

# Henry W. Leung

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 Bilingual in English & Chinese    Python, C    Canadian

## RESEARCH INTERESTS

My research broadly focused on how to adopt and adapt **deep learning** methodology to analyze big cross-domain cross-survey datasets to help us better understand the formation history and **dynamics of our MilkyWay Galaxy**. I utilize a wide range of machine learning methods in my research from simple supervised models to self-supervised Transformers and diffusion models. I am interested in big questions like how would **foundation models** like “Large Astronomy Models” play a role in data-driven astronomy as well as how **artificial intelligence** would look like in astronomy in the future. Most of my codes and models are well tested, well documented and open sourced to support open science.

## EDUCATION

<b>University of Toronto</b> <i>PhD in Astronomy &amp; Astrophysics</i> Thesis advisor: Prof. Jo Bovy	<b>In Progress</b> 2020-2024
<b>University of Toronto</b> <i>MSc in Astronomy &amp; Astrophysics</i> Thesis advisor: Prof. Jo Bovy & Prof. Abigail Crites	2019-2020
<b>University of Toronto</b> <i>HBSc in Astronomy &amp; Physics</i>	2014-2019

## MAJOR AWARDS & FELLOWSHIPS

<b>Data Science Institute Doctoral Student Fellowship</b> <i>University of Toronto</i> CAD \$75,000	2023-2027
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## PUBLICATION OVERVIEW

I am an author on **13 refereed papers** that have **2270+** citations (h-index=10). Excluding 2 collaboration papers, there are **11 refereed papers** that have **690+** citations. Details of my ORCID (0000-0002-0036-2752) associated publications can be accessed on [Astrophysics Data System \(ADS\)](#).

## TALKS AT CONFERENCE/WORKSHOPS

<b>NeurIPS Machine Learning and the Physical Sciences Workshop</b> <i>Organized by Neural Information Processing Systems (NeurIPS) Foundation</i> Talks on “Towards an Astronomical Foundation Model for Stars”	<b>New Orleans, USA</b> Dec 2023
<b>Debating the Potential of Machine Learning in Astronomical Surveys</b> <i>Organized by Flatiron Institute &amp; Institut Astrophysique de Paris</i>	<b>New York, USA</b> Nov 2023

Talks on “Towards an Astronomical Foundation Model for Stars with a Transformer-based Model”

### **Asteroseismology in the Era of Surveys from Space and the Ground**

*Organized by KU Leuven*

Talks on “Stellar Age for Giant Stars with Deep Learning”

**Leuven, Belgium**

*July 2022*

### **Gaia Hike**

*Organized by The Canadian Institute for Theoretical Astrophysics (CITA)*

Talks on how to access 220 millions multi-terabytes Gaia BP/RP spectra

**Vancouver, Canada**

*June 2022*

### **Stellar Stats Workshop**

*Organized by University of Toronto*

Talks on “Understanding the Milky Way Galaxy with Deep Learning”

**Toronto, Canada**

*May 2022*

### **Artificial Intelligence for Astronomy**

*Organized by European Southern Observatory (ESO)*

Talks on “Mapping the Milky Way Galaxy with Deep Learning”

**Garching, Germany**

*July 2019*

## **SOFTWARE**

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Most of my research are open-sourced including codes for publications: <https://github.com/henrysky>. This includes a few software packages that are well tested and well documented, for example:

### **astroNN**

*Deep Learning for Astronomers with Tensorflow*

### **milkyway\_plot**

*A handy python package to do plotting on a face-on/edge-on/allsky map milkyway with matplotlib and bokeh*

### **Galaxy10**

*A CIFAR10-like galaxy image dataset*

### **MyGaiaDB**

*Setup local SQL serverless ESA Gaia / 2MASS / ALLWISE / CATWISE databases and run query locally with python*

I have also contributed to several open-source software packages, for example:

### **galpy**

*Galactic Dynamics in python*

I have implemented an explicit Runge-Kutta method of order 8(5,3) numerical integer DOP-853 in Python and C, as well as improving 2D animation rendering performance and implementing 3D animation using plotly.js

### **mw dust**

*Dust maps in the Milky Way*

I have implemented necessary Hierarchical Equal Area isoLatitude Pixelation of a sphere (HEALPix) functionality in C for cross-platform compatibility as well as improved out-of-the box user experience

### **python-fsps**

*Python bindings to Flexible Stellar Population Synthesis (FSPS) Fortran code*

I have fixed various compilation issues such that the code is usable on Windows.

## **REFEREEING & REVIEW:**

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Referee for: *American Astronomical Society journal, Astrophysics and Space Science journal*

## **MENTORSHIPS**

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**Yiwei Jiang**

*Summer Undergraduate Data Science Research with Prof. Jo Bovy**Summer 2024*

Dating stars with contrastive learning

**Peter Shi***Summer Undergraduate Data Science Research with Prof. Jo Bovy and Dr. Yingyi Song**Summer 2023*

Mapping the chemical structure of the Milky Way with neural nets and SDSS-V

**Rohan Ashar***Undergraduate Mentorship Program**Fall 2022*

## OUTREACH

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**UofT AstroTours Team***Website director and help with monthly public talks by graduate student**2020-2023***UofT AstroTours***Public talk on "Exploring our Milky Way Galaxy with Deep Learning"**13 January 2023*

## PUBLICATIONS

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**First/Second Author (ordered by date):**[10 cites] 2024, [MNRAS.527.1494L](#) / [arXiv:2308.10944](#)

Towards an astronomical foundation model for stars with a transformer-based model

**Henry W. Leung** & Jo Bovy[14 cites] 2023, [MNRAS.522.4577L](#) / [arXiv:2302.05479](#)

A variational encoder-decoder approach to precise spectroscopic age estimation for large Galactic surveys

**Henry W. Leung**, Jo Bovy, J. Ted Mackereth & Andrea Miglio[28 cites] 2023, [MNRAS.519..948L](#) / [arXiv:2204.12551](#)

A measurement of the distance to the Galactic centre using the kinematics of bar stars

**Henry W. Leung**, et al.[145 cites] 2019, [MNRAS.490.4740B](#) / [arXiv:1905.11404](#)

Life in the fast lane: a direct view of the dynamics, formation, and evolution of the Milky Way's bar

Jo Bovy, **Henry W. Leung**, et al.[126 cites] 2019, [MNRAS.489.2079L](#) / [arXiv:1902.08634](#)

Simultaneous calibration of spectro-photometric distances and the Gaia DR2 parallax zero-point offset with deep learning

**Henry W. Leung** & Jo Bovy[156 cites] 2019, [MNRAS.483.3255L](#) / [arXiv:1808.04428](#)

Deep learning of multi-element abundances from high-resolution spectroscopic data

**Henry W. Leung** & Jo Bovy[4 cites] 2017, [JAVSO..45...30P](#) / [arXiv:1611.03334](#)

Studies of the Long Secondary Periods in Pulsating Red Giants. II. Lower-Luminosity Stars

J. R. Percy & **Henry W. Leung****Contributing Author (ordered by date):**

[3 cites] 2023, [MNRAS.526.1997P](#) / [arXiv:2306.09319](#)

Decoding the age-chemical structure of the Milky Way disc: an application of copulas and elicitable maps  
Aarya A. Patil, Jo Bovy, Sebastian Jaimungal, Neige Frankel, **Henry W. Leung**, et al.

[39 cites] 2022, [ApJS..260...32W](#) / [arXiv:2108.08860](#)

Chemical Cartography with APOGEE: Mapping Disk Populations with a 2-process Model and Residual Abundances

David H. Weinberg, et al. (includes **Henry W. Leung**)

[582 cites] 2022, [ApJS..259...35A](#) / [arXiv:2112.02026](#)

The Seventeenth Data Release of the Sloan Digital Sky Surveys: Complete Release of MaNGA, MaStar, and APOGEE-2 Data

Abdurro'uf, et al. (Collaboration paper; includes **Henry W. Leung**)

[1005 cites] 2020, [ApJS..249....3A](#) / [arXiv:1912.02905](#)

The 16th Data Release of the Sloan Digital Sky Surveys: First Release from the APOGEE-2 Southern Survey and Full Release of eBOSS Spectra

Romina Ahumada, et al. (Collaboration paper; includes **Henry W. Leung**)

[11 cites] 2020, [MNRAS.494.2268W](#) / [arXiv:1910.01646](#)

Searching for solar siblings in APOGEE and Gaia DR2 with N-body simulations

Jeremy J. Webb, Natalie Price-Jones, Jo Bovy, Simon Portegies Zwart, Jason A. S. Hunt, J. Ted Mackereth, **Henry W. Leung**, et al.

[152 cites] 2019, [MNRAS.489..176M](#) / [arXiv:1901.04502](#)

Dynamical heating across the Milky Way disc using APOGEE and Gaia

J. Ted Mackereth, Jo Bovy, **Henry W. Leung**, et al.