

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

UCLA - Post-doctoral Scholar

MAR 2016 - *Current*

- 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 $^8\text{He}/^9\text{Li}$ to quantitatively determine effect on detector live time
- Was responsible for high energy ($\gtrsim 1\text{GeV}$) 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 directionality in scintillator
- Led unprecedented particle ID capability studies in scintillator using track profile reconstruction techniques using never before observed T2K events spilling into KamLAND

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, UCLA

MAR 2016 - *Current*

- 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

- Invited Talk (Tentative): MONTE CARLO TOOLS IN CUORE
Durham University, UK - Monte Carlo Tools for Beyond the Standard Model Physics Apr 2018
- Seminar: CUORE: A BOLOMETRIC SEARCH FOR LEPTON NUMBER VIOLATION
Argonne National Laboratory Feb 2018
- Talk: CUORE AND BACKGROUND REDUCTION CASE STUDIES FOR CUPID
Pittsburgh/Carnegie Mellon University - Division of Nuclear Physics 2017 Oct 2017
- Invited talk: STATUS OF THE CUORE $0\nu\beta\beta$ DECAY SEARCH
Sanford Underground Research Facility (SURF), South Dakota - Conference on Science at SURF 2017 May 2017
- Invited talk: PARTICLE ID AND EVENT RECONSTRUCTION ALGORITHMS IN SCINTILLATOR
Fermilab - Frontiers of Liquid Scintillator Technology Mar 2016
- Seminar: HIGH ENERGY ANALYSIS AT KAMLAND AND APPLICATION TO DARK MATTER SEARCH
Los Alamos National Laboratory Nov 2015
- Seminar: HIGH ENERGY ANALYSIS AT KAMLAND AND APPLICATION TO DARK MATTER SEARCH
California Institute of Technology Nov 2015
- Seminar: HIGH ENERGY ANALYSIS AT KAMLAND AND APPLICATION TO DARK MATTER SEARCH
University of California, Los Angeles Oct 2015
- Talk: HIGH ENERGY ANALYSIS AND APPLICATION TO DARK MATTER SEARCH IN KAMLAND
University of Hawaii at Manoa - DOE project review Jul 2015
- Poster: INDIRECT DARK-MATTER DETECTION THROUGH KAMLAND
Neutrino 2012, Kyoto, Japan Jun 2012
- Talks: WHAT IS A NEUTRINO?, MINI-TIMECUBE: THE WORLD'S SMALLEST NEUTRINO DETECTOR
University of Hawaii at Manoa - Campus Open-house Nov 2010/2011
- Talk: MINI-TIMECUBE: A PORTABLE DIRECTIONAL NEUTRINO DETECTOR
Applied Antineutrino Physics 2010, Sendai, Japan Aug 2010
- Talk: KAMLAND SUMMARY
University of Hawaii at Manoa - DOE project review Sep 2009
- Talk (Student Presentation): HOW TO SOLVE θ_{23} DEGENERACY
Fermilab - International Neutrino Summer School 2009 Jul 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 β^+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 $p \rightarrow \bar{\nu}K^+$ 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.*, “ ^7Be 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

I 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 ^8He and ^9Li . 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 $\sim 10^\circ$ 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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