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

 $MSc\ in\ Astronomy\ \mathcal{E}\ Astrophysics$ 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 **2430+** 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

[17 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

[163 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.

[42 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, el al. (includes **Henry W. Leung**)

[659 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**)

[1043 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.