

# 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, <i>summa cum laude</i> , Yale University	2016
Advisor: Marla Geha	

## RESEARCH POSITIONS

Graduate Student, UC Berkeley	2016–
Kavli Summer Research Fellow, CCA, NYC	2018
Summer Visiting Researcher, MPA, 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: Lick Shane 3m - 10 nights	2020
<i>A search for detached black holes in binaries</i>	
PI: MPG/ESO La Silla 2.2m - 60 hours	2020
<i>A search for detached black holes in binaries</i>	
PI: Lick Shane 3m - 5 nights	2020
<i>A search for detached black holes in binaries</i>	
CO-I: Keck - 2 nights (PI: Alexie Leauthaud)	2019
<i>Testing the Feedback-driven Breathing Mode in Dwarf Galaxies at <math>z \approx 0.1</math></i>	
CO-I: La Silla MPG 2.2m - 150 hours (PI: Hans-Walter Rix)	2019
<i>Wide Binaries as Fundamental Calibrators of Galactic Archeology</i>	
CO-I: Magellan - 3 nights (PI: Yuan-Sen Ting)	2018
<i>The Chemical Homogeneity of Wide Binaries in Gaia DR2</i>	
CO-I: McDondald - 5 nights (PI: Keith Hawkins)	2018
<i>The Chemical Homogeneity of Wide Binaries in Gaia DR2</i>	
CO-I: Keck - 7 nights total (PI: Tucker Jones)	2017, 2018
<i>Dissecting Galaxy Formation and Testing Feedback Models on 100 pc Scales: An OSIRIS Survey of Lensed Galaxies at <math>z = 2</math></i>	

CO-I: Keck - 2.5 nights (PI: Dan Weisz)	2017
<i>Stellar Chemistry in Isolated Dwarf Galaxies</i>	
PI: Palomar Hale 200 inch - 1 night	2015
<i>Probing Radial Star-Formation Histories of Isolated Dwarf Galaxies</i>	
CO-I: Keck - 1 night (PI: Andrew Wetzel)	2015
<i>Constraining Star-Formation Quenching Mechanisms using Isolated Low-Mass Galaxies</i>	

## AWARDED SUPERCOMPUTING TIME

PI: NERSC Cori/KNL unlimited Early Access - 4.7 M cpu-hours	2017
<i>Simulating the Formation of Dwarf Galaxies</i>	

## 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 –
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## STUDENT MENTORING

Pranav Nagarajan (Berkeley undergrad)	2020–
<i>Mapping the Local Group with RR Lyrae stars</i>	
Nick Choksi (Berkeley undergrad; now Berkeley grad student)	2018 – 2019
<i>Forecasting high-redshift observations of globular cluster formation</i>	

## TEACHING EXPERIENCE

Co-Instructor, Astro 375, <i>Graduate Pedagogy</i> , UC Berkeley	2019
Sole Instructor, <i>Stellar Physics</i> , Hyeonpung High School, Daegu, South Korea	2019
Graduate Student Instructor, Astro 128, <i>Astronomy Data Lab</i> , UC Berkeley	2019, 2020
Course Designer, Astro 128, <i>Astronomy Data Lab</i> , UC Berkeley	2018, 2019
Graduate Student Instructor, Astro 160, <i>Stellar Physics</i> , UC Berkeley	2018
Graduate Student Instructor, Astro 7A, <i>Introduction to Astronomy</i> , UC Berkeley	2017
Graduate Student Instructor, Astro C12, <i>The Planets</i> , UC Berkeley	2017
Tutor & Grader, Math 120, <i>Multivariable Calculus</i> , Yale	2013 – 2016
Tutor, Math 111, <i>College Algebra</i> , Umpqua Community College	2013

## RECENT TALKS

<i>Caught in the act: a stripped-companion origin for Be stars</i> – Lunch talk, UC Berkeley	2020
<i>Be stars masquerading as black holes</i> – Special discussion on HR 6819, compact objects group, CCA	2020
<i>Black holes in detached binaries</i> – Virtual ZTF theory meeting	2020
<i>Wide binaries as probes of star formation and dynamical evolution</i> – Astronomy seminar, U. Chicago	2019
<i>Hunting for black holes in detached Galactic binaries</i> – KIPAC Tea Talk, SLAC	2019
<i>Separated at birth? An unexpected population of identical-twin binaries</i> – Lunch talk, UC Berkeley	2019
<i>Wide binaries as probes of star formation and evolution</i> – Astronomy seminar, Boston University	2019
<i>Wide binaries as dynamical probes</i> – Galaxies and cosmology seminar, Harvard CFA	2019
<i>Binary stars in wide-field surveys</i> – Tea talk, Caltech	2019
<i>Twin binaries</i> – The Milky Way 2019: LAMOST and other Leading Survey meeting, Yichang, China	2019
<i>Wide binaries as probes of star formation and evolution</i> – Charles University, Prague, Czech Republic	2019

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

## PUBLICATIONS (40 TOTAL; 17 FIRST AUTHOR; 600+ FIRST-AUTHOR CITATIONS)

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40. Stern, J., Faucher-Giguère, C.-A., Fielding, D., Quataert, E., Hafen, Z., Gurvich, A. B., Ma, X., Byrne, L., **El-Badry, K.**, Angèle-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  $\Lambda$ CDM 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  $L_{H\alpha}$  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

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