

# Dr. John A. ZuHone: Curriculum Vitae

## Personal

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Citizenship	United States of America
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## Education

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Ph. D. in Astronomy and Astrophysics, University of Chicago	2009
M. S. in Astronomy and Astrophysics, University of Chicago	2004
B. S. in Physics, University of Illinois at Urbana-Champaign	2002

## Honors, Awards, and Named Fellowships

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NASA Postdoctoral Program	2011-2014
Department of Energy Computational Science Graduate Fellowship	2004-2008
McCormick Fellowship, University of Chicago	2002-2003
Graduated With Highest Honors in Physics, University of Illinois	2002

## Research Interests

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### *Astrophysics*

Cosmology; large-scale structure formation; galaxy clusters; intracluster medium; dark matter; X-ray astronomy; astrophysical plasmas; magnetohydrodynamics; active galactic nuclei

### *Computational Science*

Numerical algorithms for computational physics; visualization and analysis techniques; infrastructure for scientific software; parallel computing; Python

### *Spacecraft Operations*

Thermal modeling of spacecraft components; analysis and visualization of telemetry; tracking and modeling of solar storms; developing software to streamline and improve spacecraft operations

## Positions Held

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<i>Chandra X-ray Center, Smithsonian Astrophysical Observatory</i> <i>Astrophysicist (GS-15), ACIS Operations</i>	2015-
<i>Kavli Institute for Astrophysics, Massachusetts Institute of Technology</i> Postdoctoral Research Associate	2014-2015

<i>Astrophysics Science Division, NASA/Goddard Space Flight Center</i> Postdoctoral Research Associate	2011-2014
<i>High-Energy Astrophysics Division, Smithsonian Astrophysical Observatory</i> Postdoctoral Research Associate	2009-2011

## **Teaching Experience**

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<i>Harvard-Smithsonian Center for Astrophysics, Volunteer Instructor</i> yt Boot Camp	2017
<i>NASA/Goddard Space Flight Center, Volunteer Instructor</i> Python Boot Camp	2014
<i>Trinity International University, Instructor</i> Physics 350, “Topics in Physical Science: Astronomy”	2007
<i>University of Chicago, Graduate Teaching Assistant</i> PHSC 12000, “The Origin of the Universe and How We Know”	2003
PHSC 11900, “Stellar Astronomy and Astrophysics”	2003
<i>University of Illinois at Urbana-Champaign, Undergraduate Teaching Assistant</i> PHYS 102, “College Physics: E&M & Modern”	2002
PHYS 111, “University Physics: Mechanics”	2002
PHYS 101, “College Physics: Mech & Heat”	2001
PHYS 111, “University Physics: Mechanics”	2001

## **Professional Service**

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### *Journal Peer Review*

- Astrophysical Journal
- Monthly Notices of the Royal Astronomical Society
- Astronomy & Astrophysics
- Astronomy & Computing

### *Committees and Working Groups*

- yt Executive Committee
- SAO HEAD10 Strategic Plan Science Support and Software Topical Panel
- SOC/LOC for the “Galaxy Clusters & Radio Relics II” workshop at the CfA, September 2024

### *Thesis and Research Review Committee Participation*

- Urmila Chadayammuri, Predoctoral Research Review Committee (SAO)
- Urmila Chadayammuri, Thesis Committee (Yale University, USA)
- Arnab Sarkar Predoctoral Research Review Committee (SAO)
- Wonki Lee, Predoctoral Research Review Committee (SAO)
- Wonki Lee, Thesis Committee (Yonsei University, South Korea)
- Emily Silich, Predoctoral Research Review Committee (SAO)
- Courtney Watson, Predoctoral Research Review Committee (SAO)
- Ivan Oparin, Predoctoral Research Review Committee (SAO)

### *Education and Public Outreach*

- CfA Volunteer for the “Cambridge Explores the Universe” event, 2018
- Staffed the *Chandra* booth at the Red Sox STEM Education Days, 2019
- Staffed the *Chandra* booth at the JFK Library “Space Fest”, 2019
- Co-led a tour of the *Chandra* Operations Control Center for the South Shore Christian Academy 9<sup>th</sup> Grade Physics Class, 2023-2024
- Spoke on Chandra and gravity to the South Shore Christian Academy 5<sup>th</sup> Grade Class, 2023
- Spoke on the 2024 total solar eclipse to the South Shore Christian Academy lower and upper grades, 2024

### *Review Panel Member*

- Astrophysics Theory Proposal (NASA)
- *Chandra* X-ray Observatory (NASA)
- Astronomy and Astrophysics Research Grants (NSF)
- U. S. Department of Energy INCITE Proposals
- *Chandra* Peer Review Panel Organizer, Cycles 24-26

### *Collaborations*

- *Astro-H* Science Working Group
- *XRISM* Science Team as Guest Scientist on the Perseus Target Team
- OLIMPO Science Team
- *Line Emission Mapper* Management Team
- *Lynx* Study Office

## **Awarded Proposals/Grants as PI or Co-PI**

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<i>Smithsonian Institution</i>	2018
Scholarly Studies: “Probing the Kinematics of the Hot and Dark Universe with Simulations of Galaxy Cluster Mergers”, \$75,000	
<i>Chandra X-ray Observatory</i>	2020
Cycle 22 <i>Chandra</i> Theory Proposal: “Simulating the Combined Effects of Mergers and AGN Feedback in the Perseus Cluster”, \$75,131	
<i>National Science Foundation</i>	2022
Astronomy & Astrophysics Research Grants: “Collaborative Research: Constraining Galaxy Cluster Merger Dynamics with Hydrodynamical Simulations and Novel Multi-Probe Observations of 10 Objects”, \$130,077 (Co-PI)	
<i>National Aeronautics and Space Administration</i>	2022
<i>XRISM</i> Guest Scientist Program: “Studying Gas Motions and Plasma Properties of Clusters of Galaxies with MHD Simulations and <i>XRISM</i> ”, \$119,904	
<i>Smithsonian Institution</i>	2022
Scholarly Studies: “Modeling the Detailed Physics of a Hot Plasma in the Brightest Galaxy Cluster in the Sky”, \$72,551	

*National Aeronautics and Space Administration* 2023

Astrophysics Decadal Survey Precursor Science: “Defining Science Requirements for Galaxy Formation and Evolution Across the UV and X-ray Wavebands with Synthetic Observations”, \$232,604

*Chandra X-ray Observatory* 2023

Cycle 25 *Chandra* Theory Proposal: “The Most Powerful Explosion in the Universe? Simulating AGN Feedback and Gas Motions in the Ophiuchus Cluster”, \$64,452

*XRISM Observatory* 2024

Cycle 1 *XRISM* Proposal: “Separating Dark Matter and Hot Gas Velocities in a Unique Merging Cluster: First Comparison of X-rays and the kSZ Effect”, \$70,586 (Co-PI, Step-1 proposal accepted, Step-2 proposal pending)

*XRISM Observatory* 2024

Cycle 1 *XRISM* Proposal: “The Chemical Composition of the Cool-Core Cluster Abell 2199”, \$192,019 (Budget PI, Step-1 proposal accepted, Step-2 proposal pending)

## **Significant Contributions to Scientific Software**

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- FLASH (<https://flash.rochester.edu/>): N-body/hydrodynamics code, co-developer
- yt (<https://yt-project.org/>): visualization and analysis software for simulations, co-developer
- unyt (<https://unyt.readthedocs.org/>): symbolic units package, co-developer
- GAMER (<https://github.com/gamer-project/gamer>): N-body/hydrodynamics code, co-developer
- pyXSIM (<https://hea-www.cfa.harvard.edu/~jzuhone/pyxsim>): simulating X-ray observations, main developer
- SOXS (<https://hea-www.cfa.harvard.edu/soxs>): simulating X-ray observations, main developer
- ACISpy (<https://cxc.cfa.harvard.edu/acis/acispy/>): analysis of spacecraft telemetry and thermal models for ACIS instrument, main developer
- acis\_thermal\_check ([https://cxc.cfa.harvard.edu/acis/acis\\_thermal\\_check](https://cxc.cfa.harvard.edu/acis/acis_thermal_check)): thermal model propagation and violations checking for the ACIS instrument, main developer

## **Computing Proficiency and Experience**

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### *Programming Languages*

proficient in: C, Fortran, Python  
conversant in: IDL, Julia, C++  
learning: Javascript

### *Software and Libraries*

Simulation codes: FLASH, Athena, Athena++, Enzo, Arepo, GAMER  
Python scientific software: NumPy, SciPy, AstroPy, yt, h5py, Jupyter

MPI (parallel computing library)  
HDF5 (hierarchical data format, <https://www.hdfgroup.org/solutions/hdf5/>)  
CIAO (Analysis tools for *Chandra* data, <https://cxc.cfa.harvard.edu/ciao/>)  
XSPEC (X-ray spectral fitting tool, <https://heasarc.gsfc.nasa.gov/xanadu/xspec/>)  
MARX (*Chandra* ray-trace simulator, <https://space.mit.edu/CXC/marx/>)  
Version Control Systems: Subversion, Mercurial, Git  
Documentation Languages and Systems: HTML, Markdown, RestructuredText, Sphinx, Jinja

## **Recent Colloquia and Conference Participation**

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- “The Physics of the Hot, X-ray Emitting Plasma in Clusters of Galaxies.” Invited Astrophysics Seminar, Department of Physics and Astronomy, University of Utah, November 2024, Salt Lake City, UT
- “25 Years of Science with Chandra.” Invited Colloquium, Department of Physics and Astronomy, Michigan State University, September 2024, East Lansing, MI
- “The Effect of Viscosity on Sloshing Motions and Cold Fronts in Galaxy Cluster Cores.” Invited Talk, ICM Theory and Computation Meeting, August 2024, Ann Arbor, MI
- “How Viscous is the ICM, Anyway?” Invited Talk, Galaxy Clusters and Radio Relics Workshop, September 2024, Cambridge, MA
- “Unveiling the Hot Circumgalactic Medium of Galaxies with Next-Generation X-ray Instruments.” Invited Talk, Multiphase Madness Workshop, August 2024, Cambridge, MA (on Zoom)
- “Unveiling the Hot Circumgalactic Medium of Galaxies with Next-Generation X-ray Instruments.” Invited Talk, European Astronomical Society Meeting, July 2024, Padua, Italy (on Zoom)
- “Mapping Galaxy Cluster Dynamics with Microcalorimeters.” Invited Talk, 2023 Merging Cluster Workshop, Yonsei University, December 2023, Seoul, South Korea
- “Magnetic Fields, Jets, Velocities, and Cosmic Rays in Merging Galaxy Clusters.” Invited Special Seminar, Yonsei University, December 2023, Seoul, South Korea
- “Probing the Processes Driving Turbulence in the Perseus Cluster with XRISM and MHD simulations.” Talk, XRISM Science Team Meeting #5, December 2022, Tsukuba, Japan
- “Magnetic Fields, Jets, Velocities, and Cosmic Rays in Merging Galaxy Clusters.” Invited High-Energy Seminar, Department of Astronomy & Astrophysics, University of Chicago, September 2022, Chicago, IL

“Line Emission Mapper: A Large-Grasp X-ray Microcalorimeter Probe Concept to Study the Evolution of Galaxies.” Invited Colloquium, Astronomy Department, University of Illinois at Urbana-Champaign, September 2022, Urbana, IL

“Magnetic Fields, Jets, Velocities, and Cosmic Rays in Merging Galaxy Clusters.” Invited Talk, ICM Theory and Computation Meeting, August 2022, Copenhagen, Denmark (on Zoom)

“The Interaction Between Merger-driven Gas Motions and AGN Feedback in Clusters of Galaxies.” Invited Talk, IAU General Assembly Focus Meeting 6, August 2022, Busan, South Korea (on Zoom)

“Simulations of the Hot and Dynamic ICM of Galaxy Clusters”, Invited Talk, STScI Symposium: “Galaxy Clusters 2022: Challenging Our Cosmological Perspectives”, April 2022, Baltimore, MD (on Zoom)

“The Interaction Between Particles and Magnetic Fields in Galaxy Cluster Mergers.” Invited Talk, Royal Astronomical Society National Astronomy Meeting, July 2021, Bath, United Kingdom (on Zoom)

“How Merger-driven Gas Motions in Galaxy Clusters Can Turn AGN Bubbles into Radio Relics.” Contributed Talk, “A new window on the radio emission from galaxies, clusters and cosmic web” Workshop, March 2021

## **Publication Summary and Metrics**

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A full list of publications (refereed and preprint) can be found [here](#).

- **23 first-author refereed publications**, with 1,040 citations and a Hirsch index of 16.
- **40 first or second-author refereed and submitted publications**, with 1,476 citations and a Hirsch index of 22.
- **107 refereed and submitted publications in which I am on the author list**, with 2,941 citations and a Hirsch index of 31.

## **Selected Publications**

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Bellomi, E., **ZuHone, J. A.**, Weinberger, R., ..., Ruszkowski, M., & Markevitch, M. “On the Origin of the Ancient, Large-scale Cold Front in the Perseus Cluster of Galaxies.” 2024, ApJ, 974, 234

Schellenberger, G., Bogdán, Á, **ZuHone, J. A.**, ..., Wang, Q. D., & Zhuravleva, I. “Mapping the Imprints of Stellar and Active Galactic Nucleus Feedback in the Circumgalactic Medium with X-Ray Microcalorimeters.” 2024, ApJ, 969, 85

Domínguez-Fernández, P., **ZuHone, J.**, Weinberger, R., ..., Nulsen, P., Brunetti, G. “Jet interaction with galaxy cluster mergers.” 2024, arXiv:2406.19681

- Zhang, C., Zhuravleva, I., Markevitch, M., **ZuHone, J.**, ..., Vogelsberger, M., & Walker, S. “Mapping the intracluster medium in the era of high-resolution X-ray spectroscopy.” 2024, MNRAS, 530, 4234
- Silich, E. M., Bellomi, E., Sayers, J., **ZuHone, J.**, ..., Zemcov, M., & Zitrin, A. “ICM-SHOX. I. Methodology Overview and Discovery of a Gas–Dark Matter Velocity Decoupling in the MACS J0018.5+1626 Merger.” 2024, ApJ, 968, 74
- Lee, W., Pillepich, A., **ZuHone, J.**, ..., Nagai, D., Finner, K. “Radio relics in massive galaxy cluster mergers in the TNG-Cluster simulation.” 2024, A&A, 686, A55
- ZuHone, J. A.**, Schellenberger, G., Ogorzałek, A., ..., Wang, Q. D., & Zhuravleva, I. “Properties of the Line-of-sight Velocity Field in the Hot and X-Ray-emitting Circumgalactic Medium of Nearby Simulated Disk Galaxies.” 2024, ApJ, 967, 49
- Botteon, A., Gastaldello, F., **ZuHone, J. A.**, ..., Shimwell, T. W., & van Weeren, R. J. “A radio bubble shredded by gas sloshing?” 2024, MNRAS, 527, 919
- Chadayammuri, U., Ntampaka, M., **ZuHone, J.**, Bogdán, Á, & Kraft, R. P. “Painting baryons on to N-body simulations of galaxy clusters with image-to-image deep learning.” 2024, MNRAS, 526, 2812
- Lee, W., **ZuHone, J.**, James Jee, M., ..., Kale, R., & Ahn, E. “Discovery of A Large-scale Bent Radio Jet in the Merging Cluster A514.” 2023, ApJ, 957, L4
- ZuHone, J.**, Bahar, Y. E., Biffi, V., ..., Zhang, X., & Ghirardini, V. “Effects of multiphase gas and projection on X-ray observables in simulated galaxy clusters as seen by eROSITA.” 2023, A&A, 675, A150
- ZuHone, J. A.**, Nulsen, P. E. J., Tseng, P.-H., Schive, H.-Y., & Jones, T. W. “Hydrodynamic Simulations of a Relativistic Jet Interacting with the Intracluster Medium: Application to Cygnus A.” 2023, Galaxies, 11, 51
- Norseth, C. T., Wik, D. R., **ZuHone, J. A.**, Miller, E. D., Bautz, M. W., & McDonald, M. “Gas clumping in the outskirts of galaxy clusters, an assessment of the sensitivity of STAR-X.” 2023, RAS Techniques and Instruments, 2, 607
- Soltis, J., Ntampaka, M., Wu, J. F., **ZuHone, J.**, ..., Ho, M., & Nagai, D. “A Machine-learning Approach to Enhancing eROSITA Observations.” 2022, ApJ, 940, 60
- Biffi, V., **ZuHone, J. A.**, Mroczkowski, T., Bulbul, E., & Forman, W. “The velocity structure of the intracluster medium during a major merger: Simulated microcalorimeter observations.” 2022, A&A, 663, A76
- Chadayammuri, U., **ZuHone, J.**, Nulsen, P., Nagai, D., & Russell, H. “Turbulent magnetic fields in merging clusters: a case study of Abell 2146.” 2022, MNRAS, 512, 2157

- Walker, S. A., Mirakhor, M. S., **ZuHone, J.**, ..., Fabian, A. C., & Diwanji, P. “Is there an enormous cold front at the virial radius of the Perseus cluster?” 2022, *ApJ*, 929, 37
- Fabian, A. C., **ZuHone, J.**, & Walker, S. A. “The interaction between rising bubbles and cold fronts in cool core clusters.” 2022, *MNRAS*, 510, 4000
- ZuHone, J.** & Su, Y. “The Merger Dynamics of the X-Ray-Emitting Plasma in Clusters of Galaxies.” 2022, *Handbook of X-ray and Gamma-ray Astrophysics*, 93
- Chadayammuri, U., **ZuHone, J.**, Nulsen, P., ..., King, L., & Russell, H. “Constraining merging galaxy clusters with X-ray and lensing simulations and observations: the case of Abell 2146.” 2022, *MNRAS*, 509, 1201
- ZuHone, J.**, Ehlert, K., Weinberger, R., & Pfrommer, C. “Turning AGN Bubbles into Radio Relics with Sloshing: Modeling CR Transport with Realistic Physics.”, 2021, *Galaxies*, 9, 91
- ZuHone, J. A.**, Markevitch, M., Weinberger, R., Nulsen, P., & Ehlert, K. “How Merger-driven Gas Motions in Galaxy Clusters Can Turn AGN Bubbles into Radio Relics.” 2021, *ApJ*, 914, 73
- Bryzcki, B., & **ZuHone, J.** “A Parameter Space Exploration of Galaxy Cluster Mergers. II: Effects of Magnetic Fields.” 2019, *ApJ*, 883, 2
- ZuHone, J.**, Zavala, J., & Vogelsberger, M. “Sloshing of Galaxy Cluster Core Plasma in the Presence of Self-Interacting Dark Matter.” 2019, *ApJ*, 882, 2
- ZuHone, J.**, & Sims, J. “Testing Emergent Gravity with Optical, X-ray, and Weak Lensing Measurements in Massive, Relaxed Galaxy Clusters.” 2019, *ApJ*, 880, 145
- Ntampaka, M., **ZuHone, J.**, Eisenstein, D., ..., Torrey, P., & Vogelsberger, M. “A Deep Learning Approach to Galaxy Cluster X-ray Masses.” 2019, *ApJ*, 876, 1
- Simionescu, A., **ZuHone, J.**, Zhuravleva, I., ..., Gu, L., & Paerels, F. “Constraining Gas Motions in the Intra-Cluster Medium.”, 2019, *SSRv*, 215, 24
- Schive, H.-Y., **ZuHone, J. A.**, Goldbaum, N. J., Turk, M. J., Gaspari, M., & Cheng, C.-Y. “GAMER-2: a GPU-accelerated adaptive mesh refinement code – accuracy, performance, and scalability.” 2018, *MNRAS*, 481, 4815
- Goldbaum, N. J., **ZuHone, J. A.**, Turk, M. J., Kowalik, K., & Rosen, A. L. 2018, “unyt: Handle, manipulate, and convert data with units in Python.” *Journal of Open Source Software*, 3(28), 809
- Walker, S. A., **ZuHone, J.**, Fabian, A., & Sanders, J. “The split in the ancient cold front in the Perseus cluster.” 2018, *Nature Astronomy*, 2, 292



- ZuHone, J. A.**, Kowalik, K., Ohman, E., Lau, E., & Nagai, D., “The Galaxy Cluster Merger Catalog: An Online Repository of Mock Observations from Simulated Galaxy Cluster Mergers.” 2018, ApJS 234, 4
- ZuHone, J.**, Miller, E. D., Bulbul, E., & Zhuravleva, I. “What Do the Hitomi Observations Tell Us About the Turbulent Velocities in the Perseus Cluster? Probing the Velocity Field with Mock Observations.” 2018, ApJ, 853, 180
- ZuHone, J.**, & Roediger, E., “Cold Fronts: Probes of Plasma Astrophysics in Galaxy Clusters.” 2016, Journal of Plasma Physics, 82, 535820301
- ZuHone, J.A.**, Miller, E.D, Simionescu, A., & Bautz, M.W. “Simulating Astro-H Observations of Sloshing Gas Motions in the Cores of Galaxy Clusters.” 2016, ApJ, 821, 6
- ZuHone, J.**, Markevitch, M., & Zhuravleva, I. “Mapping the Gas Turbulence in the Coma Cluster: Predictions for Astro-H.” 2016, ApJ, 817, 110
- Werner, N., **ZuHone, J.A.**, Zhuravleva, I., ..., & Sanders, J.S. “Deep *Chandra* Observation and Numerical Studies of the Nearest Cluster Cold Front in the Sky.” 2016, MNRAS, 455, 846
- ZuHone, J.**, Brunetti, G., Giacintucci, S., & Markevitch, M. “Secondary Models for Radio Mini-Halos in Galaxy Clusters with MHD Simulations of Gas Sloshing.” 2015, ApJ, 801, 146
- ZuHone, J. A.**, Kunz., M. W., Markevitch, M., Stone, J. M., & Biffi, V. “The Effect of Anisotropic Viscosity on Cold Fronts in Galaxy Clusters.” 2015, ApJ, 798, 90
- ZuHone, J. A.**, Markevitch, M., Brunetti, G., & Giacintucci, S. “Turbulence and Radio Mini-halos in the Sloshing Cores of Galaxy Clusters.” 2013, ApJ, 762, 78
- ZuHone, J. A.**, Markevitch, M., Ruszkowski, M., & Lee, D. “Cold Fronts and Gas Sloshing in Galaxy Clusters with Anisotropic Thermal Conduction.” 2013, ApJ, 762, 69
- ZuHone, J. A.**, Markevitch, M., & Lee, D. “Sloshing of the Magnetized Cool Gas in the Cores of Galaxy Clusters.” 2011, ApJ, 743, 16
- ZuHone, J. A.** “A Parameter Space Exploration of Galaxy Cluster Mergers. I: Gas Mixing and the Generation of Cluster Entropy.” 2011, ApJ, 728, 54
- ZuHone, J. A.**, Markevitch, M., & Johnson, R. E. “Stirring Up the Pot: Can Cooling Flows In Galaxy Clusters Be Quenched By Gas Sloshing?” 2010, ApJ, 717, 908
- ZuHone, J. A.**, Ricker, P. M., Lamb, D. Q., & Yang, H. Y. “A Line-Of-Sight Galaxy Cluster Collision: Simulated X-Ray Observations.” 2009, ApJ, 699, 1004

**ZuHone, J. A.,** Lamb, D. Q., & Ricker, P. M. “Rings of Dark Matter in Collisions  
Between Clusters of Galaxies.” 2009, ApJ, 696, 694