Chan, Ho Sang (Leon)

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Research Interests

Theoretical Astrophysics

– Stars and Compact Objects, Astrophysical Hydrodynamics, High-energy Astrophysics, Galaxies and Large-scale Structures, Cosmology

Data Analysis

– Multi-messenger Astronomy, Astronomical Big-data, Time-series Analysis, Data Mining, Deep Learning, Astronomical Surveys

Education

Master of Philosophy in Physics Aug. 2019 - Present
The Chinese University of Hong Kong

Major GPA: **3.858**/4.000
Cumulative GPA: **3.858**/4.000

Bachelor of Science in Physics with *First Class Honours* Aug. 2015 - Jul. 2019
The Chinese University of Hong Kong
College: C.W. Chu College
Stream: Enrichment Stream in Theoretical Physics

Major GPA: **3.859**/4.000
Cumulative GPA: 3.523/4.000

Research Experience

Research Visitor Jun. 2021 - Present
Center for Computational Astrophysics, Flatiron Institute, New York
Supervisors: Prof. Shirley Ho and Prof. Ashley Villar

– **Project**: *Anomaly detection of periodic variable stars with machine learning*

- Built a convolutional variational autoencoder using the `TensorFlow` package
- Searched for anomalies in the ZTF Catalogue of Periodic Variable Stars
- Identified highly anomalous Red Giants and AGB stars
- Resulted in two first-author publications (Item [1] and [2] in Conference Proceedings)
- Resulted in a first-author manuscript submitted (Item [1] in Journal Publications)

– **Project**: *Classification of periodic variable stars*

- Extracted latent features of periodic variable stars generated by the autoencoder
- Helped build a new classification model for the ZTF Catalogue of Periodic Variable Stars
- Resulted in a third-author publication (Item [4] in Journal Publications)

Undergraduate and Graduate Research Assistant May. 2018 - Present
The Chinese University of Hong Kong
Supervisors: Prof. Ming-Chung Chu and Dr. Lap-Ming Lin
Collaborator: Dr. Shing-Chi Leung (*California Institute of Technology*)

– **Project**: *Multi-dimensional simulations of dark matter-admixed Type Ia supernova*

- Helped develop a multi-dimensional finite volume hydrodynamic code in `Fortran`
- Computed gravitational-wave and neutrino signals from the supernova
- Investigated supernova nucleosynthesis in the presence of dark matter

– **Project**: *Dark matter-admixed rotating white dwarfs*

- Wrote a semi-analytic, iterative solver in `Fortran`
- Constructed models of ultra-massive rotating dark matter-admixed white dwarfs
- Predicted the deviations of the universal $I-\text{Love}-Q$ relations
- Proposed progenitor models for the 2.6 $M_\odot$ compact object discovered in GW190814
- Resulted in a first-author manuscript submitted (Item [2] in Journal Publications)

– **Project**: *Dark matter-admixed thermonuclear supernovae*

- Helped develop a one-dimensional finite volume hydrodynamic code in `Fortran`
- Computed light curves and neutrino signals from dark matter-admixed Type Ia supernovae
- Matched and explained peculiar supernovae using the dark matter-admixed model
- Suggested a formation path for dark compact objects
- Resulted in a first-author publication (Item [3] in Journal Publications)

– **Project**: *Dark matter-admixed white dwarfs*

- Wrote an ODE solver in `C++`
- Explored effects of admixing sub-GeV dark matter particles to white dwarfs
- Found a new class of exotic white dwarf

Publications

Journal Publications

1. **Chan, H. S.**, Villar, A., Cheung, S. H., Ho, S., O'Grady, A. J., Drout, M. R., & Renzo, M. (2021). *Searching for Anomalies in the ZTF Catalog of Periodic Variable Stars*. Submitted to The Astrophysical Journal. (Preview)

2. **Chan, H. S.**, Chu, M. C., & Leung, S. C. (2021). *Rotating White Dwarfs as Dark Matter Detectors*. Submitted to The Physical Review D. (Preview)

3. **Chan, H. S.**, Chu, M. C., Leung, S. C., & Lin, L. M. (2021). *Delayed Detonation Thermonuclear Supernovae with an Extended Dark Matter Component*. The Astrophysical Journal, 914(2), 138. (Preview)

4. Cheung, S. H., Villar, V.A., **Chan, H. S.**, & Ho, S. (2021). *A New Classification Model for the ZTF Catalog of Periodic Variable Stars*. Research Notes of the AAS, 5(12), 282. (Preview)

Conference Proceedings

1. **Chan, H. S.**, Cheung, S. H., Villar, A., & Ho, S. (2021). *A Convolutional Autoencoder-Based Pipeline for Anomaly Detection and Classification of Periodic Variable Stars*. NeruIPS 2021 Machine Learning and the Physical Sciences Workshop. (Preview)

2. **Chan, H. S.**, Cheung, S. H., Villar, A., & Ho, S. (2021). *Searching for the Weirdest Stars: A Convolutional Autoencoder-Based Pipeline for Detecting Anomalous Periodic Variable Stars*. NeruIPS 2021 Deep Generative Models and Downstream Applications Workshop. (Preview)

Undergraduate Project Reports

1. **Chan, H. S.** (2018). *The Equilibrium Structure and Hydrodynamical Evolution of Non-Self-Annihilating-Light Dark Matter-Admixed White Dwarfs*. CUHK Undergraduate Final Year Project. (Preview)

2. Chan, H. S., Chan, Y-Y., Cheng, P-Y., Fung, K-Y., Hung, W-H., & Lau, W-S. (2018). *Investigation of the Zenith-Angle Dependence of Muon Flux in Hong Kong, Geneva, and Leiden*. CUHK Short Summer Experimental Project. (Preview)

3. Chan, H. S., & Lei, M-L. (2017). *Simulations of Photon Trajectory in Schwarzschild Spacetime*. Course Assessment Project, Phys 3420 - Topics in Contemporary Physics. (Slides)

Conference Contributions and Talks

239th American Astronomy Society Meeting Jan. 2022
Abstract Accepted for Poster Presentation

– Title: A New Classification Method for the ZTF Catalog of Periodic Variable Stars: Towards a Search for Partial Repeating Tidal Disruption Events

239th American Astronomy Society Meeting Jan. 2022
Abstract Accepted for Poster Presentation

– Title: Searching for the Weirdest Stars: A Deep-Generative Learning Approach for Detecting Anomalous Periodic Variable Stars

NeurIPS 2021 D.G.M.S. and D.A. Workshop Dec. 2021
Poster Presentation

– Title: Searching for the Weirdest Stars: A Convolutional Autoencoder-Based Pipeline for Detecting Anomalous Periodic Variable Stars (Website)(Poster)

NeurIPS 2021 M.L. and the Physical Science Workshop Dec. 2021
Poster Presentation

– Title: A Convolutional Autoencoder-Based Pipeline for Anomaly Detection and Classification of Periodic Variables (Website)(Poster)(Recording)(Slides)

Astroinformatics 2021 Conference Nov. 2021
Poster Presentation

– Title: Searching for Anomalies in the ZTF Catalog of Periodic Variable Stars (Website)(Poster)

238th American Astronomy Society Meeting Jun. 2021
Oral Presentation

– Title: Delayed Detonation Thermonuclear Supernovae with an Extended Dark Matter Component (Recording (AAS Account Required))(Slides)

CUHK Physics Student Conference 2019 Sep. 2019
Oral Presentation

– Title: Dark Matter-Admixed White Dwarfs and their Thermonuclear Explosion - An Alternative Probe to Astronomical Dark Matter (Website)(Slides)(Gallary)

Awards And Honours

C.W. Chu College's Foundation Scholarship	2018 - 2019
Dean's Honours List	2018 - 2019
C.W. Chu College's Physics Scholarship	2017 - 2018
Dean's Honours List	2017 - 2018
C.W. Chu College's Physics Scholarship	2016 - 2017
Dean's Honours List	2016 - 2017
C.W. Chu College's Lee Wai Wing Scholarship	2015 - 2016
Honours at Entrance	2015 - 2016

Teaching Experience

Teaching assistant for upper level physics courses
The Chinese University of Hong Kong

– Phys 4021 Quantum Mechanics	Jan. 2021 - May. 2021
– Phys 4041 Electrodynamics	Sep. 2020 - Dec. 2020
– Phys 4041 Electrodynamics	Jan. 2020 - May. 2020
– Phys 4021 Quantum Mechanics	Sep. 2019 - Dec. 2019

Summer tutoring for physics undergraduates May. 2020 - Sep. 2020
The Chinese University of Hong Kong

– Tutored undergraduates who are having academic difficulties
– Taught multi-variable and vector calculus

Teaching assistant of the summer research internship May. 2019 - Aug. 2019
The Chinese University of Hong Kong

– Instructed fluid dynamics and computational physics to undergraduates
– Guided undergraduates to use a hydrodynamic code to perform simulations

Teaching assistant of the science academy for young talent Jul. 2018 - Aug. 2018
The Chinese University of Hong Kong

– Guided high school students to conduct physics experiments

Personal Skills

Languages	Cantonese (Native) Mandarin (Proficient) English (Advanced)
Programming Languages	FORTRAN, PYTHON, C++, LaTeX
Test Scores	TOEFL iBT - 105/120 Physics GRE - 990/990 (97 Percentile)