# Henry W. Leung

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in Henry Leung

Az Bilingual in English & Chinese

**⟨⟩** Python & C

Canadian & Hong Konger

#### 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**

University of Toronto	In Progress
$PhD\ in\ Astronomy\ \ \ \ \ Astrophysics$	2020-2024

Thesis advisor: Prof. Jo Bovy

University of Toronto

MSc in Astronomy & Astrophysics 2019-2020

Thesis advisor: Prof. Jo Bovy & Prof. Abigail Crites

University of Toronto

HBSc in Astronomy & Physics 2014-2019

#### PUBLICATION OVERVIEW

I am an author on **14 refereed papers** that have **2400+** citations (h-index=11). Excluding 2 collaboration papers, there are **12 refereed papers** that have **720+** citations. Details of my ORCID (ocrid) associated publications can be accessed on Astrophysics Data System (ADS).

# MAJOR AWARDS & FELLOWSHIPS

#### Data Science Institute Doctoral Student Fellowship

University of Toronto
CAD \$75,000

2023-2027

#### **SOFTWARE**

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 Keras

# milkyway\_plot 😯

A handy package for plotting face-on and all-sky maps of the Milky Way using Matplotlib and Bokeh

# Galaxy10 🦪

A CIFAR10-like galaxy image dataset

# MyGaiaDB 😯

Setup local serverless 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

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

#### mwdust 😯

Dust maps in the Milky Way

- Implemented necessary Hierarchical Equal Area isoLatitude Pixelation of a sphere (HEALPix) functionality in C
- Improved out-of-the box user experience on Linux/MaxOS/Windows by using Python instead of system packages

# python-fsps 🦪

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

- Fixed various compilation issues such that the code is usable on Windows

#### **PUBLICATIONS**

# First/Second Author (ordered by date):

[0 cites] 2024, arXiv240715703L / arXiv:2407.15703

Estimating Probability Densities with Transformer and Denoising Diffusion

Henry W. Leung, Jo Bovy & Joshua S. Speagle

[12 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

[16 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

[31 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**, el al.

[148 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**, el al.

[132 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

[162 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):

[5 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**, el al.

[41 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**)

[646 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, el al. (Collaboration paper; includes **Henry W. Leung**)

[1037 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, el 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.

[163 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, el al.