

## EMPLOYMENT

---

<b>Pennsylvania State University</b> Assistant Research Professor	University Park, PA 2022–present
<b>Pennsylvania State University</b> Postdoctoral Scholar	University Park, PA 2021–2022

## EDUCATION

---

<b>The University of Tokyo</b> Ph.D. in Physics, Advisor: Prof.Kipp Cannon – Thesis title : Modeling and Searching for Stochastic Gravitational-waves Backgrounds from Ultralight Boson Particles	Tokyo, Japan 2018–2021
<b>The University of Tokyo</b> M.S. in Physics, Advisor: Prof.Kipp Cannon – Thesis title : Towards a Search for Stochastic Gravitational-Wave Backgrounds from Ultra-light Bosons	Tokyo, Japan 2016–2018
<b>The University of Tokyo</b> B.S. in Applied Physics, Advisor: Prof.Norikatsu Mio – Thesis title : Performance evaluation of the frequency reference cavity for KAGRA gravitational-wave detector	Tokyo, Japan 2011–2016

## RESEARCH EXPERIENCE

---

<b>Pennsylvania State University</b> – Development of a low-latency gravitational wave (GW) search pipeline, GstLAL – Bayesian parameter estimation for targeted anisotropic GW background	University Park, PA 2021–present
<b>Research Center for the Early Universe, The University of Tokyo</b> <i>M.S./Ph.D. Research, supervised by Prof.Kipp Cannon</i> – Fast evaluation of trigger consistency between multiple detectors using GstLAL – Searches for ultra-light bosons using stochastic GW background	Tokyo, Japan 2016–2021
<b>LIGO Lab, California Institute of Technology</b> <i>LIGO visitor program, hosted by Prof.Alan Weinstein</i> – Development and event follow-up for online analysis of a GW detection pipeline, GstLAL – Joint study on GW search for the ultra-light boson particle through superradiant instability	Pasadena, CA Summer 2019
<b>Laboratoire d'Annecyde Physiquesdes Particules</b> <i>Visiting research, supervised by Dr.Tania Regimbau</i> – Mock data study for the detection of stochastic GW background from anisotropically distributed compact binary coalescence.	Annecy, France Fall 2018
<b>University of Minnesota</b> <i>Visiting research, supervised by Prof.Vuk Mandic</i> – Development of a search pipeline for GW background from ultra-light scalar fields.	Minneapolis, MN Spring 2018

## The University of Tokyo

*B.S. Research, supervised by Prof. Norikatsu Mio*

Tokyo, Japan

2015–2016

- Evaluating optical properties and frequency stability of the reference cavity KAGRA.

## LIGO Livingston Observatory, California Institute of Technology

*LIGO SURF program, supervised by Dr. Valery Frolov*

Livingston, LA

Summer 2014

- Constructing the theoretical model of the optical loss inside the arm cavities of the Advanced LIGO.

## SCHOLARSHIPS AND AWARDS

---

- **Best Poster Award**, Gravitational Wave Orchestra 2022
- **Best Presentation Award**, The 7th KAGRA International Workshop 2020
- **Japan Society for the Promotion of Science DC1 fellowship** 2018–2021
- **LIGO Visitor Program**, California Institute of Technology 2019
- **Overseas Challenge Program for Young Researchers**, JSPS 2019
- **GRASP Scholarship**, The University of Tokyo 2018
- **SURF Program**, California Institute of Technology 2014
- **Best Project Award**, Cosmic/Particle Spring school 2014

## RESEARCH TALKS

---

### INVITED TALKS, SEMINARS, PANEL, SYMPOSIUM

- The improvement of GstLAL's ranking statistics toward the fourth observing run* 2023  
Utrecht & UMass Dartmouth joint seminar USA (online)
- Panel for gravitational waves and multi-messenger astronomy* 2023  
New Evolution of Multi-Messenger Astrophysics, Penn State State College, USA
- Observation of neutron stars during LIGO-Virgo-KAGRA's observing runs* 2022  
APS April meeting New York, USA
- Modeling and searching for a stochastic GW background from ultralight bosons* 2021  
GW Physics and Astronomy: Genesis, The Fourth Annual Area Symposium Japan (online)
- Low-latency detection of the GWs from compact binary coalescences* 2022  
ISAS seminar, ISM astronomy seminar, JGW seminar Japan
- Low-latency detection of the GWs from compact binary coalescences* 2022  
ISM astronomy seminar Japan (online)
- Low-latency detection of the GWs from compact binary coalescences* 2022  
JGW seminar Japan (online)
- Gravitational waves from neutron star-black hole coalescences* 2021  
LIGO-Virgo-KAGRA Collaboration webinar
- First observations of black hole and neutron star mergers* 2021  
Fundamental Theory Seminar, Penn State Pennsylvania, USA
- First search for stochastic GW backgrounds from ultra-light bosons* 2018  
The CGCA seminar, University of Wisconsin Milwaukee Wisconsin, USA
- Application of a low-latency whitening filter to CBC GW searches* 2016  
RESCEU joint seminar, The University of Tokyo Tokyo, Japan

## SELECTED CONTRIBUTED TALKS

<i>The improvement of GstLAL's ranking statistics toward the fourth observing run</i>	2023
APS April meeting	Minnesota, USA
<i>First observations of black hole and neutron star mergers</i>	2021
The 8th KAGRA International Workshop	Korea (online)
<i>Modeling and searching for a stochastic GW background from ultralight bosons</i>	2021
Amaldi 14	Australia (online)
<i>Stochastic GW backgrounds from ultra-light vectors</i>	2019
The 29th Workshop on General Relativity and Gravitation in Japan	Kobe, Japan
<i>Anisotropic GW background Mock data study</i>	2019
Gravitational Wave Physics and Astronomy Workshop	Tokyo, Japan
<i>A first search for stochastic GW backgrounds from ultra-light scalars</i>	2018
Gravitational Wave Physics and Astronomy Workshop	Maryland, USA
<i>Application of a low-latency whitening filter to CBC GW searches</i>	2017
The Third KAGRA International Workshop	Taipei, Taiwan

## TEACHING EXPERIENCE

---

- **Substitute Lecturer** at Pennsylvania State University Fall 2022  
*Electromagnetism*
- **Teaching Assistant** at The University of Tokyo Fall 2016  
*Analytical mechanics*

## MENTORING EXPERIENCE

---

- **Soichiro Kuwahara** Ph.D student at The University of Tokyo  
*GPU-accelerated parameter estimation for anisotropic gravitational-wave backgrounds*
- **Santiago Jaraba** Ph.D student at Universidad Aut'ónoma de Madrid  
*Parameter estimation for anisotropic gravitational-wave backgrounds [9]*
- **Deepali Agarwal** Ph.D student at Inter-University Centre for Astronomy and Astrophysics (IUCAA)  
*Parameter estimation for anisotropic gravitational-wave backgrounds [9]*
- **Erik Floden** Ph.D student at University of Minnesota  
*Parameter estimation and spherical-harmonics searches of anisotropic gravitational-wave backgrounds [9], [13], [26]*
- **Anarya Ray** Ph.D student at University of Wisconsin-Milwaukee  
*Improving background sampling procedure for GstLAL*
- **Richard George** Ph.D student at The University of Texas at Austin  
*Improving SNR –  $\xi^2$  signal model of GstLAL [2]*
- **Andre Guimaraes** Ph.D student at Louisiana State University  
*Improving SNR –  $\xi^2$  signal model of GstLAL [2]*
- **Shio Sakon** Ph.D student at Pennsylvania State University  
*Optimization of GstLAL's template bank [11]*
- **Shomik Adhicary** Ph.D student at Pennsylvania State University  
*Improving ranking statistics for gravitational-wave detection pipeline, GstLAL [2]*
- **Prathamesh Joshi** Ph.D student at Pennsylvania State University  
*Implementation of contamination removal and bank- $\xi^2$  statistics in GstLAL [2], [7]*
- **Takuya Tsutsui** Ph.D student at The University of Tokyo  
*Rapid localization of gravitational wave sources [17]*

## PROFESSIONAL SERVICE

---

- **Thesis committee**, Pennsylvania State University 2023–2023
- **Co-leader of anisotropic stochastic-background working group**, LVK Collaboration 2022–present
- **Referee**, Physical Review D 2022–present
- **Advanced LIGO science summaries**, Writer and japanese translator 2021–present
- **Vice director**, Cosmic/Astrophysics Student Summer School in Japan 2019
- **Workshop Assistant**, Gravitational Wave Physics and Astronomy Workshop 2019

## OUTREACH

---

- **KAGRA outreach group** 2020–2021
- **SCJSF&JABA forum talk** 2020
- **Japanese translation of GW190425's science summary** 2019
- **GW education at a public school in Pasadena** 2019
- **RESCEU Open Lab** 2017, 2018
- **International Space Education Board Student Program** 2015, 2016

## SHORT AUTHOR LIST PUBLICATIONS AND PREPRINTS

- [1] **L. Tsukada**, *Extension of the bayesian searches for anisotropic stochastic gravitational-wave background with non-tensorial polarizations*, Aug. 2023. arXiv: 2308.09020 [astro-ph.IM].
- [2] **L. Tsukada**, P. Joshi, S. Adhicary, R. George, A. Guimaraes, C. Hanna, R. Magee, A. Zimmerman, P. Baral, A. Baylor, K. Cannon, S. Caudill, B. Cousins, J. D. E. Creighton, B. Ewing, H. Fong, P. Godwin, R. Harada, Y.-J. Huang, R. Huxford, J. Kennington, S. Kuwahara, A. K. Y. Li, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, W. Niu, A. Pace, C. Posnansky, A. Ray, S. Sachdev, S. Sakon, D. Singh, R. Tapia, T. Tsutsui, K. Ueno, A. Viets, L. Wade, and M. Wade, “Improved ranking statistics of the gstlal inspiral search for compact binary coalescences”, *Physical Review D*, vol. 108, no. 4, Aug. 2023.
- [3] S. Morisaki, R. Smith, **L. Tsukada**, S. Sachdev, S. Stevenson, C. Talbot, and A. Zimmerman, *Rapid localization and inference on compact binary coalescences with the advanced ligo-virgo-kagra gravitational-wave detector network*, Jul. 2023. arXiv: 2307.13380.
- [4] A. I. Renzini, A. Romero-Rodríguez, C. Talbot, M. Lalleman, S. Kandhasamy, K. Turbang, S. Biscoveanu, K. Martinovic, P. Meyers, **L. Tsukada**, K. Janssens, D. Davis, A. Matas, P. Charlton, G.-C. Liu, I. Dvorkin, S. Banagiri, S. Bose, T. Callister, F. D. Lillo, L. D’Onofrio, F. Garufi, G. Harry, J. Lawrence, V. Mandic, A. Macquet, I. Michaloliakos, S. Mitra, K. Pham, R. Poggiani, T. Regimbau, J. D. Romano, N. van Remortel, and H. Zhong, “Pygwb: A python-based library for gravitational-wave background searches”, *The Astrophysical Journal*, vol. 952, no. 1, p. 25, Jul. 2023.
- [5] A. Ray, W. Niu, S. Sakon, B. Ewing, J. D. E. Creighton, C. Hanna, S. Adhicary, P. Baral, A. Baylor, K. Cannon, S. Caudill, B. Cousins, H. Fong, R. N. George, P. Godwin, R. Harada, Y.-J. Huang, R. Huxford, P. Joshi, S. Kapadia, J. Kennington, S. Kuwahara, A. K. Y. Li, R. Magee, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, A. Pace, C. Posnansky, S. Sachdev, D. Singh, R. Tapia, **L. Tsukada**, T. Tsutsui, K. Ueno, A. Viets, L. Wade, and M. Wade, *When to point your telescopes: Gravitational wave trigger classification for real-time multi-messenger followup observations*, Jun. 2023. arXiv: 2306.07190 [gr-qc].
- [6] B. Ewing, R. Huxford, D. Singh, **L. Tsukada**, C. Hanna, Y.-J. Huang, P. Joshi, A. K. Y. Li, R. Magee, C. Messick, A. Pace, A. Ray, S. Sachdev, S. Sakon, R. Tapia, S. Adhicary, P. Baral, A. Baylor, K. Cannon, S. Caudill, S. S. Chaudhary, M. W. Coughlin, B. Cousins, J. D. E. Creighton, R. Essick, H. Fong, R. N. George, P. Godwin, R. Harada, J. Kennington, S. Kuwahara, D. Meacher, S. Morisaki, D. Mukherjee, W. Niu, C. Posnansky, A. Toivonen, T. Tsutsui, K. Ueno, A. Viets, L. Wade, M. Wade, and G. Waratkar, *Performance of the low-latency gstlal inspiral search towards ligo, virgo, and kagra’s fourth observing run*, May 2023. arXiv: 2305.05625 [gr-qc].
- [7] P. Joshi, **L. Tsukada**, and C. Hanna, *Background filter: A method for removing signal contamination during significance estimation of a gstlal anaysis*, May 2023. arXiv: 2305.18233 [gr-qc].
- [8] S. Banagiri, C. P. L. Berry, G. S. C. Davies, **L. Tsukada**, and Z. Doctor, *A unified p<sub>astro</sub> for gravitational waves: Consistently combining information from multiple search pipelines*, Apr. 2023. arXiv: 2305.00071 [astro-ph.IM].
- [9] **L. Tsukada**, S. Jaraba, D. Agarwal, and E. Floden, “Bayesian parameter estimation for targeted anisotropic gravitational-wave background”, *Physical Review D*, vol. 107, no. 2, Jan. 2023.
- [10] C. Hanna, J. Kennington, S. Sakon, S. Privitera, M. Fernandez, J. Wang, C. Messick, A. Pace, K. Cannon, P. Joshi, R. Huxford, S. Caudill, C. Chan, B. Cousins, J. D. E. Creighton, B. Ewing, H. Fong, P. Godwin, R. Magee, D. Meacher, S. Morisaki, D. Mukherjee, H. Ohta, S. Sachdev, D. Singh, R. Tapia, **L. Tsukada**, D. Tsuna, T. Tsutsui, K. Ueno, A. Viets, L. Wade, and M. Wade, “Binary tree approach to template placement for searches for gravitational waves from compact binary mergers”, *Physical Review D*, vol. 108, no. 4, 2023.

- [11] S. Sakon, **L. Tsukada**, H. Fong, C. Hanna, J. K. W. Niu, S. Adhicary, P. Baral, A. Baylor, K. Cannon, S. Caudill, B. Cousins, J. D. E. Creighton, B. Ewing, P. Godwin, R. Harada, Y.-J. Huang, R. Huxford, P. Joshi, S. Kuwahara, A. K. Y. Li, R. Magee, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, A. Pace, C. Posnansky, S. Sachdev, D. Singh, R. Tapia, T. Tsutsui, K. Ueno, A. Viets, L. Wade, M. Wade, and J. Wang, *Template bank for compact binary mergers in the fourth observing run of advanced ligo, advanced virgo, and kagra*, Nov. 2022. arXiv: 2211.16674 [gr-qc].
- [12] C. Hanna, P. Joshi, R. Huxford, K. Cannon, S. Caudill, C. Chan, B. Cousins, J. D. E. Creighton, B. Ewing, M. Fernandez, H. Fong, P. Godwin, R. Magee, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, H. Ohta, A. Pace, S. Privitera, S. Sachdev, S. Sakon, D. Singh, R. Tapia, **L. Tsukada**, D. Tsuna, T. Tsutsui, K. Ueno, A. Viets, L. Wade, M. Wade, and J. Wang, “Metric assisted stochastic sampling search for gravitational waves from binary black hole mergers”, *Physical Review D*, vol. 106, no. 8, Oct. 2022.
- [13] E. Floden, V. Mandic, A. Matas, and **L. Tsukada**, “Angular resolution of the search for anisotropic stochastic gravitational-wave background with terrestrial gravitational-wave detectors”, *Physical Review D*, vol. 106, no. 2, Jul. 2022.
- [14] K. Cannon, S. Caudill, C. Chan, B. Cousins, J. D. Creighton, B. Ewing, H. Fong, P. Godwin, C. Hanna, S. Hooper, R. Huxford, R. Magee, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, H. Ohta, A. Pace, S. Privitera, I. de Ruiter, S. Sachdev, L. Singer, D. Singh, R. Tapia, **L. Tsukada**, D. Tsuna, T. Tsutsui, K. Ueno, A. Viets, L. Wade, and M. Wade, “Gstlal: A software framework for gravitational wave discovery”, *SoftwareX*, vol. 14, p. 100680, Jun. 2021, ISSN: 2352-7110.
- [15] D. Mukherjee, S. Caudill, R. Magee, C. Messick, S. Privitera, S. Sachdev, K. Blackburn, P. Brady, P. Brockill, K. Cannon, S. J. Chamberlin, D. Chatterjee, J. D. Creighton, H. Fong, P. Godwin, C. Hanna, S. Kapadia, R. N. Lang, T. G. Li, R. K. Lo, D. Meacher, A. Pace, L. Sadeghian, **L. Tsukada**, L. Wade, M. Wade, A. Weinstein, and L. Xiao, “Template bank for spinning compact binary mergers in the second observation run of advanced ligo and the first observation run of advanced virgo”, *Physical Review D*, vol. 103, no. 8, Apr. 2021.
- [16] **L. Tsukada**, R. Brito, W. E. East, and N. Siemonsen, “Modeling and searching for a stochastic gravitational-wave background from ultralight vector bosons”, *Phys. Rev. D*, vol. 103, p. 083005, 8 Apr. 2021.
- [17] T. Tsutsui, K. Cannon, and **L. Tsukada**, “High speed source localization in searches for gravitational waves from compact object collisions”, *Phys. Rev. D*, vol. 103, p. 043011, 4 Feb. 2021.
- [18] S. Sachdev, R. Magee, C. Hanna, K. Cannon, L. Singer, J. R. SK, D. Mukherjee, S. Caudill, C. Chan, J. D. E. Creighton, B. Ewing, H. Fong, P. Godwin, R. Huxford, S. Kapadia, A. K. Y. Li, R. K. L. Lo, D. Meacher, C. Messick, S. R. Mohite, A. Nishizawa, H. Ohta, A. Pace, A. Reza, B. S. Sathyaprakash, M. Shikauchi, D. Singh, **L. Tsukada**, D. Tsuna, T. Tsutsui, and K. Ueno, “An early-warning system for electromagnetic follow-up of gravitational-wave events”, *The Astrophysical Journal*, vol. 905, no. 2, p. L25, Dec. 2020.
- [19] C. Messick, S. Sachdev, K. Cannon, S. Caudill, C. Chan, J. D. E. Creighton, R. Everett, B. Ewing, H. Fong, P. Godwin, C. Hanna, R. Huxford, S. Kapadia, A. K. Y. Li, R. K. L. Lo, R. Magee, D. Meacher, S. R. Mohite, D. Mukherjee, A. Nishizawa, H. Ohta, A. Pace, A. Reza, M. Shikauchi, L. Singer, D. Singh, J. R. SK, **L. Tsukada**, D. Tsuna, T. Tsutsui, K. Ueno, and A. Zimmerman, *Automating the inclusion of subthreshold signal-to-noise ratios for rapid gravitational-wave localization*, Nov. 2020. arXiv: 2011.02457 [astro-ph.IM].
- [20] P. Godwin, R. Essick, C. Hanna, K. Cannon, S. Caudill, C. Chan, J. D. E. Creighton, H. Fong, E. Katsavounidis, R. Magee, D. Meacher, C. Messick, S. Morisaki, D. Mukherjee, H. Ohta, A. Pace, I. de Ruiter, S. Sachdev, **L. Tsukada**, T. Tsutsui, K. Ueno, L. Wade, and M. Wade, *Incorporation of statistical data quality information into the gstlal search analysis*, Oct. 2020. arXiv: 2010.15282 [gr-qc].

- [21] C. Chan, K. Cannon, S. Caudill, H. Fong, P. Godwin, C. Hanna, S. Kapadia, R. Magee, D. Meacher, C. Messick, S. R. Mohite, S. Morisaki, D. Mukherjee, A. Nishizawa, H. Ohta, A. Pace, S. Sachdev, M. Shikauchi, L. Singer, **L. Tsukada**, D. Tsuna, T. Tsutsui, and K. Ueno, “Improving the background estimation technique in the gstlal inspiral pipeline with the time-reversed template bank”, Sep. 2020. eprint: 2009.03025.
- [22] C. Hanna, S. Caudill, C. Messick, A. Reza, S. Sachdev, **L. Tsukada**, K. Cannon, K. Blackburn, J. D. E. Creighton, H. Fong, P. Godwin, S. Kapadia, T. G. F. Li, R. Magee, D. Meacher, D. Mukherjee, A. Pace, S. Privitera, R. K. L. Lo, and L. Wade, “Fast evaluation of multidetector consistency for real-time gravitational wave searches”, *Physical Review D*, vol. 101, no. 2, Jan. 2020.
- [23] **L. Tsukada**, T. Callister, A. Matas, and P. Meyers, “First search for a stochastic gravitational-wave background from ultralight bosons”, *Physical Review D*, vol. 99, no. 10, May 2019.
- [24] S. Sachdev, S. Caudill, H. Fong, R. K. L. Lo, C. Messick, D. Mukherjee, R. Magee, **L. Tsukada**, K. Blackburn, P. Brady, P. Brockill, K. Cannon, S. J. Chamberlin, D. Chatterjee, J. D. E. Creighton, P. Godwin, A. Gupta, C. Hanna, S. Kapadia, R. N. Lang, T. G. F. Li, D. Meacher, A. Pace, S. Privitera, L. Sadeghian, L. Wade, M. Wade, A. Weinstein, and S. L. Xiao, *The gstlal search analysis methods for compact binary mergers in advanced ligo’s second and advanced virgo’s first observing runs*, Jan. 2019. arXiv: 1901.08580 [gr-qc].
- [25] **L. Tsukada**, K. Cannon, C. Hanna, D. Keppel, D. Meacher, and C. Messick, “Application of a zero-latency whitening filter to compact binary coalescence gravitational-wave searches”, *Physical Review D*, vol. 97, no. 10, May 2018.

## COLLABORATION PUBLICATIONS (MAJOR CONTRIBUTION)

- [26] B. P. Abbott *et al.*, “Search for anisotropic gravitational-wave backgrounds using data from advanced ligo and advanced virgo’s first three observing runs”, *Phys. Rev. D*, vol. 104, p. 022005, 2 Jul. 2021.
- [27] B. P. Abbott *et al.*, “Gwtc-2: Compact binary coalescences observed by ligo and virgo during the first half of the third observing run”, *Physical Review X*, vol. 11, no. 2, Jun. 2021.
- [28] B. P. Abbott *et al.*, “Observation of gravitational waves from two neutron star–black hole coalescences”, *The Astrophysical Journal Letters*, vol. 915, no. 1, p. L5, Jun. 2021.