Leo Tsukada

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Employment

Pennsylvania State University — University Park, PA
Assistant Research Professor — 2022–present
Postdoctoral Scholar — 2021–2022

Education

The University of Tokyo — Tokyo, Japan
Ph.D. in Physics, Advisor: Prof.Kipp Cannon — 2018–2021

- Thesis title : Modeling and Searching for Stochastic Gravitational-waves Backgrounds from Ultralight Boson Particles

The University of Tokyo — Tokyo, Japan
M.S. in Physics, Advisor: Prof.Kipp Cannon — 2016–2018

- Thesis title : Towards a Search for Stochastic Gravitational-Wave Backgrounds from Ultra-light Bosons

The University of Tokyo — Tokyo, Japan
B.S. in Applied Physics, Advisor: Prof.Norikatsu Mio — 2011–2016

- Thesis title : Performance evaluation of the frequency reference cavity for KAGRA detector

Research Experience

Pennsylvania State University — University Park, PA
2021–present

- Development of a low-latency gravitational wave (GW) search pipeline, GstLAL
- Bayesian parameter estimation for targeted anisotropic GW background

Research Center for the Early Universe, The University of Tokyo — Tokyo, Japan
M.S./Ph.D. Research, supervised by Prof.Kipp Cannon — 2016–2021

- Fast evaluation of trigger consistency between multiple detectors using GstLAL
- Searches for ultra-light bosons using stochastic GW background

LIGO Lab, California Institute of Technology — Pasadena, CA
LIGO visitor program, hosted by Prof.Alan Weinstein — Summer 2019

- 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

Laboratoire d'Annecyde Physiquedes Particules — Annecy, France
Visiting research, supervised by Dr.Tania Regimbau — Fall 2018

- Mock data study for the detection of stochastic GW background from anisotopically distributed compact binary coalescence.

University of Minnesota — Minneapolis, MN
Visiting research, supervised by Prof.Vuk Mandic — Spring 2018

- Development of a search pipeline for GW background from ultra-light scalar fields.

The University of Tokyo — Tokyo, Japan
B.S. Research, supervised by Prof.Norikatsu Mio — 2015–2016

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

LIGO Livingston Observatory, California Institute of Technology Livingston, LA
LIGO SURF program, supervised by Dr.Valery Frolov Summer 2014

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

Teaching Experience

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

Fellowship 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)

Overview and future prospect of LIGO-Virgo-KAGRA's fourth observing run 2023
Astronomy Society of Japan Autumn meeting Nagoya, Japan

Toward unified Bayesian parameter inference of stochastic gravitational wave backgrounds 2023
C-lab seminar, Nagoya University Nagoya, Japan

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

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

The improvement of GstLAL's ranking statistics toward the fourth observing run 2023
APS April meeting Minnesota, USA

First observations of black hole and neutron star mergers 2021
The 8th KAGRA International Workshop Korea (online)

Modeling and searching for a stochastic GW background from ultralight bosons 2021
Amaldi 14 Australia (online)

Stochastic GW backgrounds from ultra-light vectors 2019
The 29th Workshop on General Relativity and Gravitation in Japan Kobe, Japan

Anisotropic GW background Mock data study 2019
Gravitational Wave Physics and Astronomy Workshop Tokyo, Japan

A first search for stochastic GW backgrounds from ultra-light scalars 2018
Gravitational Wave Physics and Astronomy Workshop Maryland, USA

Application of a low-latency whitening filter to CBC GW searches 2017
The Third KAGRA International Workshop Taipei, Taiwan

Mentoring Experience

- **Soichiro Kuwahara** Ph.D student at The University of Tokyo spring 2022 - present
  GPU-accelerated parameter estimation for anisotropic gravitational-wave backgrounds
- **Santiago Jaraba** Ph.D student at Universidad Aut'onoma de Madrid spring 2022 - present
  Parameter estimation for anisotropic gravitational-wave backgrounds [10]
- **Deepali Agarwal** Ph.D student at IUCAA spring 2022 - present
  Parameter estimation for anisotropic gravitational-wave backgrounds [10]
- **Erik Floden** Ph.D student at University of Minnesota spring 2021 - present
  Parameter estimation and spherical-harmonics searches of anisotropic gravitational-wave backgrounds [10], [14], [27]
- **Anarya Ray** Ph.D student at University of Wisconsin-Milwaukee spring 2022 - spring 2023
  Improving background sampling procedure for GstLAL
- **Richard George** Ph.D student at The University of Texas at Austin spring 2022 - spring 2023
  Improving SNR $-\xi^2$ *signal model of GstLAL [5]*
- **Andre Guimaraes** Ph.D student at Louisiana State University spring 2022 - spring 2023
  Improving SNR $-\xi^2$ *signal model of GstLAL [5]*
- **Shio Sakon** Ph.D student at Pennsylvania State University spring 2022
  Optimization of GstLAL's template bank [12]
- **Shomik Adhicary** Ph.D student at Pennsylvania State University spring 2022 - present
  Improving ranking statistics for gravitational-wave detection pipeline, GstLAL [5]
- **Prathamesh Joshi** Ph.D student at Pennsylvania State University spring 2022 - present
  Implementation of contamination removal and bank-ξ^2 statistics in GstLAL [3], [5]
- **Takuya Tsutsui** Ph.D student at The University of Tokyo 2019
  Rapid localization of gravitational wave sources [18]

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; Physical Review Letter 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

Publication List

Short Author List Publications and Preprints

[1] **L. Tsukada**, "Extension of the bayesian searches for anisotropic stochastic gravitational-wave background with nontensorial polarizations", *Physical Review D*, vol. 108, no. 12, Dec. 2023.

[2] S. Banagiri, C. P. L. Berry, G. S. C. Davies, **L. Tsukada**, and Z. Doctor, "Unified p_{astro} for gravitational waves: Consistently combining information from multiple search pipelines", *Phys. Rev. D*, vol. 108, p. 083 043, 8 Oct. 2023.

[3] P. Joshi, **L. Tsukada**, and C. Hanna, "Method for removing signal contamination during significance estimation of a gstlal analysis", *Phys. Rev. D*, vol. 108, p. 084 032, 8 Oct. 2023.

[4] S. S. Chaudhary, *et al.* including **L. Tsukada**, *Low-latency gravitational wave alert products and their performance in anticipation of the fourth ligo-virgo-kagra observing run*, Aug. 2023. arXiv: 2308.04545 [astro-ph.HE].

[5] **L. Tsukada**, P. Joshi, *et al.*, "Improved ranking statistics of the gstlal inspiral search for compact binary coalescences", *Physical Review D*, vol. 108, no. 4, Aug. 2023.

[6] A. Renzini, *et al.* including **L. Tsukada**, "Pygwb: A python-based library for gravitational-wave background searches", *The Astrophysical Journal*, vol. 952, no. 1, p. 25, Jul. 2023.

[7] 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.

[8] A. Ray, *et al.* including **L. Tsukada**, *When to point your telescopes: Gravitational wave trigger classification for real-time multi-messenger followup observations*, Jun. 2023. arXiv: 2306.07190 [gr-qc].

[9] B. Ewing, R. Huxford, D. Singh, **L. Tsukada**, *et al.*, *Performance of the low-latency gstlal inspiral search towards ligo, virgo, and kagra's fourth observing run*, May 2023. arXiv: 2305.05625 [gr-qc].

[10] **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.

[11] C. Hanna, *et al.* including **L. Tsukada**, "Binary tree approach to template placement for searches for gravitational waves from compact binary mergers", *Physical Review D*, vol. 108, no. 4, 2023.

[12] S. Sakon, **L. Tsukada**, *et al.*, *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].

[13] C. Hanna, *et al.* including **L. Tsukada**, "Metric assisted stochastic sampling search for gravitational waves from binary black hole mergers", *Physical Review D*, vol. 106, no. 8, Oct. 2022.

[14] 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.

[15] K. Cannon, *et al.* including **L. Tsukada**, "Gstlal: A software framework for gravitational wave discovery", *SoftwareX*, vol. 14, p. 100 680, Jun. 2021, ISSN: 2352-7110.

[16] D. Mukherjee, *et al.* including **L. Tsukada**, "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.

[17] **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. 083 005, 8 Apr. 2021.

[18] 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. 043 011, 4 Feb. 2021.

[19] S. Sachdev, *et al.* including **L. Tsukada**, "An early-warning system for electromagnetic follow-up of gravitational-wave events", *The Astrophysical Journal*, vol. 905, no. 2, p. L25, Dec. 2020.

[20] C. Messick, *et al.* including **L. Tsukada**, *Automating the inclusion of subthreshold signal-to-noise ratios for rapid gravitational-wave localization*, Nov. 2020. arXiv: 2011.02457 [astro-ph.IM].

[21] P. Godwin, *et al.* including **L. Tsukada**, *Incorporation of statistical data quality information into the gstlal search analysis*, Oct. 2020. arXiv: 2010.15282 [gr-qc].

[22] C. Chan, *et al.* including **L. Tsukada**, "Improving the background estimation technique in the gstlal inspiral pipeline with the time-reversed template bank", Sep. 2020. eprint: 2009.03025.

[23] C. Hanna, S. Caudill, C. Messick, A. Reza, S. Sachdev, **L. Tsukada**, *et al.*, "Fast evaluation of multidetector consistency for real-time gravitational wave searches", *Physical Review D*, vol. 101, no. 2, Jan. 2020.

[24] **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.

[25] S. Sachdev, *et al.* including **L. Tsukada**, *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].

[26] **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)

[27] 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. 022 005, 2 Jul. 2021.

[28] 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.

[29] 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.