

Lucy Frear Fortson

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Education:

1984 B.A. Physics and Astronomy Smith College, Northampton, MA
1991 Ph.D. Physics University of California, Los Angeles, CA

Appointments (*Academic*):

July 2014 - present Associate Head of School, School of Physics and Astronomy, University of Minnesota
July 2017 - present Full Professor of Physics, University of Minnesota
July 2010 - June 2017 Associate Professor of Physics, University of Minnesota
Oct 2004 - June 2010 Vice President for Research, Adler Planetarium
Dec 2001 - June 2010 Senior Research Associate, University of Chicago Department of Astronomy and Astrophysics
Dec 2001 - Oct 2004 Director of Astronomy, Adler Planetarium
Aug 1997 - Dec 2001 Astronomy Faculty Member, Adler Planetarium
Aug 1997 - Dec 2001 Research Scientist, University of Chicago Department of Astronomy and Astrophysics
1993 - 1997 Research Associate, University of Chicago, CASA-MIA experiment
1992 - 1993 Postdoctoral Associate, National Institute for Nuclear Physics (INFN) Frascati, ICARUS Solar Neutrino Experiment
1987 - 1991 Research Assistant, University of California, Los Angeles, UA1 Experiment, CERN

Appointments (*Service*):

2021 Member, CSE Dean Search Committee, UMN, 2021.
2021 Member, CSE Data Science Initiative Director Search Committee, UMN, 2021.
2020 Member, University Review Committee, Community Engaged Scholars Award, UMN, 2020-2023.
2020 Member, American Physical Society Dwight Nicholson Medal Selection Committee, APS, 2020.
2020 Member, Conference Program Committee, Citizen Science Association Conference 2021; Maine.
2019 Chair, Local Organizing Committee (LOC) Conference for Undergraduate Women in Physics 2020, UMN, January 2020.
2017 Member, International Scientific Program Committee (ISPC) of the 35th International Conference on Cosmic Rays
2017 Chair, Local Organizing Committee (LOC) Citizen Science Association 2017 Conference, Minneapolis-St. Paul, May 2017.
2016 Member, Scientific Organizing Committee (SOC) of the European Week of Astronomy and Space Science (EWASS16).
2015 - present External Faculty Member, *Human Computation Institute*.
2015 - 2018 Editor-in-Chief, the online journal *Citizen Science Today*.
2015 Member National Science Foundation Physics Division Committee of Visitors; Chair Particle Astrophysics Subpanel.

Appointments (*Service - continued*):

2015	Member, International Scientific Program Committee (ISPC) of the 34th International Conference on Cosmic Rays.
2015	Editorial Board Member, the journal <i>Citizen Science: Theory and Practice</i> .
2014 - present	UMN Writing Enriched Curriculum Program Liaison to School of Physics and Astronomy.
Nov. 2014 - present	Board Chair, Citizen Science Alliance.
Apr. 2014 - present	Member, Publications Advisory Board (PAB) of the Citizen Science Association
Mar. 2014 - present	Member, Advisory Board for the Journal of Human Computation
2014	UMN Graduate and Professional Education Assembly organizing committee.
Jan. 2012 - present	Member, Advisory Committee WGBH Boston, NovaLabs
Dec. 2013 - 2015	Bell Museum Astronomy Exhibit Advisory Committee
Aug. 2012 - 2015	Member, UMN University Faculty Senate
Dec. 2011 - 2015	Member, LIGO Directorate's Program Advisory Committee (PAC)
2010 - present	Member (<i>ad-hoc</i>), Research Committee of the Adler Planetarium Board of Trustees
2010 - present	Advisory Board, KVA 265 - Science Through Art
2009 - 2010	Co-chair of the Astro2010 Decadel Survey Education and Public Outreach Study Group
2009 - 2010	National Optical Astronomy Observatory Education and Public Outreach Review Committee
2008 - 2010	NASA Advisory Council, Human Capital Committee
2008 - 2010	Advisory Committee, NSF-funded Center for Research Libraries, Long-Lived Data Collections: Models and Case Studies
2008 - 2009	Science Advisory Committee, ScienceChicago Project
2007 - 2009	International Year of Astronomy Organizing Committee, Subcommittee on Research Experiences for Students, Teachers, and Citizen-Scientists
2004 - 2010	Advisory Committee, Center for Elementary Math and Science Education, University of Chicago
2006 - 2008	NASA Advisory Council, Astrophysics Subcommittee
2003 - 2006	Math and Physical Science Advisory Committee, National Science Foundation

Awards:

2020	Elected Fellow American Physical Society
2020	Mullen-Spector-Truax Women's Leadership Award, University of Minnesota
2020	University of Minnesota College of Science and Engineering George W. Taylor Distinguished Service Award
2019	American Physical Society Nicholson Medal for Outreach (Leadership of Zooniverse)
2018	University of Geneva (Switzerland) Innovation Award
2016	College of Science & Engineering Recipient of the University of Minnesota President's Community-Engaged Scholar Award
2015	Honorary Award, University of Minnesota Chapter of Sigma Xi
2010	NASA Exceptional Public Service Award

Current Membership in Professional Associations and Societies:

2015	Citizen Science Association
2000	American Astronomical Society
1996	American Physical Society

Collaborations & Projects:

Nov 2014 - present	Board Chair, Member Steering Committee, Citizen Science Alliance, <i>Zooniverse</i> Collaboration
Nov 2014 - present	Principal Investigator, Chair Leadership Team for <i>Zooniverse@UMN</i> Collaboration
Jul 2010 - Nov 2014	Executive Board Member, Project Manager, Citizen Science Alliance, <i>Zooniverse</i> Collaboration
Jul 2010 - present	Principal Investigator, VERITAS Collaboration Group, University of Minnesota
Jul 2010 - present	Principal Investigator, CTA-US Collaboration Group, University of Minnesota
Jan 2009 - Jun 2010	Executive Board Member, Education Director, Citizen Science Alliance, <i>Zooniverse</i> Collaboration
Oct 2007 - Jun 2010	Principal Investigator, CTA-US Collaboration Group, Adler Planetarium
Jan 2006 - Jun 2010	Principal Investigator, START Collaboratory Project, Adler Planetarium
Oct 2004 - Jun 2010	Principal Investigator, VERITAS Collaboration Group, Adler Planetarium
Jan 2000 - Oct 2004	VERITAS Collaboration Member, University of Chicago
1997 - 2000	Principal Investigator, CASA-BLANCA experiment, University of Chicago

Research Activities:

- Dr. Fortson is Principal Investigator of the University of Minnesota group involved in the Very Energetic Radiation Imaging Telescope Array System (VERITAS) Collaboration. The primary science pursuits for the group are in studying very-high-energy γ -ray emission from Active Galactic Nuclei (AGN) used to understand the underlying emission mechanisms and black hole engine. The UMN group is the lead on organizing contributions for multi-wavelength campaigns on AGN targets. Dr. Fortson currently serves as lead for the VERITAS Analysis Coordination Group; she also serves on the VERITAS Science Board. From 2013-2015 Dr. Fortson served as a member of the VERITAS Time-Allocation-Committee (TAC) and she served as the co-chair of the Blazar Science Working Group from 2005-2015. She was Outreach lead from 2005-2010. As an extension of the VERITAS work, the University of Minnesota is a member of the Cherenkov Telescope Array Collaboration, the next-generation high-energy ground-based gamma-ray array. Recently UMN has been investigating novel gamma/hadron separation techniques using deep learning for potential use with CTA. Dr. Fortson was a recent member of the CTA Speaker and Publications Office (SAPO) and is a member of the CTA Outreach Working Group. She has held a combined \$1,800,000 in research awards, primarily from NSF, for her work in gamma-ray astronomy.

- Dr. Fortson is a co-founder of the *Zooniverse* Citizen Science platform. She is currently the Board Chair and member of the Steering Committee for the Citizen Science Alliance which runs the *Zooniverse* Collaboration, an extension of the Galaxy Zoo Project (www.galaxyzoo.org). She

also leads the Zooniverse@UMN effort funded through cross-campus contributions to develop and implement UMN-centric Zooniverse projects and is co-director of the UMN Center for Citizen Science which serves as a nexus of research with, information on and practice of the field of citizen science. Galaxy Zoo is the groundbreaking citizen science project that engaged more than 175,000 online volunteers to classify nearly one million galaxies from the SDSS database. Galaxy Zoo proved that, for some well-defined science problems, an analysis method incorporating humans as sophisticated computational algorithms can lead to important scientific results while at the same time engaging the public in the process of science. The *Zooniverse* (www.zooniverse.org) currently has over 2 million volunteers contributing to over 350 projects. *Zooniverse* is funded through grants from NSF, NASA, NEH, Microsoft, Google, TED Foundation, Sloan Foundation and the Leverhulme Trust, UK to develop and maintain the back-end infrastructure to incorporate science datasets from across all research disciplines and to develop an education framework for *Zooniverse* projects. Dr. Fortson is PI of several recent NSF awards to enable a combined system utilizing human and machine classifications to dynamically optimize knowledge discovery from large and complex data sets. Dr. Fortson has held a combined \$7,300,000 in funding, primarily from NSF, for both research with Galaxy Zoo crowdsourced data and infrastructure development for *Zooniverse* including the integration of machine learning into the platform.

Leadership and Education Activities:

Dr. Fortson has extensive experience in education, administration and leadership. She has served on multiple national and local advisory committees. As Vice President for Research at the Adler Planetarium, Dr. Fortson oversaw the research and public engagement in research programs conducted by the fifteen researchers in the departments of Astronomy, History of Astronomy and Education with an annual budget of over \$1.2 million. Dr. Fortson developed many of the Education & Public Outreach activities at the Adler and developed the themes, written content and interactives for three museum galleries covering over 10,000 square feet. She has been Project Director for three Planetarium shows in Adler's theaters and set up the astronomy data visualization team at the Adler (now the Space Visualization Laboratory). Dr. Fortson contributed to Adler's Teacher Professional Development programs through planning and participation as a content provider. She has given numerous lectures and presentations on astronomy and education topics to school classes, corporate events and continuing education groups. She has been featured in several newspaper articles (including the Chicago Tribune and New York Times), appeared on numerous television and radio programs as well as podcasts. At UMN, she has taught courses in introductory physics, undergraduate introduction to cosmology and best practices for teaching physics as well as an honors seminar on crowdsourcing. She has been working to introduce Zooniverse activities into the classroom at UMN to provide introductory level students with the opportunity to engage in the process of research. She gives several outreach lectures a year ranging from gatherings of local astronomy enthusiasts to national or international events such as National Public Radio's Science Friday Live Streaming events or CERN's Public Lecture series.

- Dr. Fortson has been a principal organizer and proceedings editor for several international level conferences and workshops, including both Citizen Science and Gamma-ray conferences and workshops. Most recently she chaired the LOC for the Citizen Science Association annual meeting (St Paul, MN 2017). She organized "What are we Learning from the Gamma Ray Sky?" held at UMN October 2013; organized and chaired a special session "Keys to Classic Astrophysical Puzzles: High Energy Gamma-Rays with VERITAS and Beyond" at the January 2016 American Astronomical Society meeting as well as several previous Multiwavelength Campaign workshops

for high energy astrophysics (e. g. “The 2nd Multiwavelength Workshop for the Next Generation Gamma-ray Experiments”.) Dr. Fortson also co-chaired the Astronomical Society of the Pacific’s conference “EPO in a Changing World” Chicago, September 2007 and served on the program committee for the May 2008 ASP meeting held in conjunction with the 212th American Astronomical Society meeting. Dr. Fortson chaired the NASA Future Forum event hosted October 10th, 2008 at the Adler celebrating NASA’s 50th Anniversary. This day-long event brought together educators, academics and corporate leaders from the Chicago area to participate in panel discussions focused on the impact of space science on our society.

Selected Publications *Science - Gamma-Ray Astrophysics:*

- Algaba, J. C., et al., (Multi-collaboration paper), *Broadband Multi-wavelength Properties of M87 during the 2017 Event Horizon Telescope Campaign*, *Astrophys. Journal Letters*, 911:1, L11 (2021)
- Archer, A., et al., (VERITAS Collaboration, <http://veritas.sao.arizona.edu>), *VERITAS Discovery of VHE Emission from the Radio Galaxy 3C 264: A Multi-Wavelength Study*, *Astrophys. Journal*, 896:1, 41 (2020), arXiv:2005.03110.
- Abeysekara, A. U., (Multi-collaboration paper), *The Great Markarian 421 Flare of February 2010: Multiwavelength Variability and Correlation Studies*, *Astrophys. Journal*, **890**, 2 (2020), arXiv:2002.03567.
- Benbow, W., et al., (Multi-collaboration paper), *Direct measurement of stellar angular diameters by the VERITAS Cherenkov Telescopes*, *Nature Astronomy*, Volume 3, p. 511-516, (2019), arXiv:1904.06324.
- Aartsen, M. G., et al., (Multi-collaboration paper), *Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A*, *Science*, **361** 6398 (2018), arXiv:1807.08816.
- Archer, A. et al., *HESS J1943+213: An Extreme Blazar Shining through the Galactic Plane*, *Astrophys. Journal*, **862**, 41 (2018), arXiv:1806.04144.
- Abeysekara, A. U., et al., (VERITAS Collaboration), *Multiwavelength Observations of the Blazar BL Lacertae: A New Fast TeV Gamma-Ray Flare*, *Astrophys. Journal*, **856** 2 (2018), arXiv:1802.10113.
- Ahnen, M. L., et al., (Multi-collaboration paper), *Multiband variability studies and novel broadband SED modeling of Mrk 501 in 2009*, *Astron. & Astrophys.*, (2017), arXiv:1612.09472.
- Abeysekara, A. U., et al., (VERITAS Collaboration), *A Luminous and Isolated Gamma-Ray Flare from the Blazar B2 1215+30*, *Astrophys. Journal*, **836** 205 (2017), arXiv:1701.01067.
- Archambault, S., et al., *Search for Magnetically Broadened Cascade Emission from Blazars with VERITAS*, *Astrophys. Journal*, **835** 288 (2017), arXiv:1701.00372.
- Abeysekara, A. U., et al., *A Search for Spectral Hysteresis and Energy-dependent Time Lags from X-Ray and TeV Gamma-Ray Observations of Mrk 421*, *Astrophys. Journal*, **834** 2 (2017), Arxiv:1611.04626.
- Abeysekara, A. U., et al., *VERITAS and multiwavelength observations of the BL Lacertae object 1ES 1741+196*, *Monthly Notices of the Royal Astronomical Society*, **459** 2550 (2016), Arxiv:1603.07286.
- Archambault, S., et al., *Discovery of Very High Energy Gamma Rays from 1ES 1440+122*, *Monthly Notices of the Royal Astronomical Society*, **461** 202 (2016).

- Fortson, L., for the VERITAS Collaboration, *Highlights of recent results from the VERITAS gamma-ray observatory*, Journal of Physics: Conference Series, **718** Issue 5, article id. 052013 (2016).
- Balokovic, M., et al., *Multiwavelength Study of Quiescent States of Mrk 421 with Unprecedented Hard X-Ray Coverage Provided by NuSTAR in 2013*, In press for publication in Astrophys. Journal (2016), Arxiv:1512.02235.
- Abeyssekara, A. U., et al., *Gamma-Rays from the Quasar PKS 1441+25: Story of an Escape*, Astrophys. Journal Letters **815** L22 (2015), Arxiv:1512.04434.
- Weinstein, A. and Fortson, L., et al., *Testing a Novel Self-Assembling Data Paradigm in the Context of IACT Data*, Contribution to the 34th International Cosmic Ray Conference (2015), Arxiv:1509.02202.
- Aleksic, J., et al., *The 2009 multiwavelength campaign on Mrk 421: Variability and correlation studies*, Astronomy and Astrophysics **576** A126 (2015), Arxiv:1502.02650.
- Aleksic, J., et al., *Unprecedented study of the broadband emission of Mrk 421 during flaring activity in March 2010*, Astronomy and Astrophysics **578** A22 (2015), Arxiv:1412.3576.
- Archambault, S., et al., *Deep Broadband Observations of the Distant Gamma-Ray Blazar PKS 1424+240*, Astrophys. Journal Letters **785** L16 (2014), Arxiv:1403.4308.
- Acciari, V. A., et al., *Observation of Markarian 421 in TeV gamma rays over a 14-year time span*, Astroparticle Physics **54**, 1 (2014), ArXiv:1310.8150.
- Beatty, J. J., et al., *Snowmass Cosmic Frontiers 6 (CF6) Working Group Summary The Bright Side of the Cosmic Frontier: Cosmic Probes of Fundamental Physics*, (2013), ArXiv:1310.5662.
- Archambault, S., et al., *Discovery of a New TeV Gamma-Ray Source: VER J0521+211*, Astrophysical Journal **776**, 69 (2013), Arxiv:1308.5017.
- Dumm, J., & Fortson, L., *Gamma-ray Signatures of Ultra High Energy Cosmic Ray Line-of-sight Interactions*, (2013), ArXiv:1305.0253.
- Weinstein, A., Dumm, J., Fortson, L. & Mukherjee, R., *The impact of astrophysical particle acceleration on searches for beyond-the-Standard-Model physics*, (2013), ArXiv:1305.0082.
- Arlen, T., et al., *Rapid TeV Gamma-Ray Flaring of BL Lacertae*, Astrophysical Journal **762**, 92 (2013), ArXiv:1211.3073.
- Arlen, T., et al., *Constraints on Cosmic Rays, Magnetic Fields, and Dark Matter from Gamma-Ray Observations of the Coma Cluster of Galaxies with VERITAS and Fermi*, Astrophys. J., **757** 123 (2012) (with C. Pfrommer and A. Pinzke).
- Aliu, E., et al. (VERITAS Collaboration), *Multiwavelength Observations of the AGN 1ES 0414+009 with VERITAS, Fermi-LAT, Swift-XRT, and MDM*, Astrophys. J., **755**, 118 (2012).
- Aliu, E., et al. (VERITAS Collaboration), *Discovery of High-energy and Very High Energy γ -Ray Emission from the Blazar RBS 0413*, Astrophys. J., **750**, 94 (2012).
- Willett, K., Nelson, T., & Fortson, L., *Environmental Clustering Properties of High-Energy Blazars*, American Institute of Physics Conference Series, edited by F. A. Aharonian, W. Hofmann, & F. Rieger (2012).
- Fortson, L. for the VERITAS Collaboration and Fermi-LAT Collaborators: James Chiang, Stephen Fegan, Berrie Giebels, Deirdre Horan, Grzegorz Madejski, David Paneque; *Results from VERITAS Observations on the Giant Flare from Mrk 421 in February 2010* American Institute of Physics Conference Series, edited by F. A. Aharonian, W. Hofmann, & F. Rieger (2012).

- Acciari, V.A., et al. (VERITAS Collaboration), *TeV and Multi-wavelength Observations of Mrk 421 in 2006-2008*, *Astrophys. J.*, **738**, 25 (2011).
- Acciari, V.A., et al. (VERITAS Collaboration), *The Discovery of γ -Ray Emission from the Blazar RGB J0710+591*, *Astrophys. J.*, **715** L49-L55 (2010).
- Acciari, V.A., et al. (VERITAS Collaboration), *Veritas 2008-2009 Monitoring of the Variable Gamma-ray Source M 87*, *Astrophys. J.*, **716** 819 (2010).
- Acciari, V.A., et al. (VERITAS Collaboration), *A connection between star formation activity and cosmic rays in the starburst galaxy M82*, *Nature*, **462** Issue 7274 (2009) pp. 770.
- Horan, D., et al., *Multiwavelength Observations of Markarian 421 in 2005 - 2006*, *Astrophys. J.*, **695** 596 (2009).
- Acciari, V.A., et al. (VERITAS Collaboration), *Discovery of Very High Energy Gamma-ray Radiation from the BL Lac 1ES 0806+524*, *Astrophys. J.*, **690** L126-L129 (2009).
- Acciari, V.A., et al. (VERITAS Collaboration) *VERITAS Discovery of >200 GeV Gamma-Ray Emission from the Intermediate-Frequency-Peaked BL Lacertae Object W Comae*, *Astrophys. J.* **684** L73-L77 (2008).
- Fortson, L., Kildea, J., (VERITAS collaboration) *The AGN Monitoring Program with the Whipple 10m Observatory*, in proceedings of “Workshop on Blazar Variability across the Electromagnetic Spectrum”, PoS(BLAZARS2008)039 <http://pos.sissa.it/> (2008).
- Holder, J. et al. *The first VERITAS telescope*, *Astro. Part. Phys.*, **25** 391 (2006).
- Rebillot, P. et al. *Multiwavelength Observations of the Blazar Markarian 421 in 2002 December and 2003 January*, *Astrophys. J.*, **641** 740 (2006).
- Blazejowski, M., et al., *A Multiwavelength View of the TeV Blazar Markarian 421: Correlated Variability, Flaring, and Spectral Evolution*, *Astrophys. J.*, **630** 130 (2005) .
- Swordy, S. & Fortson, L. F., editors *The 2nd VERITAS Symposium on TeV Astrophysics of Extragalactic Sources*, *New Ast Rev*, **48** 321 (2004).

Selected Publications *Science - Galaxy Evolution:*

- Mehta, V. et al., *Investigating Clumpy Galaxies in the Sloan Digital Sky Survey Stripe 82 using the Galaxy Zoo*, accepted *The Astrophysical Journal*, (2021), arXiv:2011.01232.
- Clarke, L. et al., *An old stellar population or diffuse nebular continuum emission discovered in green pea galaxies*, accepted *The Astrophysical Journal*, (2021), arXiv:2012.07668.
- Dickinson, H. et al., *Galaxy Zoo: Morphological Classification of Galaxy Images from the Illustris Simulation*, *The Astrophysical Journal*, **853**, 194 (2018), arXiv:1801.08541.
- Simmons, B. D., et al., *Galaxy Zoo: quantitative visual morphological classifications for 48 000 galaxies from CANDELS*, *Monthly Notices of the Royal Astronomical Society*, **464**, 4420 (2017), arXiv:1610.03070.
- Willett, K. W. et al, *Galaxy Zoo: Morphological Classifications for 120,000 Galaxies in HST Legacy Imaging*, *Monthly Notices of the Royal Astronomical Society* **464**, 4176 (2017), arXiv:1610.03068.
- Holincheck, A. J., et al., *Galaxy Zoo: Mergers - Dynamical models of interacting galaxies*, *Monthly Notices of the Royal Astronomical Society*, **459**, 720 (2016), ArXiv:1604.00435.
- Banfield, J. K., et al., *Radio Galaxy Zoo: host galaxies and radio morphologies derived from visual inspection*, *Monthly Notices of the Royal Astronomical Society*, **453**, 2326 (2015), ArXiv:1507.07272.

- Willett, K. W., et al., *Galaxy Zoo 2: the dependence of the star formation-stellar mass relation on spiral disc morphology*, Monthly Notices of the Royal Astronomical Society, **449**, 820 (2015), ArXiv:1502.03444.
- Galloway, M., et al., *Galaxy Zoo: the effect of bar-driven fuelling on the presence of an active galactic nucleus in disc galaxies*, Monthly Notices of the Royal Astronomical Society, **448**, 3442 (2015), ArXiv:1502.01033.
- Schawinski, K., et al., *The green valley is a red herring: Galaxy Zoo reveals two evolutionary pathways towards quenching of star formation in early- and late-type galaxies*, Monthly Notices of the Royal Astronomical Society **440**, 889 (2014), ArXiv:1402.4814.
- Willett, K. W., et al., *Galaxy Zoo 2: detailed morphological classifications for 304 122 galaxies from the Sloan Digital Sky Survey*, Monthly Notices of the Royal Astronomical Society, **435**, 2835 (2013), ArXiv:1308.3496.
- Masters, K., et al., *Galaxy Zoo: bars in disc galaxies*, MNRAS, **411** Issue 3 (2011) pp. 2026.

Selected Publications *Citizen Science & Zooniverse Projects or Infrastructure:*

- Lea A. Shanley, Lucy Fortson, Tanya Berger-Wolf, Kevin Crowston, Pietro Michelucci *Imagine All the People: Citizen Science, Artificial Intelligence, and Computational Research*, A Computing Community Consortium (CCC) white paper (2020) arXiv:2104.00093
- Walmsley, M., et al., *Galaxy Zoo DECaLS: Detailed Visual Morphology Measurements from Volunteers and Deep Learning for 314,000 Galaxies*, accepted MNRAS (2021) arXiv:2102.08414
- Walmsley, M., et al., *Galaxy Zoo: Probabilistic morphology through Bayesian CNNs and active learning*, MNRAS **491**, 2 (2020) arXiv: 1905.07424
- Wright, D. E., Fortson, L., Lintott, C., Laraia, M, and Walmsley. M., *Help Me to Help You: Machine Augmented Citizen Science*, (2019) ACM Transactions on Social Computing **2**(3): 1-20.
- Mahabal, A., et al., *Machine Learning for the Zwicky Transient Facility*, PASP (2019) **131** (997) arXiv:1902.01936.
- Trouille, L., Lintott, C., Fortson, L., *Citizen science frontiers: Efficiency, engagement, and serendipitous discovery with human-machine systems*, PNAS (2019) **116** (6) 1902-1909.
- Willi, M., et al., *Identifying animal species in camera trap images using deep learning and citizen science*, Methods in Ecology and Evolution **10** 80 (2019).
- Fortson, L., et al., *Optimizing the human-machine partnership with Zooniverse*, In CI 2018: ACM Collective Intelligence- Zurich 2018. arxiv:1809.09738.
- Beck, M., et al., *Integrating human and machine intelligence in galaxy morphology classification tasks*, Monthly Notices of the Royal Astronomical Society, **476**, 5516 (2018). arXiv:1802.08713.
- Bird, R., et al., *Muon Hunter: a Zooniverse project*, 2018 TAUP Conference Proceedings (accepted) arXiv:1802.08907.
- Wright, D., et al., *A transient search using combined human and machine classifications*, 2017 MNRAS **472**, p.1315 arXiv:1707.05223.
- Williams, A., et al., *A computational pipeline for crowdsourced transcriptions of Ancient Greek papyrus fragments*, 2014 IEEE International Conference on Big Data **1**, 100 (2014).
- Williams, A., et al., *Identification of Ancient Greek Papyrus Fragments Using Genetic Sequence Alignment Algorithms*, 2014 IEEE 10th International Conference on e-Science **2**, 5 (2014).

- Fortson, L., et al., *Galaxy Zoo: Morphological Classification and Citizen Science*, Chapter published in *Advances in Machine Learning and Data Mining for Astronomy*. Editors: Michael Way, Jeff Scargle, Ashok Srivastava, and Kamal Ali. arXiv:1104.5513; published 2012.
- Smith, A.M., et al., *Galaxy Zoo Supernovae*, MNRAS, **412** (2011) pp. 1309.

Selected Publications *Reviews, Editorials, Education and Outreach:*

- Fortson, L., *From Green Peas to STEVE: Citizen Science Engagement in Space Science* Chapt 10; **Space Science and Public Engagement** Elsevier; Editor: Amy Kaminski, April 2021.
- Fortson, L., et al., *Cosmology: A few words on infinity*, Nature, Volume 513, Issue 7519, pp. 485 (2014).
- Fortson, L., *Blazing the Trails: Essays by Leading Women in Science* pgs 114-123; Editors: Emma Ideal, Rhiannon Meharchand, July 2013.
- Fortson, L., SubbaRao, M., & Greenberg, G., *Using Collaborative Environments in Research-based Science Education*, Proc. Astro. Soc. Pac., **389** 239-243 (2008).
- Carney, K., Fortson, L., & Nichols, M., *CI-Team: Introducing Quasar Research to High School Science Teachers using the Cyber-infrastructure*, Proc. Astro. Soc. Pac., **389** 91-95 (2008).
- Fortson, L., *The Importance of Involving Research Scientists in Education and Outreach* NASA OSS Education & Public Outreach Conference; ASP Conf. Series, Vol. 319; Eds. C. Narasimhan, B. Beck-Winchatz, & I. Hawkins (2004).

Grant History (foundation and federal):

Research Initiatives:

- Principal Investigator ~\$340,000 NSF, *CHS: Small: Collaborative Research: Optimizing the Human-Machine System for Citizen Science*, (UMN) 2020
- Principal Investigator ~\$189,000 NSF, *SUPPLEMENT-Building the Twenty-First Century Citizen Science Framework to Enable Scientific Discovery Across Disciplines*, (UMN) 2020
- Principal Investigator ~\$945,000 NSF, *Building the Twenty-First Century Citizen Science Framework to Enable Scientific Discovery Across Disciplines*, (UMN) 2019
- Principal Investigator ~\$250,000 NSF, *Very High Energy Gamma-ray Astrophysics with VERITAS*, (UMN) 2018
- Co-Principal Investigator ~\$655,000 NSF, *Eyes on the future: optimizing science output for next generation surveys with joint crowdsourced and automated classification techniques - renewal*, (UMN) 2017
- Principal Investigator ~\$60,000 NASA, *VERITAS Monitoring of the Periodic Blazar PG 1553+133 During Fermi-LAT Predicted Maximum*, (UMN) 2017
- Principal Investigator ~\$360,000 NSF, *Optimizing the Human-Machine System for Citizen Science*, (UMN) 2016
- Principal Investigator ~\$365,000 NSF, *Very High Energy Particle Astrophysics with VERITAS*, (UMN) 2014
- Co-Principal Investigator ~\$625,000 NSF, *Eyes on the future: optimizing science output for next generation surveys with joint crowdsourced and automated classification techniques*, (UMN) 2014
- UMN Principal Investigator ~\$171,500 NSF, *Collaborative Research: CDS&E: Investigating a Self-assembling Data Paradigm for Detector Arrays*, (UMN) 2014

- Principal Investigator ~\$58,500 UMN GIA program, *Using Crowdsourcing to Understand the Evolution of Galaxy Morphology*, (UMN) 2014
- Principal Investigator ~\$15,000 Harvard-Smithsonian Astrophysical Observatory, *VEGAS Software Maintenance*, (UMN) 2014
- Principal Investigator ~\$440,000 NSF, *Very High Energy Particle Astrophysics with VERITAS*, (UMN) 2011
- Principal Investigator ~\$1.9 million NSF, *CDI-Type II: Zooniverse - Conquering the Data Flood with a Transformative Partnership between Citizen Scientists and Machines*, (UMN/Adler) 2010
- Principal Investigator ~\$400,000 NSF, *TeV Studies of Active Galactic Nuclei and Starburst Galaxies with the VERITAS Gamma-ray Observatory*, (UMN/Adler) 2009
- Principal Investigator \$500,000 Brinson Foundation, *Astrophysics Research* (Adler) 2008
- Principal Investigator \$200,000 NSF, *Pointing Monitor System for the VERITAS Gamma-ray Observatory and TeV Studies of Active Galactic Nuclei*, (Adler) 2007
- Principal Investigator \$49,000 NSF, *BLANCA: Broad Lateral Non-Imaging Cherenkov Array*, 1996 (U of Chicago and Adler)

Citizen Science Projects & Infrastructure:

- Senior Personnel ~\$28,000 ACLS Digital Extension Grant, *Optimizing Crowdsourced Transcription using Handwritten Text Recognition*, (UMN SPA portion) 2020
- Senior Personnel ~\$31,000 LCCMR - Cedar Creek, (UMN SPA portion) 2020
- Principal Investigator ~\$313,500 NASA Cooperative Agreement, *Building the NASA Citizen Science Community with Zooniverse*, (UMN SPA portion) 2020
- Co-Investigator ~\$857,000 MN-Partnership Awards (UMN-Mayo Clinic), *AI Assisted High-content Microscopic Image Analysis For Understanding Human Disease Processes*, (UMN SPA portion \$276,250) 2020
- Co-Investigator ~\$572,000 NASA-ROSES, *Solar jet-associated energetic electrons escaping the Sun*, (UMN) 2020
- Co-Investigator ~\$30,000 UMN OVPR - Serendipity Grants, *Towards a Center for Citizen Science at the University of Minnesota*, (UMN) 2016
- Co-Investigator ~\$233,000 NSF, *The View from Behind the Curtain: Establishing a Database of Supreme Court Conference Note Transcriptions*, (UMN) 2015
- Co-Investigator ~\$89,000 NHPRC, *Decoding the Civil War: Engaging the Public with 19th Century Technology & Cryptography through Crowdsourcing and Online Educational Modules*, (UMN) 2015
- Principal Investigator ~\$20,000 Sloan Foundation (Roy Rosenzweig Center for History and New Media), *PressForward: Citizen Science Today*, (UMN) 2015
- Co-Principal Investigator ~\$220,000 NEH, *Digging into Data: Resurrecting Early Christian Lives*, (UMN) 2013
- Principal Investigator \$250,000 Minnesota Futures Research Grant, *The Data Deluge: Applying Data Processing Techniques Derived from Astrophysics Citizen Science Projects to Research Problems in Egyptian Papyrology*, (UMN) 2011
- Principal Investigator \$19,955 NSF, *Zooniverse US-UK Planning Meeting: Bringing together Science and Education Teams*, (Adler) 2009

Other:

- Co-Investigator \$796,167 NSF, *STARS: Science Through Astronomical Research of Stars*, (AAVSO, Adler portion \$20,000) 2009

- Co-Investigator or Senior Staff on over \$7.3 million in foundation awards for Sky Theater and new Galaxies and Cosmology exhibit, 2008
- Principal Investigator \$270,763 NSF, *CI Team: Introducing High School Science Teachers to 21st Century Research Techniques made Possible by Cyberinfrastructure*, 2004
- Co-lead \$3 million, congressional mandate - NASA, Cyberspace Gallery (Adler), 1999

Recent Invited Engagements:

- Dwight Nicholson Medal for Outreach (2019), APS April Meeting (Virtual), April 17, 2021 “*A Brief Tour of the Zooniverse: How Crowdsourcing Science is Solving Big Data Problems in Research*”.
- Curiosity Drives Progress Lecture Series: Impacting Communities, UMN College of Science and Engineering (Virtual), October 8, 2020 “*To the Zooniverse and Beyond: How Crowdsourcing Science is Solving Big Data Problems for UMN Researchers*”.
- Invited speaker: BigCog: Scaling Cognitive Science, Princeton, December 16, 2019 “*Optimizing the Human-Machine Partnership with Zooniverse*”.
- Keynote speaker: Building the NASA Citizen Science Community, Tucson, June 20, 2019 “*The Successes of Zooniverse in Space Science Research*”.
- Keynote speaker: Collective Intelligence Conference, Zurich, July 7, 2018 “*Optimizing the Human-Machine Partnership with Zooniverse*”.
- Invited panelist: University of Minnesota, Nobel Prize Inspiration Initiative, April 25, 2018 “*How to Approach Grand Challenges*”.
- Invited speaker: University of California, Los Angeles, Department of Physics and Astronomy Colloquium, Los Angeles, CA November 3, 2016 “*To the Zooniverse and Beyond: How Crowdsourcing Science is Solving Big Data Problems in Astronomy*”.
- Invited speaker (and co-organizer): Citizen Science Convergence Colloquium - UMN; May 6, 2016 “*Citizen Science 2.0: Pulling it all together*”.
- Invited speaker: Citizen Science 2.0 - SwissNex, San Francisco; April 8, 2016 “*To the Zooniverse and Beyond: the Future of Citizen Science*”.
- Invited speaker: David Cline Memorial Symposium, UCLA; February 20, 2016 “*Connections: David Cline through the lens of a UA1 graduate student*”.
- Invited speaker: Conservation Biology Seminar (UMN); December 7, 2015 “*Zooniverse at your fingertips: A crowdsourcing solution for producing research with the data deluge*”.
- Invited speaker: University of Utah, High Energy Astrophysics Seminar; Salt Lake City, UT; November 6, 2015 “*Looking for evidence of secondary gamma rays in blazar spectra from cosmic ray line of sight interactions*”.
- Invited speaker: University of Utah, Department of Physics and Astronomy Colloquium, Salt Lake City, UT; November 5, 2015 “*To the Zooniverse and Beyond: How Crowdsourcing Science is Solving Big Data Problems in Astronomy*”.
- Invited speaker: University of Utah, Center for Science and Mathematics Education (CSME) Seminar; Salt Lake City, UT; November 5, 2015 “*Education in and with the Zooniverse Citizen Science Platform*”.
- Invited participant: White House Citizen Science Forum and Workshop “Open Science and Innovation: Of the People, By the People, For the People”, The White House, Washington DC; September 30, 2015.
- Invited keynote speaker: Sigma Xi Annual Meeting Minnesota; May 3, 2015 “*Zooniverse at your fingertips: A crowdsourcing solution for producing research with the data deluge*”.

- Invited speaker: Department of Plant Biology Citizen Science Workshop; April 8, 2015 *“Zooniverse at your fingertips: Citizen Science: Involving an Engaged Public in Your Research Projects with Zooniverse”*.
- Invited speaker: Agricultural, Biological, and Environmental Sciences, UMN Libraries seminar; April 7, 2015 *“Zooniverse at your fingertips: A crowdsourcing solution for producing research with the data deluge”*.
- Invited speaker: Towards Big Steps Enabled by “Big Data Science”, Workshop organized by the National Science Foundation; Arlington, VA; January 29-30, 2015 *“Big Data Lessons from the Zooniverse”*.
- Invited speaker: Opportunities and Challenges of Citizen Science, ETH Zurich, Switzerland; January 22-23, 2015 *“To the Zooniverse and Beyond: The Future of Citizen Science”*.
- Invited speaker: American Association of University Women; January 19, 2015 *“A Brief Tour of the Zooniverse: How Crowdsourcing Science is Solving Big Data Problems in Research”*.
- Invited Keynote speaker 2014 International Conference on Collaboration Technologies and Systems, Minneapolis, MN; May 21, 2014 *“Talking in the Zooniverse: A Collaborative Tool for Citizen Scientists”*.
- Invited to organize two panels for the 26th Nobel Peace Prize Forum 2014: “Crowdsourcing to Create Common Ground” and presenter at both panels, March 8, 2014.
- Invited panelist for Graduate and Professional Education Assembly (UMN) panel: “Research and Scholarship using Digital Tools, Technologies and Approaches”, April 2, 2014; presented *“The Zooniverse at Your Fingertips: A Crowdsourcing Solution for Producing Research from the Data Deluge”*.
- Invited panelist for 2013 History of Science Society Annual Meeting panel: “Crowdsourcing Science: Science By the People?”; presented “The Zooniverse at Your Fingertips”, Nov 21, 2013
- Department of Astronomy, University of Maryland Oct 2, 2013 “What’s up in the Zooniverse? A partnership between humans and machines to get the most out of the flood of data”.
- Department of Physics, McGill University, Canada April 9, 2013 “What’s up in the Zooniverse? A partnership between humans and machines to get the most out of the flood of data”.
- University of Minnesota, School of Physics and Astronomy Colloquium, “The Changing View of Blazars from Gamma Ray Observations with VERITAS”, November 14, 2012.
- Summer 2012: Gordon Research Conference: “The Extreme Universe: The Science and Tools of High Energy Astrophysics in the Classroom”, and “The Zooniverse: Engaging with the Process of Research”.
- Spring 2012: The Snowbird Workshop on Dark Matter Observations through Gamma Rays: “VERITAS Constraints on Dark Matter from Observations of the Coma Cluster”.
- Spring 2012: Open Research & Learning: Collaboration, Connections and Communities; “Zooniverse and Open Access Data: Encouraging Public Participation in Research” UMN
- Spring 2011: Physics Department Colloquium, Case Western Reserve University: VERITAS and CTA
- Spring 2011: Astronomy Department Colloquium, Univ. of Wisconsin: VERITAS and CTA
- Spring 2011: Morgridge Institute Public Lecture, Univ. of Wisconsin: Zooniverse
- Spring 2011: Minnesota Astronomical Society, Public Lecture: Zooniverse
- Spring 2011: National Science Foundation lecture series: Zooniverse

Course Assignments:

- Fall 2020: AST 1011H - Honors Introductory Astronomy.
- Spring 2014, 2016, 2018; Fall 2019: Phys 3022 - Introduction to Cosmology.
- Fall 2014: HSEM 2519H - Honors Seminar on Crowdsourcing.
- Fall 2010, 2011, 2012, 2013: Phys 1101 - Introductory College Physics I.
- Spring 2012, 2013: Phys 1102 - Introductory College Physics II.
- Fall 2011, 2012: Phys 5071 - Best Practices in College Physics Teaching I.
- Spring 2012, 2013: Phys 5072 - Best Practices in College Physics Teaching II.
- Fall 2010, Spring 2011: Physics 5980 - Introduction to Research Seminar I, II.

University, College or School Committees:

- Summer 2014 - present: Associate Head, School of Physics & Astronomy
- Spring 2021: CSE Data Science Initiative Director Search Committee
- Spring 2021: CSE Dean Search Committee
- AY 2019-20: School of Physics & Astronomy Faculty Search Committee
- AY 2018-19: MifA Faculty Search Committee
- Fall 2012 - 2015: Member, University Faculty Senate.
- AY 2013-14: Member, Graduate Education and Professional Assembly event planning committee.
- Fall 2013 - present: Member, Bell Museum Astronomy exhibit UMN faculty consulting committee.
- Fall 2012 - Fall 2014: Chair, Undergraduate Education Committee.
- Fall 2011 - Spring 2012: Member, Undergraduate Education Committee.
- Fall 2011 - Spring 2013: Member, Graduate Recruitment Committee.

Graduate and Postdoctoral Advisors:

Dr. David B. Cline, Thesis Advisor, UCLA.
 Dr. Pio Picchi, Postdoctoral Advisor, ICARUS Collaboration, CERN.
 Dr. James Cronin, Postdoctoral Advisor, CASA-MIA Collaboration, University of Chicago.
 Dr. Rene Ong, Postdoctoral Advisor, CASA-MIA Collaboration, UCLA.

Postdoctoral Fellows Advised:

Dr. David Steele, Adler Planetarium; currently research scientist Los Alamos National Laboratory
 Dr. Jeffrey Grube, Adler Planetarium; currently faculty Stephens Institute, New Jersey
 Dr. Niklas Karlsson, Adler Planetarium and UMN (now financial industry, Sweden)
 Dr. Marco Perale, UMN (now Marie Curie Fellow, Oxford University)
 Dr. James Brusuelas, UMN (now post-doctoral scholar, Oxford University)
 Dr. Jonathan Dumm, UMN (now Fellow, Oskar Klein Institute, Sweden)
 Dr. Thomas Nelson, UMN (now Research Faculty, University of Pittsburgh)
 Dr. Kyle Willett, UMN (now data scientist at Amazon Seattle)
 Dr. Cameron Rulten, UMN (now researcher at University of Durham, UK)
 Dr. Hugh Dickinson, UMN (now researcher at Open University, UK)
 Dr. Karlen Shahinyan, UMN (now data scientist at start-up, Boston)
 Dr. Darryl Wright, UMN (now data scientist at Mayo Clinic, Rochester, MN)

Dr. Patrick Wilcox, UMN (now Physics faculty St Cloud State University, MN)

Doctoral Students Advised:

Ms. Ann Isaacs, current doctoral student in Astrophysics
Mr. Dominic Adams, current doctoral student in Astrophysics
Dr. Karlen Shahinyan, PhD 2018; post-doc at UMN, now data scientist
Dr. Melanie Galloway, PhD 2018, now researcher at Zeiss Optical
Dr. Joseph Fowler, faculty at Princeton University, now Research Scientist NIST

Master's Students Advised:

Mr. Suhail Alnahari, Data Science Masters UMN 2021
Mr. Abinash Sinha, Computer Science Masters UMN 2020
Mr. Saurabh Jogalekar, Data Science Masters UMN 2019
Mr. Manish Rai, Data Science Masters UMN 2019
Ms. Shruti Verma, Data Science Masters UMN 2019
Mr. Marco Willi, Data Science Masters UMN 2018; now Industry, Zurich
Mr. Daniel Hanson, Data Science Masters UMN 2018; now Target Corp
Dr. Juliana Vievering, UMN (Masters) - switched to Space Physics for PhD 2019
Dr. Miranda Pihlaja Straub, UMN (Physics Masters, Education Department PhD 2019).
Mr. Amit Kapadia, UMN (Masters 2012); now self-employed programmer

Undergraduate Students Advised:

Ms. Anne Duerr, UMN UROP & senior thesis (spring 2020 - present).
Mr. Saji Champlin, UMN (summer 2020 - present).
Ms. Rafia Omer, UMN (fall 2019 - fall 2020).
Ms. Macy Bauers, UMN UROP (spring 2020).
Mr. Michael Laraia, UMN (spring 2017- spring 2019.)
Ms. Taylor Chadwick, senior thesis, UMN (2018).
Mr. Matthew Urke, Wayzata High School junior summer (2016).
Ms. Katherine Chworowsky, sophomore and senior summer, UMN (2016, 18).
Mr. Michael Hank, freshman summer, sophomore, junior year, UMN (2013-16).
Ms. Katelyn Koiner, REU summer, Univ. of North Dakota, ND (2015).
Mr. Ryan Madden, senior year research project, senior thesis, UMN (2014-15).
Ms. Staci Tiedeken, senior year research project, senior thesis, UMN (2014-15).
Ms. Margaret Molter, REU summer, MacAlaster College, MN (2013).
Mr. Zachary Pace, REU summer, senior thesis, Univ. of Buffalo, NY (2013-14).
Mr. Anthony Clasen, senior summer, research assistant, UMN (2012).
Mr. Andrew Sargent, junior summer, senior thesis, UMN (2012-13).
Mr. David Hung, senior thesis, UMN (2012).
Mr. Yinchuan Yu, sophomore year, UMN (2011).
Ms. Jasmine MacKenzie, freshman summer, sophomore year and summer, UMN (2011-12).
Ms. Caitlin Johnson, junior summer, senior year, UMN (2011-12).

Professional Staff Mentored:

Mr. Suhail Alnahari, Research Associate 3, UMN Feb 2021 - current

Mr. Erik Ostlund, Developer 2, UMN Jun 2021 - current

Ms. Andrea Simenstad, Developer 2, UMN Feb 2015 - Aug 2020