

Dr. John L. Kelley

Curriculum Vitae

Contact Wisconsin IceCube Particle Astrophysics Center
222 W. Washington Ave., Suite 500
Madison, WI 53703 U.S.A.

Phone: +1 (608) 263-5664

jkelley@icecube.wisc.edu

Citizenship U.S.A.

Education

2003 – 2008 Ph.D., physics
University of Wisconsin – Madison
Madison, Wisconsin, U.S.A.
Thesis: “Searching for Quantum Gravity with High-Energy Atmospheric Neutrinos and AMANDA-II” (advisor A. Karle)

1990 – 1994 B.S., physics and mathematics, *magna cum laude*
Duke University
Durham, North Carolina, U.S.A.

Employment

2021 – present Scientist
Wisconsin IceCube Particle Astrophysics Center
Department of Physics, University of Wisconsin – Madison
Madison, Wisconsin, U.S.A.

2018 – 2021 Associate scientist
Wisconsin IceCube Particle Astrophysics Center
Department of Physics, University of Wisconsin – Madison
Madison, Wisconsin, U.S.A.

2012 – 2018 Assistant scientist
Wisconsin IceCube Particle Astrophysics Center
Department of Physics, University of Wisconsin – Madison
Madison, Wisconsin, U.S.A.

2009 – 2012 Postdoctoral researcher
Department of Astrophysics, Radboud University Nijmegen
Nijmegen, The Netherlands

2003 – 2008 Graduate research assistant, AMANDA/IceCube group
Department of Physics, University of Wisconsin – Madison
Madison, Wisconsin, U.S.A.

1998 – 2003 Staff engineer, microprocessor design
MIPS Technologies, Inc.
Mountain View, California, U.S.A.

1997 – 1998 Member of technical staff: core design
Silicon Graphics, Inc.
Mountain View, California, U.S.A.

Management, Advising, and Teaching Experience

2023 – present Director of Operations of the IceCube Neutrino Observatory. Responsible for the ongoing maintenance and operations program for IceCube.

2013 – 2023 Detector operations manager of the IceCube Neutrino Observatory. Daily supervision of a team of 6 local software engineers and physicists. Coordination of an international group of operations experts via weekly teleconference.

2020 – 2022 Supervision of Ph.D. student (J. Peterson), photomultiplier tube waveform processing techniques.

2014 – 2018 Supervision of undergraduate students: A. Christenson (2014–2015), radio event reconstruction methods. M. Beheler-Amass (2014–2018), radio raytracing methods and beamforming algorithms. M. Beydler (2015), G. Mercado (2016), S. McCarthy (2017), and C.W. Robertson (2018), REU summer research students.

2010 – 2012 Supervision of Ph.D. student (A. Nelles), radio detection of high-energy cosmic rays.

2009 – 2012 Electronics working group leader of the Auger Engineering Radio Array.

2000 – 2003 Engineering design team leader, MIPS Technologies, Inc., including supervision of summer interns.

1993 – 1994 Teaching assistant and telescopic observing instructor, introductory astronomy class, Duke University.

Professional Activities

2021 – present External technical reviewer, data acquisition systems for the CMB-S4 experiment.

2019 – present Journal reviewer, Journal of Instrumentation (JINST) and Journal of Astronomical Telescopes, Instruments, and Systems (JATIS).

2010 – 2012 Member, Committee for Astroparticle Physics in the Netherlands (CAN). National committee responsible for advocating research priorities and strategy, organizing conferences, and creating educational opportunities in particle astrophysics.

Awards and Grants

2023 – present Co-principal investigator for NSF #2310097, “Askaryan Radio Array: A World-Class, Forward-Looking, and Dynamic Neutrino Astrophysics Observatory From 100 PeV”.

2021 – present Key personnel for NSF #2042807, “Management and Operations of the IceCube Neutrino Observatory 2021-2026”.

2013–2021 Significant contributions to successful grant applications NSF #1600823 “Management and Operations of the IceCube Neutrino Observatory 2016–2021” and NSF #1250720 “BIGDATA: Advancing real-time data processing and reduction in radio astronomical detectors”.

2010–2011 LKBF Travel Grants
Stichting Het Leids Kerkhoven-Bosscha Fonds, Netherlands

2006 United States Antarctica Service Medal
U.S. National Science Foundation

2003 Van Vleck Graduate Fellowship
University of Madison – Wisconsin Department of Physics

1994 Julia Dale Memorial Mathematics Award
Duke University Department of Mathematics

Research Activities

2012 – present **IceCube Neutrino Observatory**, a high-energy neutrino detector located at the geographic South Pole.

- **Operations:** Led a team of physicists and engineers responsible for maintenance and operation of the IceCube detector. Coordinated software development, planned and executed hardware upgrades, and led effort to monitor data quality. Average uptime of the detector is approximately 99%.
- **Detector development:** Maintained and developed several low-level software components of the IceCube data acquisition system. Researched software waveform unfolding methods for use on next-generation DOMs. Development and testing of electronics for prototype scintillator array.
- **Field work:** Deployed six summer seasons to Amundsen-Scott South Pole station, Antarctica (10 total deployments). Planned and led successful upgrade of IceCube data-taking computers.

2013 – present **Askaryan Radio Array (ARA)**, an ultra-high-energy radio neutrino detector at the South Pole.

- **Operations:** Co-principal investigator (PI) of ARA operations. Planned and implemented South Pole maintenance and operations and interfaced with the IceCube Neutrino Observatory.
- **Data analysis:** Developed graphics processing unit (GPU) algorithms for beamforming radio signals from the ARA antenna array.
- **Detector development:** Developed Linux device driver for high-speed PCIe data readout for the ARA data acquisition hardware.

2009 – 2012 **AERA** (Auger Engineering Radio Array), an extension of the **Pierre Auger Observatory** for radio detection of ultra-high energy cosmic rays.

- **Detector development:** As electronics working group leader, coordinated production, testing, calibration, and integration of the electronics of the first AERA radio detector stations. Planned and led successful deployment of 21 stations in Argentina. Developed high-speed digital filtering techniques for use on the radio signals. Wrote Linux device driver for custom digitization hardware. Collaborated on development of a distributed wireless communication and triggering system.
- **Data analysis:** Analyzed AERA's first self-triggered radio cosmic ray events. Analyzed first commissioning data to characterize anthropogenic noise sources. Investigated sensitivity of radio arrays to horizontal neutrino-induced air showers.

2007 – 2009 **IceRay / ARA / AURA R&D** for an Antarctic radio neutrino detector.

- **Detector development:** Integrated and tested a prototype radio Cherenkov surface detector in collaboration with the University of Hawaii. Tested and characterized in-ice radio detector modules (AURA).

2003 – 2009

IceCube and AMANDA-II neutrino telescopes.

- **Data analysis:** Performed a search for signatures of quantum gravity in the energy and zenith angle distributions of high-energy atmospheric neutrinos. Performed a search for high-energy neutrinos from cosmic ray interactions in the Galactic plane.
- **Simulation:** Maintained the simulation software distribution for the AMANDA-II experiment. Maintained the AMANDA/IceCube version of the CORSIKA cosmic ray air shower simulation package.
- **Testing and calibration:** Co-developed primary self-calibration software for IceCube digital optical modules (DOMs). Developed production tests for IceCube DOMs.
- **Software development:** Developed low-level software for IceCube LED flasher-board reprogramming (JTAG) and operation. Developed first DAQ for IceTop air shower tanks. Developed prototype FPGA module for high-speed ping-pong digitization in IceCube modules.
- **Field work:** Deployed during four summer seasons to Amundsen-Scott South Pole station, Antarctica. Installed prototype IceTop air shower tanks and DAQ. Installed, debugged, and repaired IceCube surface cabling.

Summary of Technical Skills

In addition to scientific analysis skills such as proficiency in Python, ROOT, and Mathematica, I have significant professional experience in microprocessor logic and circuit design, as well as software design for numerous applications, especially embedded systems. I have programming experience in C, C++, Python, Java, Perl, shell, Verilog, VHDL, Fortran, Pascal, Visual Basic, and MIPS assembler.

Selected Conference Talks

Evolution of the Data Acquisition System for IceCube-Gen2, VLVnT Workshop, 18 May 2021 (virtual).

The IceCube Detector Systems: Current Status and Future Plans, International Workshop on Next Generation Nucleon Decay and Neutrino Detectors (NNN18), Vancouver, Canada, 1 November 2018.

Observation of Deep, Distant Impulsive RF Transmitters by the Askaryan Radio Array, 35th International Cosmic Ray Conference, Busan, Korea, 14 July 2017.

Next Steps in Neutrino Astronomy with IceCube, Scientific Committee for Antarctic Research (SCAR) Open Science Conference, Kuala Lumpur, Malaysia, 23 August 2016.

Next Steps in Neutrino Astronomy, TeV Particle Astrophysics 2015, Kashiwa, Japan, 30 October 2015 (invited summary).

The IceCube Data Acquisition System, Detector Design and Technology for Next Generation Neutrino Observatories, Aachen, Germany, 10 December 2014.

Generation-2 DOM Development for IceCube Extensions, Mediterranean and Antarctica Neutrino Telescope Symposium (MANTS), Geneva, Switzerland, 20 September 2014.

Observation of High-energy Astrophysical Neutrinos with IceCube, Experimental Search for Quantum Gravity, Trieste, Italy, 5 September 2014.

The IceCube Data Acquisition System, VLVnT13 Workshop, Stockholm, Sweden, 6 August 2013.

Searching for Quantum Gravity with the IceCube Neutrino Observatory, Experimental Search for Quantum Gravity workshop, Perimeter Institute, Waterloo, Canada, 23 October 2012 (invited).

Searching for Physics Beyond the Standard Model with the IceCube Neutrino Observatory, Beyond the Standard Model of Particle Physics, Quy Nhon, Vietnam, 16 July 2013.

Data Acquisition, Triggering, and Filtering at the Auger Engineering Radio Array, VLvT Workshop, Erlangen, Germany, 12 October 2011.

LOFAR: Detecting Cosmic Rays with a Radio Telescope, 32nd International Cosmic Ray Conference, Beijing, China, 17 August 2011.

Searching for Quantum Gravity with Ultra-high Energy Neutrinos, Experimental Search for Quantum Gravity 2010, NORDITA, Stockholm, Sweden, 12 July 2010 (invited).

The Pierre Auger Observatory: Recent Results and Future Plans, BEYOND 2010, Cape Town, South Africa, 4 February 2010 (invited).

A Radio-Frequency Extension to the Pierre Auger Cosmic Ray Observatory, Nederlandse Natuurkundige Vereniging (NNV) Meeting, Lunteren, The Netherlands, 6 November 2009.

Searching for Quantum Gravity with High-energy Atmospheric Neutrinos and AMANDA-II, 18th Particles and Nuclei International Conference (PANIC08), Eilat, Israel, 11 November 2008.

IceRay: An IceCube-centered Radio GZK Array, ARENA 2008 Workshop on Acoustic and Radio EeV Neutrino Detection Activities, Rome, Italy, 24 June 2008.

Testing Violation of Lorentz Invariance with Atmospheric Neutrinos and AMANDA-II, Fourth Meeting on CPT and Lorentz Symmetry, Bloomington, Indiana, 9 August 2007.

Tests of Quantum Gravity with Neutrino Telescopes, Workshop “From Quantum to Emergent Gravity: Theory and Phenomenology,” Trieste, Italy, 15 June 2007 (invited).

A Search for High-energy Muon Neutrinos from the Galactic Plane with AMANDA-II, 29th International Cosmic Ray Conference, Pune, India, 6 August 2005.

Invited Colloquia

The Cosmic Ray and Neutrino Connection: Extreme Astrophysics at the Ends of the Earth, Embry Riddle Aeronautical University, Prescott, Arizona 17 September 2013.

A New Window onto Ultra-high Energy Cosmic Rays: Super-hybrid Air Shower Observations at the Pierre Auger Observatory, SISSA, Trieste, Italy, 14 June 2011.

Searching for Quantum Gravity with High-energy Cosmic Rays and Neutrinos, Utrecht University, Utrecht, Netherlands, 3 May 2010.

Radio Detection of High-energy Cosmic Rays and Neutrinos, Université Libre de Bruxelles, Brussels, Belgium, 30 October 2009.

Publications

Selected Refereed Journal Papers

R. Abbasi *et al.*, Observation of high-energy neutrinos from the Galactic plane, *Science* **380**, 1338 (2023).

A. Coleman *et al.*, Ultra-high energy cosmic rays: The intersection of the Cosmic and Energy Frontiers, *Astroparticle Physics* **149**, 102819 (2023).

R. Abbasi *et al.*, Evidence for neutrino emission from the nearby active galaxy NGC 1068, *Science* **378**, 538 (2022).

M. G. Aartsen *et al.*, Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A, *Science* **361**, eaat1378 (2018).

- M. G. Aartsen *et al.*, The IceCube Neutrino Observatory: Instrumentation and Online Systems, *Journal of Instrumentation* **12**, P03012 (2017), arXiv:1612.05093, **Corresponding author**.
- M. G. Aartsen *et al.*, All-sky Search for Time-integrated Neutrino Emission from Astrophysical Sources with 7 yr of IceCube Data, *Astrophys. J.* **835**, 151 (2017), arXiv:1609.04981.
- P. Allison *et al.*, Constraints on the ultra-high-energy neutrino flux from Gamma-Ray bursts from a prototype station of the Askaryan radio array, *Astroparticle Physics* **88**, 7 (2017), arXiv:1507.00100.
- P. Allison *et al.*, Performance of two Askaryan Radio Array stations and first results in the search for ultrahigh energy neutrinos, *Phys. Rev. D* **93**, 082003 (2016), arXiv:1507.08991.
- P. Allison *et al.*, First constraints on the ultra-high energy neutrino flux from a prototype station of the Askaryan Radio Array, *Astroparticle Physics* **70**, 62 (2015), arXiv:1404.5285.
- M. G. Aartsen *et al.*, Observation of High-Energy Astrophysical Neutrinos in Three Years of IceCube Data, *Physical Review Letters* **113**, 101101 (2014), arXiv:1405.5303.
- M. G. Aartsen *et al.*, First Observation of PeV-Energy Neutrinos with IceCube, *Physical Review Letters* **111**, 021103 (2013), arXiv:1304.5356.
- S. Yousaf, R. Bakhshi, M. van Steen, S. Voulgaris, and J. L. Kelley, Exploring design tradeoffs of a distributed algorithm for cosmic ray event detection, *Journal of Instrumentation* **8**, P03011 (2013), arXiv:1209.6577.
- Pierre Auger Collaboration *et al.*, Constraints on the Origin of Cosmic Rays above 10^{18} eV from Large-scale Anisotropy Searches in Data of the Pierre Auger Observatory, *Astrophys. J.* **762**, L13 (2013), arXiv:1212.3083.
- P. Abreu *et al.*, Results of a self-triggered prototype system for radio-detection of extensive air showers at the Pierre Auger Observatory, *Journal of Instrumentation* **7**, P11023 (2012), arXiv:1211.0572.
- The Pierre Auger Collaboration, J. Abraham *et al.*, Measurement of the Depth of Maximum of Extensive Air Showers above 10^{18} eV, *Physical Review Letters* **104**, 091101 (2010), arXiv:1002.0699.
- The IceCube Collaboration, R. Abbasi *et al.*, The IceCube data acquisition system: Signal capture, digitization, and timestamping, *Nuclear Instruments and Methods in Physics Research A* **601**, 294 (2009), arXiv:0810.4930.

Selected Conference Proceedings

- J. Kelley *et al.*, Evolution of the IceCube data acquisition system for IceCube-Gen2, *Journal of Instrumentation* **16**, C09017 (2021).
- M. Duvernois *et al.*, The IceCube Generation-2 Digital Optical Module and Data Acquisition System, *Proceedings of Science: 34th International Cosmic Ray Conference (The Hague, Netherlands)* **1148** (2015).
- J. L. Kelley *et al.*, Event triggering in the IceCube data acquisition system, *AIP Conf. Proc.* **1630**, 154 (2014).
- J. L. Kelley, Data acquisition, triggering, and filtering at the Auger Engineering Radio Array, *Nuclear Instruments and Methods in Physics Research A* **725**, 133 (2013), arXiv:1205.2104.
- J. L. Kelley and the Pierre Auger Collaboration, AERA: The Auger Engineering Radio Array, *Proc. of the 32nd International Cosmic Ray Conference* (2011), arXiv:1107.4807.
- J. L. Kelley and the IceCube Collaboration, Searching for Quantum Gravity with High Energy Atmospheric Neutrinos and AMANDA-II, *Nuclear Physics A* **827**, 507 (2009).

- P. Allison *et al.*, IceRay: An IceCube-centered radio-Cherenkov GZK neutrino detector, *Nuclear Instruments and Methods in Physics Research A* **604**, 64 (2009), arXiv:0904.1309.
- J. Ahrens, J. L. Kelley, and the IceCube Collaboration, Testing alternative oscillation scenarios with atmospheric neutrinos using AMANDA-II data from 2000 to 2003, *Proc. of the 30th International Cosmic Ray Conference* **5**, 1295 (2008), arXiv:0711.0353.
- J. L. Kelley, Searching for quantum gravity with neutrino telescopes, *Proceedings of Science — From Quantum to Emergent Gravity: Theory and Phenomenology* **022** (2007).
- J. Ahrens, J. L. Kelley, and the IceCube Collaboration, Testing alternative oscillation scenarios with atmospheric neutrinos using AMANDA-II data from 2000 to 2003, in *CPT and Lorentz Symmetry*, edited by V. A. Kostelecký, , *Proc. of the Fourth Meeting* Vol. 1, p. 234, 2007.
- J. L. Kelley and the IceCube Collaboration, Testing Lorentz invariance with atmospheric neutrinos and AMANDA-II, *Proc. of the First Workshop on Exotic Physics with Neutrino Telescopes* (2007), arXiv:astro-ph/0701333.
- G. Battistoni, R. Ganugapati, A. Karle, J. L. Kelley, and T. Montaruli, Comparison of high energy interaction models used for atmospheric shower simulations above 1 TeV, *Journal of Physics Conference Series* **60**, 330 (2007).
- J. L. Kelley and the IceCube Collaboration, A Search for High-energy Muon Neutrinos from the Galactic Plane with AMANDA-II, *Proc. of the 29th International Cosmic Ray Conference* **5**, 127 (2005), arXiv:astro-ph/0509546.
- Y. Ho *et al.*, A Process-Portable 64b Embedded Microprocessor with Graphics Extensions and a 3.6GB/sec Interface , *Proceedings of the 2001 IEEE International Solid-State Circuits Conference* **234** (2001).
- T. Lettieri, J. L. Kelley, and C. Ehrlich, Investigation of annular forces using an oscillating, gas-operated piston gauge, *AIP Conf. Proc.* **309**, 1605 (1994).
- J. L. Kelley and B. A. Ratnam, Damping of Ruchhardt oscillations in closed ended piston gages, *Bulletin of the American Physical Society* **36**, 346 (1991).

Patents

- S. Banerjee, J. L. Kelley, and R. C. Kinter, Multi-ISA instruction fetch unit for a processor, and applications thereof, U.S. patent 7,707,389 (2010).
- Y. Ho, J. L. Kelley, and X. Jiang, Processor with improved accuracy for multiply-add operations, U.S. patent 7,346,643 (2008).
- Y. Ho, M. J. Schulte, and J. L. Kelley, System and method for improving the accuracy of reciprocal square root operations performed by a floating-point unit, U.S. patent 6,912,559 (2005).
- J. L. Kelley and Y. Ho, Floating-point processor with improved intermediate result handling, U.S. patent 6,697,832 (2004).
- X. Jiang, Y. Ho, and J. L. Kelley, Method and apparatus for predicting floating-point exceptions, U.S. patent 6,631,392 (2003).

February 22, 2024