Kareem El-Badry

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Research Interests

binary stars, stellar mass black holes, white dwarfs;
near-field cosmology, galactic archaeology, globular clusters;
galaxy formation, low-mass galaxies, stellar feedback

Education

Ph.D., Astrophysics, University of California, Berkeley — 2021 (anticipated)
Advisors: Eliot Quataert, Dan Weisz

M.A., Astrophysics, University of California, Berkeley — 2018
B.S., Astrophysics, *summa cum laude*, Yale University — 2016
Advisor: Marla Geha

Research Positions

Graduate Student, UC Berkeley — 2016–
Kavli Summer Research Fellow, CCA, NYC — 2018
Summer Visiting Researcher, MPIA, Heidelberg — 2017 – 2019
Summer Undergraduate Research Fellow, Caltech — 2015
Undergraduate Research Assistant, Yale — 2015 – 2016
Dean's Summer Research Fellow, Yale — 2014

Honors & Awards

Robert J. Trumpler Award, Berkeley — 2020
CCAPP Price Prize in Cosmology and AstroParticle Physics — 2018
NSF Graduate Research Fellowship — 2016 – 2021
Berkeley Fellowship — 2016 – 2018
Hellman Award for Graduate Study — 2016 – 2018
George Beckwith Prize in Astronomy, Yale — 2016
Phi Beta Kappa, Yale — 2015
Jerry Inskeep Memorial Scholarship, Yale — 2014

Awarded Telescope Time

PI: MPG/ESO La Silla 2.2m - 140 hours — 2020
Searching for detached black holes with FEROS
PI: Lick Shane 3m - 15 nights — 2020
A search for detached black holes in binaries
PI: MPG/ESO La Silla 2.2m - 60 hours — 2020
A search for detached black holes in binaries
PI: Lick Shane 3m - 5 nights — 2020
A search for detached black holes in binaries
CO-I: Keck - 2 nights (PI: Alexie Leauthaud) — 2019
Testing the Feedback-driven Breathing Mode in Dwarf Galaxies at $z \approx 0.1$
CO-I: La Silla MPG 2.2 m - 150 hours (PI: Hans-Walter Rix) — 2019
Wide Binaries as Fundamental Calibrators of Galactic Archeology
CO-I: Magellan - 3 nights (PI: Yuan-Sen Ting) — 2018
The Chemical Homogeneity of Wide Binaries in Gaia DR2
CO-I: McDondald - 5 nights (PI: Keith Hawkins) — 2018
The Chemical Homogeneity of Wide Binaries in Gaia DR2
CO-I: Keck - 7 nights total (PI: Tucker Jones) — 2017, 2018

Dissecting Galaxy Formation and Testing Feedback Models on 100 pc Scales: An OSIRIS Survey of Lensed Galaxies at $z = 2$

CO-I: Keck - 2.5 nights (PI: Dan Weisz) 2017

Stellar Chemistry in Isolated Dwarf Galaxies

PI: Palomar Hale 200 inch - 1 night 2015

Probing Radial Star-Formation Histories of Isolated Dwarf Galaxies

CO-I: Keck - 1 night (PI: Andrew Wetzel) 2015

Constraining Star-Formation Quenching Mechanisms using Isolated Low-Mass Galaxies

Awarded Supercomputing Time

PI: NERSC Cori/KNL unlimited Early Access - 4.7 M cpu-hours 2017

Simulating the Formation of Dwarf Galaxies

Observing Experience

Public data – significant experience with data from Gaia, Kepler/K2, TESS, LAMOST, SDSS, ZTF

Keck DEIMOS – 2.5 nights 2017

Lick Shane telescope, KAST Spectrograph – 1 night 2016

Palomar Hale telescope, Wide-Field IR Camera – 1 night 2015

Keck ESI – 3 nights 2015, 2016

WIYN, Hydra Multi-Fiber Spectrograph – 2 nights 2014

Arecibo, L-Band HI – 2 nights 2013, 2014

Journal Referee

A&A, ApJ, ApJL, MNRAS, MNRASL 11 papers total; 2017 –

Student mentoring

Pranav Nagarajan (Berkeley undergrad) 2020–

Mapping the Local Group with RR Lyrae stars

Nick Choksi (Berkeley undergrad; now Berkeley grad student) 2018 – 2019

Forecasting high-redshift observations of globular cluster formation

Teaching Experience

Co-Instructor, Astro 375, *Graduate Pedagogy*, UC Berkeley 2019

Sole Instructor, *Stellar Physics*, Hyeonpung High School, Daegu, South Korea 2019

Graduate Student Instructor, Astro 128, *Astronomy Data Lab*, UC Berkeley 2019, 2020

Course Designer, Astro 128, *Astronomy Data Lab*, UC Berkeley 2018, 2019

Graduate Student Instructor, Astro 160, *Stellar Physics*, UC Berkeley 2018

Graduate Student Instructor, Astro 7A, *Introduction to Astronomy*, UC Berkeley 2017

Graduate Student Instructor, Astro C12, *The Planets*, UC Berkeley 2017

Tutor & Grader, Math 120, *Multivariable Calculus*, Yale 2013 – 2016

Tutor, Math 111, *College Algebra*, Umpqua Community College 2013

Recent Talks

A stripped-companion origin for Be stars – Bildsten group meeting, KITP 2020

Caught in the act: a stripped-companion origin for Be stars – Lunch talk, UC Berkeley 2020

Be stars masquerading as black holes – Special discussion on HR 6819, compact objects group, CCA 2020

Black holes in detached binaries – Virtual ZTF theory meeting 2020

Wide binaries as probes of star formation and dynamical evolution – Astronomy seminar, U. Chicago 2019

Hunting for black holes in detached Galactic binaries – KIPAC Tea Talk, SLAC 2019

Separated at birth? An unexpected population of identical-twin binaries – Lunch talk, UC Berkeley 2019

Wide binaries as probes of star formation and evolution – Astronomy seminar, Boston University 2019

Wide binaries as dynamical probes – Galaxies and cosmology seminar, Harvard CFA 2019

Binary stars in wide-field surveys – Tea talk, Caltech 2019
Twin binaries – The Milky Way 2019: LAMOST and other Leading Survey meeting, Yichang, China 2019
Wide binaries as probes of star formation and evolution – Charles University, Prague, Czech Republic 2019
Wide binaries in 2019 – Universe of Binaries meeting, Telč, Czech Republic 2019
Gas kinematics of low-mass galaxies – CosmoDwarfs meeting, Durham, UK 2019
Conduction and cooling in supernovae-driven superbubbles – Galaxy coffee, MPIA, Heidelberg 2019
A new model for superbubbles driven by clustered supernovae – Lunch talk, UC Berkeley 2019
Successes and challenges in modeling low-mass galaxies – FLASH seminar, UC Santa Cruz 2019
Successes and challenges in modeling low-mass galaxies – Cosmology seminar, UC Davis 2019
The globular cluster systems of low-mass halos – Lorentz Center workshop, Leiden, Netherlands 2019
Feedback in low-mass galaxies at high redshift – Near/Far workshop, Napa, CA 2018
White dwarf demographics with Gaia – Lunch talk, UC Berkeley 2018
The binary fraction and metallicity – GSPS, UC Berkeley 2018
Dwarf galaxies as laboratories for astrophysics and cosmology – CCAPP Price Prize lecture, Ohio State 2018
Stars re-shaping galaxies – Galactic angular momentum focus group, IAU, Vienna, Austria 2018
Thermal conduction in superbubble evolution – KSPA, CCA, NYC 2018
What can Gaia do for white dwarfs? – Lunch talk, CCA, NYC 2018
The formation and hierarchical assembly of globular clusters – Galaxy coffee, MPIA, Heidelberg 2018
What do globular clusters tell us about the high-redshift universe? – Galaxy lunch, Yale 2018
How to fit a stellar spectrum – GSPS, UC Berkeley 2018
Gas kinematics from unresolved HI data – Lunch talk, UC Berkeley 2018
Globular cluster formation scenarios – Near/Far workshop, Napa, CA 2017
How to find long-period spectroscopic binaries – Lunch talk, UC Berkeley 2017
A self-consistent model for binary star spectra – SFB seminar, ARI, Heidelberg 2017
Effects of stellar feedback on dwarf galaxy evolution – Galaxy coffee, MPIA, Heidelberg 2017
Angular momentum of low-mass halos (poster) – Galaxy-Halo Connection Workshop, KITP 2017
Does the IMF vary in ultrafaint galaxies? – GSPS, UC Berkeley 2017
What regulates disk formation in low-mass galaxies? – Lunch talk, UC Berkeley 2017
Small-scale problems in ΛCDM: feedback to the rescue? – GalForm seminar, UC Berkeley 2017
Dust and the simulated SED – Near/Far Workshop, Santa Rosa, CA 2016
Dynamical modeling of low-mass galaxies – Lunch talk, UC Berkeley 2016
Can baryonic feedback save ΛCDM on small scales? – undergraduate thesis talk, Yale 2016

Publications (40 total; 17 first author; 600+ first-author citations)

40. Stern, J., Faucher-Giguère, C.-A., Fielding, D., Quataert, E., Hafen, Z., Gurvich, A. B., Ma, X., Byrne, L., **El-Badry, K.**, Anglès-Alcàzar, D., Chan, T.-K., Feldmann, R., Kereš, D., Wetzel, A., Murray, N., Hopkins, P. F., 2020, "Virialization of the inner CGM in the FIRE simulations and implications for galaxy discs, star formation and feedback", arXiv: 2006.13976, MNRAS, submitted.

39. **El-Badry, K.** and Quataert, E., 2020, "A stripped-companion origin for Be stars: clues from the putative black holes HR 6819 and LB-1", arXiv:2006.11974, MNRAS, submitted.

38. Li, F., Rahman, M., Murray, N., Hafen, Z., Faucher-Giguère, C.-A., Stern, J., Hummels, C. B., Hopkins, P. F., **El-Badry, K.**, Kereš, D., 2020, "Probing the CGM of low-redshift dwarf galaxies using FIRE simulations", MNRAS, submitted.

37. Lazar, A., Bullock, J. S., Boylan-Kolchin, M., Chan, T.-K., Hopkins, P. F., Graus, A., Wetzel, A., **El-Badry, K.**, Wheeler, C., Straight, M. C., Kereš, D., Faucher-Giguère, C.-A., Fitts, A., Garrison-Kimmel, S., 2020, "A dark matter profile to model diverse feedback-induced core sizes of ΛCDM haloes", arXiv:2004.10817, MNRAS, submitted.

36. Coronado, J., Rix, H.-W., Trick, W., **El-Badry, K.**, Rybizki, J., Xiang, M., 2020, "From birth associations to field stars: mapping the small-scale orbit distribution in the Galactic disc", arXiv:2002.09496, MNRAS, accepted.

35. Santistevan, I. B., Wetzel, A., **El-Badry, K.**, Bland-Hawthorn, J., Boylan-Kolchin, M., Bailin, J., Faucher-Giguère, C.-A., Benincasa, S., 2020, "Growing pains: the formation times and building blocks of Milky Way-mass galaxies in the FIRE simulations", arXiv:2001.03178, MNRAS, in press.

34. Pelliccia, D., Mobasher, B., Darvish, B., Lemaux, B. C., Lubin, L. M., Hirtenstein, J., Shen, L., Wu, P.-F., **El-Badry, K.**, Wetzel, A., Jones, T., 2020, "Effects of stellar feedback on stellar and gas kinematics of star-forming galaxies at $0.6 < z < 1.0$", arXiv:2001.00590, ApJL, accepted.

33. **El-Badry, K.** and Quataert, E., 2019, "Not so fast: LB-1 is unlikely to contain a $70\,M_\odot$ black hole", arXiv:1912.04185, MNRASL, 2020, 493, 22.

32. Hafen, Z., Faucher-Giguère, C.-A., Anglès-Alcàzar, D., Stern, J., Kereš, D., Esmerian, C., Wetzel, A., **El-Badry, K.**, Chan, T.-K., Murray, N., 2019, "The fates of the circumgalactic medium in the FIRE simulations", arXiv:1910.01123, MNRAS, 494, 3581.

31. Tian, H.-J., **El-Badry, K.**, Rix, H.-W., Gould, A., 2019, "The separation distribution of ultrawide binaries across galactic populations", arXiv:1909.04765, ApJS, 246, 4.

30. Hawkins, K., Lucey, M., Ting, Y.-S., Ji, A., Katzberg, D., Thompson, M., **El-Badry, K.**, Teske, J., Nelson, T., Carrillo, A., 2019, "Identical or fraternal twins?: The chemical homogeneity of wide binaries from *Gaia* DR2", arXiv:1912.08895, MNRAS, 492, 1164.

29. **El-Badry, K.**, Rix, H.-W., Tian, H., Duchêne, G., Moe, M., 2019, "Discovery of an equal-mass "twin" binary population reaching 1000+ AU separations", arXiv:1906.10128, MNRAS, 489, 5822.

28. Jahn, E. D., Sales, L. V., Wetzel, A., Boylan-Kolchin, M., Chan, T.K., **El-Badry, K.**, Lazar, A., Bullock, J. S., 2019, "Dark and luminous satellites of LMC-mass galaxies in the FIRE simulations", MNRAS, 489, 5348.

27. Samuel, J., Wetzel, A., Tollerud, E., Garrison-Kimmel, S., Loebman, S., **El-Badry, K.**, Hopkins, P.F., Boylan-Kolchin, M., Faucher-Giguère, C.-A., Bullock, J., Benincasa, S., Bailin, J., 2019, "A profile in FIRE: resolving the radial distributions of satellite galaxies in the Local Group with simulations", arXiv:1904.11508, MNRAS, 491, 1471

26. Garrison-Kimmel, S., Wetzel, A., Hopkins, P. F., Sanderson, R., **El-Badry, K.**, Graus, A., Chan, T.K., Feldmann, R., Boylan-Kolchin, M., Hayward, C., Bullock, J. S., Fitts, A., Samuel, J., Wheeler, C., Kereš, D., Faucher-Giguère, C.-A., 2019, "Star formation histories of dwarf galaxies in the FIRE simulations: dependence on mass and Local Group environment", arXiv:1903.10515, MNRAS, 489, 4574.

25. **El-Badry, K.**, Ostriker, E. O., Kim, C.-G., Quataert, E., Weisz, D. R., 2019, "Evolution of supernovae-driven superbubbles with conduction and cooling", arXiv:1902.09547, MNRAS, 490, 1961.

24. Dickey, C. M., Geha, M., Wetzel, A., **El-Badry, K.**, 2019, "AGN all the way down? AGN-like line ratios are common in the lowest-mass isolated quiescent galaxies", arXiv:1902.01401, ApJ, 884, 180.

23. Emami, N., Siana, B., Weisz D. R., Johnson, B. D., Ma, X., **El-Badry, K.**, 2018, "A closer look at bursty star formation with $L_{\mathrm{H}\alpha}$ and L_{UV} distributions", arXiv:1809.06380, ApJ, 881, 71.

22. Fitts, A., Boylan-Kolchin, M., Bozek, B., Bullock, J. S., Graus, A., Robles, V., Hopkins P. F., **El-Badry, K.**, Garrison-Kimmel, S., Faucher-Giguère, C.-A., Wetzel, A., Kereš, D., 2018, "Dwarf galaxies in CDM, WDM, and SIDM: disentangling baryons and dark matter physics", arXiv: 1811.11791, MNRAS, 490, 962.

21. Hafen, Z., Faucher-Giguère, C.-A., Anglès-Alcàzar, D., Stern, J., Kereš, D., Hummels, C., Esmerian, C., Garrison-Kimmel, S., **El-Badry, K.**, Wetzel, A., Chan, T. K., Hopkins, P. F., Murray, N., 2018, "The origins of the circumgalactic medium in the FIRE simulations", arXiv:1811.11753, MNRAS, 488, 1.

20. Hirtenstein, J., Jones T., Wang, X., Wetzel, A., **El-Badry, K.**, Hoag, A., Treu, T., Bradač, M., Morishita, T., 2018, "The OSIRIS lens-amplified survey (OLAS) I: dynamical effects of stellar feedback in low mass galaxies at $z \sim 2$", arXiv:1811.11768, ApJ, 880, 54.

19. **El-Badry, K.,** 2019, "The geometric challenge of testing gravity with wide binaries", arXiv:1810.13397, MNRAS, 482, 5018.

18. **El-Badry, K.** and Rix, H.-W., 2019, "The wide binary fraction of solar-type stars: emergence of metallicity dependence at $a < 200$ AU", arXiv:1809.06860, MNRASL, 482, 139.

17. **El-Badry, K.** and Rix, H.-W., 2018, "Imprints of white dwarf recoil in the separation distribution of Gaia wide binaries", arXiv:1807.06011, MNRAS, 480, 4884.

16. Garrison-Kimmel, S., Hopkins, P. F., Wetzel, A., Bullock, J., Boylan-Kolchin, M., Kereš, D., Faucher-Giguère, C.-A., **El-Badry, K.**, Lamberts, A., Quataert, E., Sanderson R. E., 2018, "The Local Group on FIRE: Dwarf galaxy populations across a suite of hydrodynamic simulations", arXiv:1806.04143, MNRAS, 487, 1380.

15. Debattista, V. P., Gonzalez O. A., Sanderson R. E., **El-Badry, K.,** Garrison-Kimmel, S., Wetzel, A., Faucher-Giguère, C.-A., Hopkins, P. F., 2018, "Formation, vertex deviation and age of the Milky Way's bulge: input from a cosmological simulation with a late-forming bar", arXiv:1805.12199, MNRAS, 485, 5073.

14. **El-Badry, K.**, Rix, H.-W., Weisz, D. R. 2018, "An empirical measurement of the initial-final mass relation with Gaia white dwarfs", arXiv:1805.05849, ApJL, 860, 17.

13. **El-Badry, K.**, Quataert, E., Weisz, D. R., Choksi, N., Boylan-Kolchin, M. 2019, "The formation and hierarchical assembly of globular cluster populations", arXiv:1805.03652, MNRAS, 482, 4528.

12. **El-Badry, K.**, Bland-Hawthorn, J., Wetzel, A., Quataert, E., Weisz, D. R., Boylan-Kolchin, M., Hopkins, P. F., Faucher-Giguère, C.-A., Kereš, D., Garrison-Kimmel, S. 2018, "Where are the most ancient stars in the Milky Way?", arXiv:1804.00659, MNRAS, 480, 652.

11. Fitts, A., Boylan-Kolchin, M., Bullock, J., Weisz, D. R., **El-Badry, K.**, Wheeler, C., Faucher-Giguère, C.-A., Quataert, E., Hopkins, P. F., Kereš, D., Wetzel, A., 2018, "No assembly required: mergers are mostly irrelevant for the growth of low-mass dwarf galaxies", arXiv:1801.06187, MNRAS, 479, 319.

10. **El-Badry, K.**, Bradford, J., Quataert, E., Geha, M., Boylan-Kolchin, M., Weisz, D. R., Wetzel, A., Hopkins, P. F., Chan, T. K., Fitts, A., Kereš, D., Faucher-Giguère, C.-A. 2018, "Gas kinematics in FIRE simulated galaxies compared to spatially unresolved HI observations", arXiv:1801.03933, MNRAS, 477, 1536.

9. Garrison-Kimmel, S., Hopkins, P. F., Wetzel, A., **El-Badry, K.**, Sanderson R. E., Bullock, J., Ma, X., van de Voort, F., Hafen, Z., Faucher-Giguère, C.-A., Hayward, C. C., Quataert, E., Kereš, D., Boylan-Kolchin, M., 2018, "The origin of the diverse morphologies and kinematics of Milky Way-mass galaxies in the FIRE-2 simulations", arXiv:1712.03966, MNRAS, 481, 4133.

8. Chan, T. K., Kereš, D., Wetzel, A., Hopkins, P. F., Faucher-Giguère, C.-A., **El-Badry, K.**, Garrison-Kimmel, S., Boylan-Kolchin, M. 2017, "The origin of ultra diffuse galaxies: stellar feedback and quenching", arXiv:1711.04788, MNRAS, 478, 906.

7. **El-Badry, K.**, Ting, Y.-S., Rix, H.-W., Quataert, E., Weisz, D. R., Cargile, P., Conroy, C., Hogg, D. W., Bergemann, M., Liu, C., 2018, "Discovery and characterization of 3000+ main-sequence binaries from APOGEE spectra", arXiv:1711.08793, MNRAS, 476, 528.

6. **El-Badry, K.**, Rix, H.-W., Ting, Y.-S., Weisz, D. R., Bergemann, M., Cargile, P., Conroy, C., Eilers, A.-C. 2018, "Signatures of unresolved binaries in stellar spectra: implications for spectral fitting", arXiv:1709.03983, MNRAS, 473, 5043.

5. Hopkins, P. F., Wetzel, A., Kereš, D., Faucher-Giguère, C.-A., Quataert, E., Boylan-Kolchin, M., Murray, N; Hayward, C. C., **El-Badry, K.** 2017, "How to model supernovae in simulations of star and galaxy formation", arXiv:1707.07010, MNRAS, 477, 1578.

4. **El-Badry, K.**, Quataert, E., Wetzel, A., Hopkins, P. F., Weisz, D. R., Chan, T. K., Fitts, A., Boylan-Kolchin, M., Kereš, D., Faucher-Giguère, C.-A., Garrison-Kimmel, S. 2018, "Gas kinematics, morphology, and angular momentum in the FIRE simulations", arXiv:1705.10321, MNRAS, 473, 1930.

3. **El-Badry, K.**, Weisz, D. R., Quataert, E. 2017, "The statistical challenge of constraining the low-mass IMF in Local Group dwarf galaxies", arXiv:1701.02347, MNRAS, 468, 319.

2. **El-Badry, K.**, Wetzel, A., Geha, M., Quataert, E., Hopkins, P. F., Kereš, D., Chan, T. K., Faucher-Giguère, C.-A. 2017, "When the Jeans do not fit: How stellar feedback drives stellar kinematics and complicates dynamical modeling in low-mass galaxies", arXiv:1610.04232, ApJ, 835, 193.

1. **El-Badry, K.**, Wetzel, A., Geha, M., Hopkins, P. F., Kereš, D., Chan, T. K., Faucher-Giguère, C.-A. 2016, "Breathing FIRE: How stellar feedback drives radial migration, rapid size fluctuations, and population gradients in low-mass galaxies", arXiv:1512.01235, ApJ, 820, 131.

Skills

Computer Languages	Python, C/C++, Fortran, Stan, SQL/ADQL, R, Mathematica, LaTeX, bash, git
Parallel Computing	MPI, OpenMP, Python multiprocessing
Machine Learning	PyTorch, TensorFlow
Other Software	GIZMO, Athena++, MUSIC, MESA, FSPS, GALFIT, TOPCAT, MS Paint™
Language	German (fluent), Spanish (conversational)