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Thomas Lai

Research Interests

- Investigating the physics and properties of the interstellar medium (ISM) using multi-wavelength observations from UV to far infrared, including facilities like HST, AKARI, Spitzer, JWST, Keck, and Lowell Discovery Telescope
- Exploring the connection between AGN and starburst phenomena in nearby luminous infrared galaxies, focusing on their outflow impact on the ISM by analyzing dust and gas properties
- Examining the properties of the ISM in low metallicity dwarf galaxies, providing insights into the conditions of high redshift galaxies
- Developing state-of-the-art spectral decomposition models for mid-infrared emissions, particularly from polycyclic aromatic hydrocarbon (PAH) molecules, to enhance infrared spectroscopy diagnostics, especially for JWST integral field spectroscopy (IFS)
- Addressing fundamental questions in ISM studies, including the nature of diffuse interstellar bands (DIBs) and extended red emission (ERE)

Employment/Professional Experience

Sep 2021 – present **Postdoctoral Scholar**, *Caltech/IPAC*, CA, USA
PI: Dr. Lee Armus; in collaboration with the GOALS team

2018 **Keck Visiting Scholar**, *Keck Observatory*, HI, USA
Mentor: Dr. Carlos Alvarez
Project: *Updating DEIMOS Throughput Curves with 16 Years of Observations*

2015 – 2019 **University Fellow**, *University of Toledo*, OH, USA
Advisor: Dr. J.D.T Smith; the highest award from the UT graduate school
Project: *Exploring Small Dust Grains in Different Galaxy Environments*

2014 **Doreen and Lyman Spitzer Graduate Fellow**, *University of Toledo*, OH, USA
Advisor: Dr. Adolf Witt; award for incoming graduate student from the department of Physics & Astronomy
Project: *The Extended Red Emission in IC 59 and IC 63*
The Connection between DIBs and ERE

2013 – 2014 **Research Assistant**, *ASIAA*, Taipei, Taiwan
Advisor: Dr. Ciska Kemper, Dr. Sundar Srinivasan, and Dr. Masaaki Otsuka
Project: *Near-infrared Photometry of Evolved Asymptotic Giant Branch Stars in M33*

2012 **Corporal**, *The Republic of China Army*, Taiwan

2011 – 2012 **Research Assistant**, *National Central University*, Taoyuan, Taiwan
Advisor: Dr. Chung-Ming Ko
Project: *2MASS Whole Sky Star Count*

Education

2014–2021 **Ph.D. in Astronomy & Physics**, *University of Toledo, OH, USA*
Advisors: Dr. J.D.T. Smith and Dr. Adolf Witt
Thesis Title: *"Exploring Small Dust Grains in Different Galaxy Environments"*

2007–2011 **B.A. in Space Science**, *National Central University*, *Taoyuan, Taiwan*

Honors and Awards

2023 **AAS Travel Grant**, American Astronomical Society

2022 **HST GO30 Grant**, STScI

2022 **JWST GO1 Grant**, STScI

2019 **Award for Best Graduate Student Presentation ($125)**, University of Toledo

2019 **FAMOUS travel grant ($500)**, American Astronomical Society

2019 **Graduate Research Scholar Travel Award ($500)**, College of Natural Science & Mathematics, University of Toledo

2018 **AAS Travel Grant ($1,607)**, American Astronomical Society

2016 **Award for Best Graduate Student Presentation ($250)**, University of Toledo

2015–2019 **University Fellowship (4 years - $72,000 + tuition)**, Highest award from Graduate School, University of Toledo

2014 **Doreen and Lyman Spitzer Graduate Fellowship in Astrophysics ($9,000)**, Department of Physics and Astronomy, University of Toledo

2008 **Outstanding Award**, National Central University

Publications

Author of 30 refereed publications (including 6 submitted papers)

First/Second author with major contribution:

10. **Lai, T.S.-Y.**, Smith, J.D.T. et al., (ApJ in press)
Spectroscopic Constraints on the Mid-Infrared Attenuation Curve: I - Attenuation Model using PAH Emissions
9. **Lai, T.S.-Y.**, Armus, L. et al., 2023, ApJL, 957L, 26L
GOALS-JWST: Small neutral grains and enhanced 3.3 micron PAH emission in the Seyfert galaxy NGC 7469
8. Armus, L., **Lai, T.S.-Y.** et al., 2023, ApJL, 942L, 37A
GOALS-JWST: Mid-Infrared Spectroscopy of the Nucleus of NGC 7469
7. **Lai, T.S.-Y.**, Armus, L. et al., 2022, ApJL, 940, L5
GOALS-JWST: Tracing AGN Feedback on the Star-Forming ISM in NGC 7469
6. U, V, **Lai, T.S.-Y.** et al., 2022, ApJL, 941L, 36L
GOALS-JWST: Resolving the Circumnuclear Gas Dynamics in NGC 7469 in the Mid-infrared
5. **Lai, T.S.-Y.**, Smith, J.D.T, Baba, S, Spoon, H.W.W, Imanishi, 2020, ApJ, 905, 55
All the PAHs: an AKARI-Spitzer Cross-Archival Spectroscopic Survey of Aromatic Emission in Galaxies
4. Witt, A.N, **Lai, T.S.-Y.**, Astrophysics and Space Science Journal, 2020Ap&SS.365.58W
The Observational Constraints of the Extended Red Emission
3. **Lai, T.S.-Y.**, Witt, A.N, Alvarez, C, Cami, J, 2020, MNRAS, 492, 5853L
Are the Carriers of Diffuse Interstellar Bands and Extended Red Emission the Same?
2. **Lai, T.S.-Y.**, Witt, A.N, Crawford, K, 2017, MNRAS, 469, 4933L
Extended Red Emission in IC59 and IC63
1. Chang, C.K., **Lai, T.S.-Y.**, Ko, C.M. & Peng, T.H., 2012, ApJ, 759, 94
The Information of The Milky Way from Two Micron All Sky Survey Whole Sky Star Count: The Bimodal Color Distributions

Others:

20. Chown, R.,..., **Lai, T.S.-Y.**, (submitted to A&A)
PDRs4All IV. An embarrassment of riches: Aromatic infrared bands in the Orion Bar

19. Bolatto, A.,..., **Lai, T.S.-Y.**, (in press)
JWST Observations of Starbursts: Polycyclic Aromatic Hydrocarbon Emission at the base of the M82 Galactic Wind
18. Van De Putte, D.,..., **Lai, T.S.-Y.**, (submitted to A&A)
PDRs4All VIII: Mid-IR emission line inventory of the Orion Bar
17. Schroetter, I.,..., **Lai, T.S.-Y.**, (in press)
PDRs4All VII. The 3.3 um aromatic infrared band as a tracer of physical properties of the ISM in galaxies
16. Buiten, V.,..., **Lai, T.S.-Y.**, (in press)
GOALS-JWST: Mid-Infrared Molecular Gas Excitation Probes the Local Conditions of Nuclear Star Clusters and the AGN in the LIRG VV 114
15. Bianchin, M.,..., **Lai, T.S.-Y.**, (in press)
GOALS-JWST: Gas Dynamics and Excitation in NGC7469 revealed by NIRSpec
14. Pasquini, S.,..., **Lai, T.S.-Y.**, (in press)
PDRs4All VI: Probing the Photochemical Evolution of PAHs in the Orion Bar Using Machine Learning Techniques
13. Peeters, E.,..., **Lai, T.S.-Y.**, (submitted to A&A)
PDRs4All III: JWST's NIR spectroscopic view of the Orion Bar
12. Habart, E.,..., **Lai, T.S.-Y.**, (submitted to A&A)
PDRs4All II: JWST's NIR and MIR imaging view of the Orion Nebula
11. Eiermann, J.,..., **Lai, T.S.-Y.**, 2024MNRAS.tmp..301E
The 3D Geometry of Reflection Nebulae IC 59 and IC 63 with their illuminating Star Gamma Cas
10. Kader, J.,..., **Lai, T.S.-Y.**, (submitted to Nature)
The Past, Present, and Future of a Precessing Jet-Driven Outflow in Early Interaction Pair VV 340
9. Berné, O.,..., **Lai, T.S.-Y.**, 2024Sci, 383, 988P
A far-ultraviolet–driven photoevaporation flow observed in a protoplanetary disk
8. Donnelly, G.,..., **Lai, T.S.-Y.**, (in press)
The Impact of an AGN on PAH Emission in Galaxies: the Case of Ring Galaxy NGC 4138
7. Linden, S.,..., **Lai, T.S.-Y.**, 2023, ApJ, 944L, 55L
GOALS-JWST: Revealing the Buried Star Clusters in the Luminous Infrared Galaxy VV 114
6. Bohn, T.,..., **Lai, T.S.-Y.**, 2023, ApJ, 942L, 36B
GOALS-JWST: NIRCam and MIRI Imaging of the Circumnuclear Starburst Ring in NGC 7469
5. Rich, J.,..., **Lai, T.S.-Y.**, 2022, ApJ, 944L, 50R
GOALS-JWST: Pulling Back the Curtain on the AGN and Star Formation in VV 114
4. Evans, E.,..., **Lai, T.S.-Y.**, 2022, ApJ, 940L, 8E
GOALS-JWST: Hidden Star Formation and Extended PAH Emission in the Luminous Infrared Galaxy VV 114
3. Inami, H.,..., **Lai, T.S.-Y.**, 2022, ApJ, 940L, 6I
GOALS-JWST: Unveiling Dusty Compact Sources in the Merging Galaxy IIZw096
2. Song, Y.,..., **Lai, T.S.-Y.**, 2022, ApJ, 940, 52S
Characterizing Compact 15-33 GHz Radio Continuum Sources in Local U/LIRGs
1. Berné, O.,..., **Lai, T.S.-Y.**, 2022, PASP, 134, 054301,
PDRs4All: A JWST Early Release Science Program on Radiative Feedback from Massive Stars

Successful Observing Proposals

- **JWST GO3:** A Deep Look into PAHs: Resolved PAH and Fine-Structure Emission in z=1 Main-Sequence Galaxies, 2024, 48 hrs (PI: Faisst, A)

- **JWST GO3:** A Systematic Study of the 3.3—3.5 micron PAH Features at z∼0 with Archival NIRSpec Observations, 2024, AR (PI: Sandstrom, K)
- **JWST GO2:** Measuring Dust Evolution Over the Past 10 Billion Years With 3-12 micron Spectra for 60 High-Redshift Galaxies, 2023, 42 hrs (PI: McKinney, J)
- **JWST GO2:** A JWST Survey of Ultraluminous Infrared Galaxies, 2023, 98 hrs (PI: Armus, L)
- **JWST GO2:** The JWST Whirlpool Galaxy Treasury, 2023, 62 hrs (PI: Sandstrom, K)
- **JWST GO2:** Big Impact in Little Galaxies? A JWST Investigation of AGN Outflows in Dwarf Galaxies, 2023, 22 hrs (PI: Bohn, T)
- **HST GO30-mid:** From Galactic Cores to the Cosmic Web – A Study of Feedback and Multiphase Galactic Winds with HST and JWST, 2022 (PI: U, V)
- **ALMA Cyc9:** Heating and Cooling of the Interstellar Medium in Dusty Galaxies at Cosmic Noon, 2022 (PI: McKinney, J)
- **HST GO30:** Linking the UV Bump with PAHs in Low Metallicity Starburst II Zw 40, 2022 **(PI: Lai, T)**
- **HST GO29:** In the Belly of the Beast: Star Cluster Formation and Evolution in the Centers of local LIRGs, 2021 (PI: Evans, A)
- **JWST GO1:** How Do the Small Survive: PAH's in Low Metallicity Starburst II Zw 40, 2020 **(PI: Lai, T)**
- **JWST GO1:** The Vanishing Act: PAHs and Heavy Element Abundance in M101, 2020 (PI: Smith, JD)
- **JWST ERS 1288:** Radiative Feedback from Massive Stars as Traced by Multiband Imaging and Spectroscopic Mosaics, 2018 (PI: Berne, O)
- **Discovery Channel Telescope / DeVeny Spectrograph:** The search of connection between Diffuse Interstellar Bands and Extend Red Emission, 2017 (2017Q4T01), 1 full night **(PI: Lai, T)**
- **Keck/DEIMOS:** Potential Connection Between DIBs and ERE in the Reflection/Emission Nebula IC 63, 20170716, 1 full night (PI: Alvarez, C)
- **Discovery Channel Telescope / DeVeny Spectrograph:** The search of connection between Diffuse Interstellar Bands and Extend Red Emission, 2016 (2016Q3T02), 2 full nights **(PI: Lai, T)**
- **SMA:** Using SMA to observe FU Orionis stars RNO 1C/1B, 1 full night **(PI: Lai, T)**

Mentoring Experience

2024–*present* **Grant Donnelly**, *IPAC Visiting Graduate Fellow*
2023–*present* **Sara Duval**, *U of Toledo*

Service

Aug, 2023 **SOC**, *2023 GOALS Workshop*
Aug, 2021 **Coordinator**, *Python Visualization Workshop*
2020–*present* **Referee**, *The Astrophysical Journal*
2020–*present* **Builder**, *AKARI-Spitzer Extragalactic Spectral Survey (ASESS)*
Jun 2020 Conference for Undergraduate Women in Physics (CUWiP), *U of Toledo*
Oct 2017 50th anniversary of the Ritter Observatory

Outreach

Sep 8–10, 2023 **Volunteer**, *Sequoia Dark Sky Festival*

May 2016 **Volunteer**, *Cedar Point Physics, Science and Math Week*

Sep 2015 **Volunteer**, *Total Lunar Eclipse Outreach Program*

Teaching Experience

- **Graduate Teaching Assistant**, *Fall 2014, Summer 2016, Summer 2018, and Summer 2019*

Skills

- **Programming:** Python, IDL, Git, Markdown, HTML, LaTeX, IRAF, SExtractor, SQL
- **Software Development:** Developer of CAFE and PAHFIT
- **Software:** Astropy, JWST pipeline, Cubeviz, Jupyter notebooks, lmfit, MCMC, sphinx
- **Operating System:** Mac OS, Linux, Windows
- **Tools:** APT and ETC for both JWST and HST

Talks & Posters

Talks:

Apr 10, 2024 **Probing the Smallest Interstellar Dust Grains with JWST in Various Galaxy Environments (invited)**, *IPAC Seminar*, Pasadena, CA

Mar 5, 2024 **Probing the Smallest PAH Population with JWST in Different Galaxy Environments**, *The Physics and Impact of Astrophysical Dust*, Aspen, CO

Nov 3, 2023 **Tracing AGN Feedback on the Star-Forming ISM with JWST NIRspec & MIRI IFU**, *Illuminating the Dusty Universe*, Florence, Italy

Sep 1, 2023 **Tracing AGN Feedback on the Star-Forming ISM with JWST NIRspec & MIRI IFU (invited)**, *GISS, Caltech/IPAC*, Pasadena, CA

Apr 17, 2023 **Tea Talk (invited)**, *Caltech*, Pasadena, CA

Feb 23, 2023 **Tracing AGN Feedback on the Star-Forming ISM in NGC 7469 with JWST (invited)**, *ASIAA Seminar*, Taipei

Dec 14, 2022 **Tracing AGN Feedback on the Star-Forming ISM in NGC 7469 with JWST**, *STScI JWST First Result Conference*

Nov 7, 2022 **Tracing AGN Feedback on the Star-Forming ISM in NGC 7469 with JWST**, *IRSTIG Webinar (invited)*, virtual

Jan 4, 2022 **Probing the Resolved Dusty Universe with JWST (invited)**, *NTU seminar*, virtual

Aug 2, 2021 **How to Make Good Plots**, *Python Visualization Workshop*, Toledo, OH

Jul 21, 2021 **All the PAHs: Exploring Small Dust Grains In Galaxies**, *GOALS workshop*, virtual

Jan 6, 2020 **Understanding small dust grains in different interstellar environments**, *AAS dissertation talk*, Hawaii

Dec 6, 2018 **Outreach talk: DEIMOS Throughput After 16 Years of Operations (invited)**, *Keck Visiting Scholar Party*, Keck observatory

Dec 5, 2018 **DEIMOS Throughput After 16 Years of Operations**, *Keck Visiting Scholar Presentation*, Keck observatory

Nov 19, 2018 **Exploring Small Dust Grains Across Different Interstellar Environments (invited)**, *Astronomy Seminar*, Keck observatory

Jun 13, 2017 **Extended Red Emission in IC 59 and IC 63 (invited)**, *Astronomy Seminar*, JAXA, Japan

Dec 31, 2015 **Extended Red Emission in IC63 & IC59: How Does it Produce? (invited)**, *Astronomy Seminar*, National Central University

May 23–25, 2014 **The Mass Loss from Asymptotic Giant Branch Stars in M33**, *The Astronomical Society of the Republic of China Annual Meeting*

Aug 29, 2013 **Near-Infrared Photometry of Evolved Stars in the Nearby Galaxy M33**, *ASIAA Summer Student Presentation*

Posters:

Jun 12–16, 2022 **A JWST Study of the Starburst-AGN Connection in Merging Luminous Infrared Galaxies**, *AAS240*, Pasadena, CA

Mar 4–8, 2019 **All the PAHs: a Spitzer–AKARI Cross-Archival Spectroscopic Survey of Aromatic Emission in Galaxies**, *Dusting the Universe*, The University of Arizona, Tucson, AZ

Nov 11–15, 2013 **Near-Infrared Photometry of Evolved Stars in The Nearby Galaxy M33**, *Science Eyes and Minds towards Cosmic Horizon*, Sokendai, Japan

Aug 20–24, 2012 **The Information of Milky Way from 2MASS Whole Sky Star Counts: the Bimodal Color Distributions**, *IAU 28th General Assembly*, Beijing, China

Article

- **Revealing All the PAHs in Galaxies with an AKARI-Spitzer Survey**, *IRSIG newsletter*

Workshops:

Apr, 2022 **PAH Fest**, *University of Florida*, FL

Apr 30–May 4, 2018 **Python in Astronomy 2018**, *Flatiron Institute*, NY

Apr 2–6, 2018 **PAHs in the ISM: Observational, Experimental and Computational Tools**, *Les Houches*, France

Mar 7, 2017 **ALMA/VLA/VLBA workshop**, *University of Michigan*

Aug 1–5, 2016 **SciCoder 8**, *Yale University*