Michinari Sakai

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Summary

- Expertise in Geant4 and particle simulations with 8 years of experience
- Experience with cosmogenic radiation and nuclear decay simulations in 3 major particle detector experiments
- Innovative problem solving skills with the ability to interface original work with larger collaboration

Experience

UC Berkeley — Post-doctoral Scholar — June 2018 — *Current*

- Building apparatus for measuring micro-physical optical properties of tetraphenyl butadiene (TPB)
- Responsible for Geant4 simulation of optical modeling of apparatus and TPB material

UCLA — Post-doctoral Scholar — 2016 — 2018

- Mentored and worked with 2 undergraduate students to simulate radiation shielding structures in Geant4 to mitigate γ/β backgrounds for next generation $0\nu\beta\beta$ searches requiring ultra-low backgrounds
- Currently spearheading the development of a precision α background model with goal for further background reduction to reach sensitivity goal of covering the inverted neutrino mass hierarchy of $0\nu\beta\beta$ decay in ^{130}Te

University of Hawaii at Manoa — Research Assistant — 2009 — 2016

- Led development of Geant4 detector simulation to conducted case studies of neutron capture doping agents in solid scintillator. Simulation results were later used to oversee design during detector construction
- Was responsible for background simulation studies associated with long lived cosmogenic isotopes ^{8}He/^{9}Li to quantitatively determine effect on detector live time
- Was responsible for high energy ($\gtrsim$ 1 GeV) energy calibration using cosmic ray muons and applying this to neutrino analysis for first time
- Spearheaded development of novel directional neutrino detection technique 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 directionaly in scintillator

Skills

Software/Tools:	Geant4, ROOT, Pads, AutoCAD
Programming Languages:	Proficient in C, C++, Python, Fortran, Mathematica, BASH
Human Languages:	English (native), Japanese/Korean (trilingual proficiency)

Leadership

Mentor, *UC Berkeley* — June 2018 — *Current*

- Advising undergraduate student with Geant4 based optical simulation for current hardware project

Mentor, *UCLA* — 2016

- Taught weekly Geant4 tutorials to 3 PhD-level students and an undergraduate student for 1 semester; students are now able to take on simulation projects of their own and make original contribution

Teaching Assistant, *University of Hawaii at Manoa* — 2007 — 2009

- Planned classwork and taught 2 weekly undergraduate Physics Laboratory classes of over 20 students each for 3 semesters, received very positive reviews
- Mentored undergraduate students in undergraduate Physics classwork for 2 hours each week for 3 semesters

Education

PhD, Experimental Particle Physics — 2016

GPA: 4.0/4.0, 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: 4.3/4.5, 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] C. Alduino *et al.*, "Study of Rare Nuclear Processes with CUORE," *Submitted to: Int. J. Mod. Phys. A*, 2018.

[2] 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.

[3] C. Alduino *et al.*, "Search for Neutrinoless $\beta^{+}EC$ Decay of ^{120}Te with CUORE-0," 2017.

[4] N. Moggi *et al.*, "Results from CUORE and CUORE-0," *AIP Conf. Proc.*, vol. 1894, no. 1, p. 020016, 2017.

[5] C. Alduino *et al.*, "Low Energy Analysis Techniques for CUORE," *Eur. Phys. J.*, vol. C77, no. 12, p. 857, 2017.

[6] C. Alduino *et al.*, "CUORE sensitivity to $0\nu\beta\beta$ decay," *Eur. Phys. J.*, vol. C77, no. 8, p. 532, 2017.

[7] C. Alduino *et al.*, "The projected background for the CUORE experiment," *Eur. Phys. J.*, vol. C77, no. 8, p. 543, 2017.

[8] A. Gando *et al.*, "A search for electron antineutrinos associated with gravitational wave events GW150914 and GW151226 using KamLAND," *Astrophys. J.*, vol. 829, no. 2, p. L34, 2016. [Erratum: Astrophys. J.851,no.1,L22(2017)].

[9] V. A. Li *et al.*, "Invited Article: miniTimeCube," *Rev. Sci. Instrum.*, vol. 87, no. 2, p. 021301, 2016.

[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.

[11] K. Asakura *et al.*, "KamLAND Sensitivity to Neutrinos from Pre-Supernova Stars," *Astrophys. J.*, vol. 818, no. 1, p. 91, 2016.

[12] C. Lane *et al.*, "A new type of Neutrino Detector for Sterile Neutrino Search at Nuclear Reactors and Nuclear Nonproliferation Applications," 2015.

[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.

[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.

[15] A. Gando *et al.*, "^{7}Be Solar Neutrino Measurement with KamLAND," *Phys. Rev.*, vol. C92, no. 5, p. 055808, 2015.

[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.

[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.

Statement of Research

In have a strong background in radiation/particle interaction simulations and how they affect real particle detector hardware. My expertise also involves processing and analyzing large physics data sets using analysis tools such as ROOT and Python. I have experience working in 3 multinational collaboration experiments where I spearheaded 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 experiments that I collaborated with.

I have worked as the lead GEANT4 simulation designer for the mini-TimeCube experiment at University of Hawaii at Manoa from August 2009 to March 2016. Mini-TimeCube is an ambitious project to build the world's smallest portable neutrino detector. In this project, I mentored 3 undergraduate 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 during construction of the detector, and to develop directional particle detection algorithms that are now being tested in analyses of neutrons from test sources as well as neutrinos from nuclear reactors at the National Institute of Standards and Technology (NIST). 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. Invited Article: miniTimeCube. Rev. Sci. Instrum., 87(2):021301, 2016, 1602.01405).

I have been involved with the CUORE (Cryogenic Underground Observatory for Rare Events) experiment at the University of California, Los Angeles since March of 2016. The main objective of the CUORE experiment is to hunt for lepton number violation by observing neutrinoless double beta ($0\nu\beta\beta$) decay in ^{130}Te. CUORE employs an almost 20 fold increase in detector mass compared to its previously successful pilot experiment CUORE-0. My work in the collaboration currently involves development of a GEANT4 based precision background model together with a graduate student colleague to better understand the radioactive contaminations in the detector. The energy spectrum of the backgrounds in the so called α region ($\gtrsim$ 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 backgrounds and extrapolate this new knowledge 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).

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 interaction simulations and how they affect real particle detectors, as well as, my comfort in using tools to analyze large physics data sets makes me a strong candidate for your position. Also I would like to reemphasize my previous accomplishments in independently creating 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.

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