 7D and 7LD, Classical Electromagnetism, Lab and Discussion, Spring 2015
 - Physics 7C and 7LC, Classical Physics, Lab and Discussion, Winter 2015
 - Physics 3A, Basic Physics, Discussion, Fall 2014
 - Physics 7D and 7LD, Classical Electromagnetism, Lab and Discussion, Summer 2014
 - Physics 7D and 7LD, Classical Electromagnetism, Lab and Discussion, Spring 2014
 - Physics 3LB, Basic Physics, Lab, Winter 2014
 - Physics 7C and 7LC, Classical Physics, Lab and Discussion, Fall 2013

Undergraduate Research Assistant

May 2012 – Apr 2013

University of Colorado at Colorado Springs

- Conducted theoretical research pertaining to the use of liquid crystals for phase shifters and filters that operate at the microwave frequencies.
- Adviser: Prof. Karen Livesey

Physics Instructor

Jan 2012 – May 2012

After School University

- Designed and implemented physics courses for kids in grades K - 12.

Math and Physics Tutor

Jan 2010 – May 2013

The Center for Excellence in Mathematics

- Tutored math and physics at the walk-in tutoring center for the University of Colorado at Colorado Springs.
- Led weekly study sessions for undergraduate math courses.
- Received weekly pedagogical training, including instruction in methods of active learning.

Emergency Room Technician

Sep 2006 – Jan 2010

Memorial Hospital

- Certified EMT
- Aided nurses and doctors in emergency care.

Volunteer Fire Fighter

Sep 2004 – Sep 2007

Tri-Lakes Monument Fire Department

- Certified EMT

**CONFERENCES,
WORKSHOPS, AND
SCHOOLS**

- **American Physical Society (APS) April Meeting** (April 2021)
- **9th International Fermi Symposium** (April 2021)
- **Fermi-LAT Collaboration Meeting** (March 2021)
- **237th Meeting of the American Astronomical Society (AAS)** (January 2021)
- **Fermi-LAT Collaboration Meeting** (September 2020)
- **Fermi-LAT Collaboration Meeting** (March 2020)
- **AMEGO Team Meeting** (George Washington University, 2019, workshop)
- **36th International Cosmic Ray Conference** (Madison, WI, 2019)
- **Dark Matter Advanced Training Institute and UCLA Dark Matter 2018** (school and conference)
- **São Paulo School of Advanced Science on High Energy and Plasma Astrophysics in the CTA Era** (2017)
- **Dark Matter at the LHC** (UCI, 2017, workshop)
- **UCLA Dark Matter 2016** (conference)

**DATA SCIENCE
SUPPLEMENTAL
TRAINING**

- **Statistics, Data Mining, and Machine Learning in Astronomy**, 2015, course, UCI
- **Learning From Data**, 2014, online course, Abu-Mostafa, Magdon-Ismael, Lin (Caltech)
- **Learning Python**, 2014, self-study, Mark Lutz (O’Rielly books)
- **Probability and Statistics for Engineers and Scientist**, 2010, self-study
- **Principles of Computer Science**, 2010, UCCS

REFERENCES

- **Professor Marco Ajello**
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- **Igor V. Moskalenko**
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