Michinari Sakai

Email: michsakai@gmail.com • Phone: 808-206-4357 • Address: 1235 Solano Ave Apt 10, Albany, CA, 94706, USA

Summary

- Extensive experience in particle physics simulation code and handling/processing large amounts of simulated data.
- Proficient in large-scale data analysis and algorithm software development with 8 years of experience.
- Innovative problem solving skills with the ability to interface original work with larger collaboration.

Experience

Post-doctoral Researcher, *UC Berkeley* — June 2018 — *Present*
- Supervisor for simulation/modeling of photon interactions with optical wavelength shifters.
- Data analysis lead for energy spectrum of radioactive isotope alpha decays.

Post-doctoral Researcher, *UCLA* — 2016 — 2018
- Mentor for 2 PhD students to simulate radiation shielding structures to mitigate gamma/beta backgrounds for next generation neutrinoless double beta decay searches requiring ultra-low radiation environments.
- Lead developer of precision alpha decay spectrum model to improve characterization of backgrounds in neutrinoless double beta decay decay searches.

Research Assistant, *University of Hawaii at Manoa* — 2009 — 2016
- Spearheaded development of a novel directional neutrino detection technology in scintillator and demonstrated with data for the first time that this can be applied to conduct indirect dark matter searches in scintillator. First ever physics application of neutrino directionality in scintillator.
- Lead developer of detector simulation code to conducted case studies of neutron capture doping agents in solid scintillator. Simulation results were later used to oversee detector design and construction.

Skills

Software/Tools:	ROOT, Geant4, LabView, SolidWorks, AutoCAD, ComSol, Git, Pads
Programming Languages:	Proficient in Python, C/C++, Mathematica, Matlab, BASH; Some experience with R
Human Languages:	English (native), Japanese/Korean (trilingual proficiency)

Leadership

Mentor, *UC Berkeley/UCLA* — March 2016 — *Present*
- Advised 2 students with optical simulation code for current hardware project. Students are now undertaking independent research tasks and contributing original work.
- Taught weekly Geant4 physics simulation tutorials to 3 PhD-level students for a semester. Students successfully learned to take on independent projects.

Teaching Assistant, *University of Hawaii at Manoa* — 2007 — 2009
- Planned coursework and taught 2 weekly physics laboratory curriculum for classes of over 20 students each for 3 semesters. Received especially positive reviews for clarity of explanation of material, and teaching style.

Education

PhD, Experimental Particle Physics — 2016
- GPA: 3.97/4.00, University of Hawaii at Manoa
- Dissertation: High Energy Neutrino Analysis at KamLAND and Application to Dark Matter Search

Double BS, Physics and Mathematics — 2005
- GPA: 4.33/4.50, Sun Moon University, S. Korea
- President's Award 2005, Award for Outstanding Academic Achievement – Samsung Corp.

Talks and Presentations

- Talk: Results from the CUORE experiment — May 2019
  Sanford Underground Research Facility (SURF), South Dakota - Conference on Science at SURF 2019
- Seminar: Search for Physics Beyond the Standard Model with Neutrinos — May 2018
  Lawrence Livermore National Laboratory
- Invited Talk: Monte Carlo Tools in CUORE — Apr 2018
  Durham University, UK - Monte Carlo Tools for Beyond the Standard Model Physics
- Seminar: CUORE: A Bolometric Search for Lepton Number Violation — Feb 2018
  Argonne National Laboratory
- Talk: CUORE and Background Reduction Case Studies for CUPID — Oct 2017
  Pittsburgh/Carnegie Mellon University - Division of Nuclear Physics 2017
- Invited talk: Status of the CUORE $0\nu\beta\beta$ Decay Search — May 2017
  Sanford Underground Research Facility (SURF), South Dakota - Conference on Science at SURF 2017
- Invited talk: Particle ID and event reconstruction algorithms in scintillator — Mar 2016
  Fermilab - Frontiers of Liquid Scintillator Technology
- Seminar: High Energy Analysis at KamLAND and Application to Dark Matter Search — Nov 2015
  Los Alamos National Laboratory
- Seminar: High Energy Analysis at KamLAND and Application to Dark Matter Search — Nov 2015
  California Institute of Technology
- Seminar: High Energy Analysis at KamLAND and Application to Dark Matter Search — Oct 2015
  University of California, Los Angeles
- Talk: High Energy Analysis and Application to Dark Matter Search in KamLAND — Jul 2015
  University of Hawaii at Manoa - DOE project review
- Poster: Indirect Dark-Matter Detection Through KamLAND — Jun 2012
  Neutrino 2012, Kyoto, Japan
- Talks: What is a Neutrino?, mini-TimeCube: The World's Smallest Neutrino Detector — Nov 2010/2011
  University of Hawaii at Manoa - Campus Open-house
- Talk: mini-TimeCube: A Portable Directional Neutrino Detector — Aug 2010
  Applied Antineutrino Physics 2010, Sendai, Japan
- Talk: KamLAND Summary — Sep 2009
  University of Hawaii at Manoa - DOE project review
- Talk (Student Presentation): How to solve θ_{23} degeneracy — Jul 2009
  Fermilab - International Neutrino Summer School 2009

Publications

[1] M. Sakai (corresponding author) *et al.*, "Directional Neutrino Detection and Topological Event Reconstruction Methods for GeV Scale Neutrinos in KamLAND," *Draft currently in preparation*, 2019 (tentative).

[2] C. Alduino *et al.*, "Study of Rare Nuclear Processes with CUORE," *Submitted to: Int. J. Mod. Phys. A*, 2018. https://arxiv.org/abs/1801.05403.

[3] C. Alduino *et al.*, "First Results from CUORE: A Search for Lepton Number Violation via $0\nu\beta\beta$ Decay of ^{130}Te," *Phys. Rev. Lett.*, vol. 120, no. 13, p. 132501, 2018. https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.132501.

[4] C. Alduino *et al.*, "Search for Neutrinoless $\beta^{+}EC$ Decay of ^{120}Te with CUORE-0," 2017. https://journals.aps.org/prc/abstract/10.1103/PhysRevC.97.055502.

[5] C. Alduino *et al.*, "Low Energy Analysis Techniques for CUORE," *Eur. Phys. J.*, vol. C77, no. 12, p. 857, 2017. https://link.springer.com/article/10.1140/epjc/s10052-017-5433-1.

[6] C. Alduino *et al.*, "CUORE sensitivity to $0\nu\beta\beta$ decay," *Eur. Phys. J.*, vol. C77, no. 8, p. 532, 2017. https://link.springer.com/article/10.1140/epjc/s10052-017-5098-9.

[7] C. Alduino *et al.*, "The projected background for the CUORE experiment," *Eur. Phys. J.*, vol. C77, no. 8, p. 543, 2017. https://link.springer.com/article/10.1140/epjc/s10052-017-5080-6.

[8] V. A. Li *et al.*, "Invited Article: miniTimeCube," *Rev. Sci. Instrum.*, vol. 87, no. 2, p. 021301, 2016. https://aip.scitation.org/doi/abs/10.1063/1.4942243.

[9] A. Gando *et al.*, "Search for electron antineutrinos associated with gravitational wave events GW150914 and GW151226 using KamLAND," *Astrophys. J.*, vol. 829, no. 2, p. L34, 2016. https://aip.scitation.org/doi/abs/10.1063/1.4942243.

[10] K. Asakura *et al.*, "Search for the proton decay mode $p \to \overline{\nu}K^{+}$ with KamLAND," *Phys. Rev.*, vol. D92, no. 5, p. 052006, 2015. https://journals.aps.org/prd/abstract/10.1103/PhysRevD.92.052006.

[11] K. Asakura *et al.*, "KamLAND Sensitivity to Neutrinos from Pre-Supernova Stars," *Astrophys. J.*, vol. 818, no. 1, p. 91, 2016. https://iopscience.iop.org/article/10.3847/0004-637X/818/1/91.

[12] C. Lane *et al.*, "A new type of Neutrino Detector for Sterile Neutrino Search at Nuclear Reactors and Nuclear Nonproliferation Applications," 2015. https://arxiv.org/abs/1501.06935.

[13] K. Asakura *et al.*, "Study of electron anti-neutrinos associated with gamma-ray bursts using KamLAND," *Astrophys. J.*, vol. 806, no. 1, p. 87, 2015. https://iopscience.iop.org/article/10.1088/0004-637X/806/1/87/meta.

[14] T. I. Banks *et al.*, "A compact ultra-clean system for deploying radioactive sources inside the KamLAND detector," *Nucl. Instrum. Meth.*, vol. A769, pp. 88–96, 2015. https://www.sciencedirect.com/science/article/pii/S0168900214011000.

[15] A. Gando *et al.*, "^{7}Be Solar Neutrino Measurement with KamLAND," *Phys. Rev.*, vol. C92, no. 5, p. 055808, 2015. https://journals.aps.org/prc/abstract/10.1103/PhysRevC.92.055808.

[16] S. Abe *et al.*, "Measurement of the 8B Solar Neutrino Flux with the KamLAND Liquid Scintillator Detector," *Phys. Rev.*, vol. C84, p. 035804, 2011. https://arxiv.org/abs/1106.0861.

[17] J. Kumar, J. G. Learned, M. Sakai, and S. Smith, "Dark Matter Detection With Electron Neutrinos in Liquid Scintillation Detectors," *Phys. Rev.*, vol. D84, p. 036007, 2011. https://journals.aps.org/prd/abstract/10.1103/PhysRevD.84.036007.

Statement of Research

I have a strong background in radiation/particle transport simulations and how they affect real particle detector hardware. My expertise also involves processing and analyzing large-scale physics data using analysis tools such as ROOT and Python. I have experience working in 3 multinational collaboration physics experiments where I spear-headed independent research initiatives and successfully interfaced my original work with the larger team. Some of my past accomplishments that I take pride in include development of unprecedented particle detection algorithms that I project will open whole new physics searches by the collaborations that I have worked with.

I have been involved with the CUORE (Cryogenic Underground Observatory for Rare Events) experiment at the University of California, Los Angeles, and University of California, Berkeley since 2016. The main objective of the CUORE experiment is to observe neutrinoless double beta ($0\nu\beta\beta$) decay in ^{130}Te, one of the most rarest processes thought to occur in nature. My work in the collaboration involves developing a Geant4 based precision background model together with a PhD student colleague to better understand the radioactive contaminations in the detector that undergo alpha decay. The energy spectrum of the background isotopes that produce alpha daughters ($\gtrsim$ 2.7 MeV) exhibit peculiar features that, if understood correctly, will better explain the types of contamination sources and their distributions in the materials comprising the experiment. This can help us to better understand our background sources and extrapolate this understanding to the energy region of interest (2465 keV to 2575 keV) for $0\nu\beta\beta$ decay in ^{130}Te. I have previously also mentored 2 undergraduate students and worked together with them to simulate and investigate new radioactivity shielding schemes for further background reduction in future $0\nu\beta\beta$ decay experiments that will cover the inverted hierarchy region of the effective Majorana neutrino mass. A paper for our first $0\nu\beta\beta$ analysis using CUORE data was published in March 2018 (https://arxiv.org/abs/1710.07988).

I led the development of the Geant4 simulation code for the mini-TimeCube (mTC) experiment at the University of Hawaii at Manoa from 2009 to 2016. mTC was an ambitious project to build the world's smallest portable neutrino detector. In this project, I mentored 3 students and worked in collaboration with them to conduct case studies for optimizing the detector design, test candidate neutron capture doping elements in plastic scintillator, and simulate the response of the multi-channel-plate (MCP) photomultiplier tubes (PMTs) deployed in the detector. The studies were used to develop directional particle detection algorithms and to guide the overall design of the detector during its construction phase. I have also conducted simulation studies for cosmic-ray muons and long-lived cosmogenic background isotopes such as ^{8}He and ^{9}Li. These backgrounds are extremely difficult to tag due to their long life-time ($\gtrsim$ s scale) and travel distances. The studies have been vital to the project. A paper summarizing our accomplishments was published in 2016 (V.A. Li et al. Feb 3, 2016. 19 pp. Rev.Sci.Instrum. 87 (2016) no.2, 021301).

While working at the University of Hawaii at Manoa, I also developed a novel directional event reconstruction algorithm for high-energy $\gtrsim$GeV scale neutrinos while working with KamLAND (Kamioka Liquid Scintillation Antineutrino Detector), and demonstrated with data that this technique can be applied to indirect dark matter search by looking for a directional flux of neutrinos from the core of the Sun and Earth. Studies done with Monte Carlo suggest that the accuracy of deducing the neutrino direction using this new method is better than that of water-Cherenkov detectors (the conventional method for directional neutrino detection) by $\sim$10° in this energy regime. This method was verified using never before observed neutrino events spilling into KamLAND from the T2K neutrino beam-line. The results were consistent with expectation. According to my knowledge, this is the first ever physics application of neutrino directionality in scintillator.

In summary my strong background in radiation/particle transport simulations and how they affect real particle detectors, as well as, my comfort in using tools to analyze large-scale physics data makes me a strong candidate. Also I would like to reemphasize my previous accomplishments in innovating novel particle detection techniques to solve complex problems and interface my original work with a large team of collaborators. I believe I can make a significant impact in your team.

References

*Supplied upon request or please contact in person.

Yury Kolomensky — Professor, University of California, Berkeley, +1-510-642-9619
ygkolomensky@lbl.gov
LeConte Hall #319, Berkeley, CA, 94720-7300, USA

Huan Z. Huang — Professor, University of California, Los Angeles, +1-310-825-9297
huang@physics.ucla.edu
475 Portola Plaza #5-136, Los Angeles, CA 90095-1547, USA

John G. Learned — Professor, University of Hawaii at Manoa, +1-808-956-2964
jgl@phys.hawaii.edu
2505 Correa Rd. #327, Honolulu, Hawaii 96822, USA

Lindley Winslow — Jerrold R. Zacharias Assistant Professor, MIT, +1-617-253-2332
lwinslow@mit.edu
77 Massachusetts Avenue, Bldg. 26-569, Cambridge, MA 02139, USA

Thomas O'Donnell — Assistant Professor, Virginia Tech, +1-540-231-3308
tdonnell@vt.edu
850 West Campus Drive #313, Blacksburg, VA 24061, USA