

Madeline Lucey

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The University of Texas at Austin, Dept. of Astronomy

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RESEARCH INTERESTS

Galactic archaeology, near-field cosmology, population II stars, the Galactic bulge, carbon-enhanced metal-poor stars, red clump stars, stellar evolution, stellar spectroscopy, data mining and machine learning

EDUCATION

The University of Texas at Austin

August 2018 - Present

Ph.D. Astronomy

Thesis: Uncovering Galactic Fossils from the Early Universe

Advisor: Keith Hawkins

The University of Texas at Austin

August 2020

M.A. Astronomy

Colorado College

May 2018

B.A. Physics: Astrophysics Emphasis, Magna Cum Laude

FIRST AUTHOR PUBLICATIONS

4. **M. Lucey**, K. Hawkins, M. Ness, T. Nelson, V.P. Debattista, A. Luna, T. Bensby, K.C. Freeman, C. Kobayashi, *The COMBS Survey - III. The Chemodynamical Origins of Metal-Poor Bulge Stars*, MNRAS, Submitted
 - This paper is the third installment of the COMBS survey that aims to chemo-dynamically characterize the metal-poor population in the Galactic bulge in order to determine its origins. In this work, I develop a pipeline to perform stellar parameter and elemental abundance analysis for 319 stellar spectra from the VLT/GIRAFFE. Using dynamical results from COMBS II, I separate the sample into four groups which I associate with various Galactic structures: the inner bulge, the outer bulge, the halo and the disk. I define a new term: *chemical complexity*, which is used to compare the chemical dimensionality and mean strength of abundance correlations of different stellar populations. I find that the inner and outer bulge populations are more chemically complex than the halo population. This result suggests that the older bulge population has likely been enriched by a larger diversity of supernova events compared to the halo population. I also find one inner bulge star whose chemistry may indicate a pair-instability supernova signature, along with two stars with chemistry consistent with second-generation globular cluster stars.
3. **M. Lucey**, K. Hawkins, M. Ness, V.P. Debattista, A. Luna, M. Asplund, T. Bensby, L. Casagrande, S. Feltzing, K.C. Freeman, C. Kobayashi, A.F. Marino, *The COMBS Survey - II. Distinguishing the Metal-Poor Bulge from the Halo Interlopers*, 2021, MNRAS, 501, 5981
 - This paper is the second part of the COMBS survey that aims to chemo-dynamically characterize the metal-poor population in the Galactic bulge in order to determine its origins. In this work, I perform probabilistic orbit analysis for 523 stars to determine what fraction of these stars will stay confined to the bulge as opposed to being halo interlopers, which are just passing through the bulge. I also calculate metallicity estimates from the Ca-II NIR Triplet for 473 stars using VLT/GIRAFFE spectra. I found that $\sim 50\%$ of metal-poor stars in the bulge will stay confined to the bulge and that fraction decreases steadily with decreasing

metallicity. I also show that the confined stars have a line-of-sight velocity distribution that is consistent with a B/P bulge, indicating hierarchical formation may not be important early on in the Milky Way's formation.

2. **M. Lucey**, Y.-S. Ting, N. Ramachandra, K. Hawkins, *From the Inner to Outer Milky Way: A Photometric Sample of 2.6 Million Red Clump Stars*, 2020, MNRAS, 495, 3087
 - In this work, I select red clump stars from the ~ 200 million stars which have photometry from 2MASS, AllWISE, *Gaia*, and Pan-STARRS. I do this by inferring the effective temperature, surface gravity, and the asteroseismic parameters (period spacing and frequency separation) using a Mixture Density network. The final result is a sample of ~ 2.6 million red clump stars with a contamination rate of $\sim 33\%$. This is the largest and most distant sample of red clump stars with $> 75,000$ stars at distances > 10 kpc.
1. **M. Lucey**, K. Hawkins, M. Ness, M. Asplund, T. Bensby, L. Casagrande, S. Feltzing, K.C. Freeman, C. Kobayashi, A.F. Marino, *The COMBS survey - I. The Chemical Origins of Metal-Poor Stars in the Galactic Bulge*, 2019, MNRAS, 488, 2283
 - This paper is the first part of the Chemical Origins of Metal-poor Bulge Stars (COMBS) survey that will chemo-dynamically characterize the metal-poor bulge population. In this work, I determined the stellar parameters of 26 stars and their elemental abundances for 22 elements using $R \sim 47,000$ VLT/UVES spectra and contrast their elemental properties with that of other Galactic stellar populations. I found that the elemental abundances we derive for our metal-poor bulge stars have lower overall scatter than typically found in the halo. This indicates that these stars may be a distinct bulge population.

CO-AUTHOR PUBLICATIONS

3. K. Hawkins, **M. Lucey**, J. Curtis, *The Chemical Nature of the Young 120-Myr-old Nearby Pisces-Eridanus Stellar Stream Flowing through the Galactic Disk*, 2020, MNRAS, 496, 2422
 - I proposed for and collected the data using the Tull spectrograph on the 2.7m telescope at McDonald Observatory.
2. K. Hawkins, **M. Lucey**, Y.-S. Ting, A. Ji, D. Katzberg, M. Thompson, K. El-Badry, J. Teske, T. Nelson, A. Carrillo, *Identical or fraternal twins? : The chemical homogeneity of wide binaries from Gaia DR2*, 2020, MNRAS, 492, 1164
 - I collected the data using the Tull spectrograph on the 2.7m telescope at McDonald Observatory.
1. B. Pope, G. Davies, K. Hawkins, T. White, A. Stokholm, A. Bieryla, D. Latham, **M. Lucey**, C. Aerts, S. Aigrain, V. Antoci, T. Bedding, D. Bowman, A. Chontos, G. Esquerdo, D. Huber, P. Jofré, S. Murphy, T. van Reeth, V. Aguirre, J. Yu, *The Kepler Smear Campaign I: An Asteroseismic Catalogue of Bright Red Giants*, 2019, ApJ, 244, 18
 - I performed the spectroscopic stellar parameter and chemical abundance analysis.

GRANTS, AWARDS AND FELLOWSHIPS

NSF Graduate Research Fellow	2020-Present
Frank N. Edmonds, Jr. Memorial Fellowship in Astronomy	2019
Kavli Summer Program in Astrophysics Fellow	2019
University of Texas at Austin Graduate School Fellowship	2018
David and Karen Smith Cowperthwaite Award for Excellence in Physics	2018
Keller Venture Grant (\$1,200)	2016
Nominated for Euclid Scholarship	2016

AWARDED TELESCOPE TIME

PI: McDonald Obs. 2.7m, 6 nights	2019
→ <i>Chemically Characterizing a Newly Discovered Stellar Stream</i>	
Co-I: McDonald Obs. 2.7m, 6 nights (PI:Andreia Carrillo)	2019
→ <i>Detailed chemical abundances of Gaia-Enceladus stars</i>	
Co-I: McDonald Obs. 2.7m, 5 nights (PI:Keith Hawkins)	2018
→ <i>The Chemical Homogeneity of Wide Binaries in Gaia DR2</i>	
Co-I: WIYN 3.5m, 4 nights (PI:Natalie Gosnell)	2018
→ <i>Clusters with K2: systematics from membership and binarity</i>	

OBSERVING EXPERIENCE

McDonald Obs, VIRUS-W - 4 nights	2020
McDonald Obs, Tull spectrograph - 17 nights	2018, 2019
WIYN, Hydra Multi-Fiber Spectrograph – 1 night	2018

TEACHING EXPERIENCE

Teaching Assistant	
Introductory Astronomy	Fall & Spring 2019
Learning Assistant	
Introductory Physics I & II	2015–2018
Tutoring	
Math and Physics Department	2015–2018

NOTABLE PRESENTATIONS

Invited Talks

Board of Visitors Meeting, University of Texas at Austin, *Uncovering Galactic Fossils from the Early Universe*, 2020

Colorado College Across the Country: Change-makers Who are Defining the CC Experience, *Astronomy in Thailand: Inspiring Young Scientists*, 2018

Colorado College Venture Grant Forum, *Astronomy in Thailand: Inspiring Young Scientists*, 2017

Poster Presentations

American Astronomical Society Meeting Abstracts, 237, *The COMBS Survey - II. Distinguishing the Metal-Poor Bulge from the Halo Interlopers*, 2021

Frank N. Bash Symposium *Selecting a Pristine Sample of 5 Million Red Clump Stars*, 2019

American Astronomical Society Meeting Abstracts, 231, *Cataloging the Praesepe Cluster: Identifying Interlopers and Binary Systems*, 2018

Colorado College Summer Collaborative Research Experience Symposium, *Cataloging the Praesepe Cluster: Identifying Interlopers and Binary Systems*, 2017

Seminars

University of Texas at Austin, *The COMBS Survey*, 2020

Kavli 2019 Alumni Event, *The COMBS Survey*, 2020

University of Texas at Austin, *Galaxy Formation with the Milky Way*, 2020

Kavli Summer Program in Astrophysics, *Declumping the Red Clump*, 2019

University of Texas at Austin, *The COMBS Survey*, 2019

Senior Thesis Presentation, *Cataloging the Praesepe Cluster*, 2018

Public Talks

Astronomy on Tap ATX, *Why Stars are Better than Everything Else*, 2020

Frank N. Bash Visitor's Center at McDonald Observatory, *Uncovering Galactic Fossils from the Early Universe*, 2019

STUDENT MENTORSHIP

Alice Luna, undergraduate, now PhD student at U. Chicago

2020-2021

DEPARTMENTAL SERVICE

Graduate Recruitment, University of Texas at Austin

2020 & 2021

Task Force to Reform the Graduate Program, University of Texas at Austin August 2020-May 2021

COMMUNITY ENGAGEMENT

GUMMY, Graduate Mentor

Jan 2018–Present

Astronomy on Tap ATX, Social Media Coordinator

May 2018–Present

Girl Day, Organizer, University of Texas at Austin

February 2019–Present

AWARE, University of Texas at Austin

Sept 2018–Present

Women in STEM, Colorado College

Jan 2017–May 2018

Astronomy in Thailand: Inspiring Young Scientists,

Oct 2016–Jan 2017

COMPUTING SKILLS

Languages: Python, IDL, SQL/ADQL, LaTeX, bash/shell, git

Packages: TensorFlow, Pytorch, Scikit learn, Pandas

Software: BACCHUS, IRAF, TOPCAT, iSpec, SME