# Alexander P. Ji

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## RESEARCH INTERESTS: NEAR-FIELD COSMOLOGY

The first stars and galaxies: metal-free stars, first galaxy relics, reionization
The origin of the elements, especially the rapid neutron-capture process
Milky Way halo substructure and the nature of dark matter
High-resolution stellar spectroscopy

## EDUCATION AND APPOINTMENTS

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|---|---|
| **Hubble Fellow**, Observatories of the Carnegie Institution of Washington | Aug 2017 - Present |
| **Ph. D. Physics**, Massachusetts Institute of Technology<br>Advised by Anna Frebel, Astrophysics division | Sep 2012 - Jun 2017 |
| **M.S. Statistics**, Stanford University<br>Focus on Applied Statistics and Machine Learning | Jun 2012 |
| **B. S. Physics**, Stanford University<br>Minor in Computer Science | Jun 2011 |

## HONORS AND AWARDS

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|---|---|
| Hubble Fellowship | 2017-2020 |
| Carnegie Fellowship | Deferred |
| APS DAP Cecilia Payne-Gaposchkin Thesis Award Finalist | Apr 2019 |
| Martin Deutsch Award for Excellence in Experimental Physics, MIT | Sep 2016 |
| Young Scientist at 66th Lindau Nobel Laureate Meeting, Germany | Jun 2016 |
| Best Poster Prize, Nuclei in the Cosmos XIV, Japan | Jun 2016 |
| Henry Kendall Teaching Award, MIT | Sep 2014 |
| Whiteman Fellow, MIT | Sep 2012 - Aug 2013 |
| Outstanding Learning Assistant, American Association of Physics Teachers | Jun 2012 |
| Stanford Alumni Award of Excellence | Jun 2011 |

## INVITED TALKS

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| **Talk** "Chemical evolution in ultra-faint dwarf galaxies", Dwarf Galaxies, Durham | Jul 2019 |
| **Lecture** "Cosmology and First Stars", JINA Frontiers Summer School, MSU | May 2019 |
| **Talk** "Signatures of the First Stars in Relics of the First Galaxies",<br>APS Cecilia Payne-Gaposchkin Doctoral Dissertation Award in Astrophysics Finalist | Apr 2019 |
| **Talk** "Signatures of the First Stars in Relics of the First Galaxies", APS Denver | Apr 2019 |
| **Talk** "r-process nucleosynthesis in the first galaxies", Stellar Archaeology, Tokyo | Dec 2018 |
| **Talk** "Connecting dwarf galaxies to the stellar halo", Metal-Poor Galaxy, Ringberg | Jul 2018 |
| **Talk** "r-process nucleosynthesis in dwarf galaxies", AAS Denver | Jun 2018 |
| **Colloquium** U. Virginia (Joint Physics/Astronomy) | Feb 2018 |
| **Seminar** "A rare and prolific r-process event in Reticulum II", CCAPP/OSU | Oct 2016 |
| **Highlight Talk** "Dwarf galaxy archaeology with Reticulum II", First Stars V, Heidelberg | Aug 2016 |
| **Talk** "A single prolific r-process event preserved in an ultra-faint dwarf galaxy",<br>American Physical Society Hot Topics Session, April Meeting | Apr 2016 |
| **Colloquium** "A rare and prolific r-process event in Reticulum II", University of Toledo | Jan 2016 |

## CONTRIBUTED TALKS AND POSTERS

**Talk** "Lanthanide fractions in neutron star mergers from metal-poor stars", ASU — Mar 2019
**Talk** "Dwarf galaxy archaeology with Reticulum II", UC Irvine — May 2018
**Talk** "A full abundance pattern in Reticulum II", JINA Frontiers — May 2018
**Talk** "Homogeneous Abundances in Ultra-faint Dwarf Galaxies", JINA Forging Connections — Jun 2017
**Talk** "Dwarf galaxy archaeology with Reticulum II", The Galactic Renaissance — Feb 2017
**Seminars** "Dwarf galaxy archaeology with Reticulum II", 7 talks — Apr-Nov 2016
At Caltech, CfA, UCSC, Yale, Carnegie, KIPAC, Tufts
**Poster** "Stellar Abundances in Ultra-faint Dwarf Galaxies", GMT Science Meeting — Sep 2017
**Poster** "A rare and prolific r-process event in Reticulum II", Nuclei in the Cosmos XIV — Jun 2016
**Poster** "Satellite Planes in Caterpillar", Local Group Astrostatistics Conf, U Michigan — Jun 2015
**Poster** "Testing early star formation", Near-Field Far-Field Conf, UC Irvine — Feb 2014

## TEACHING

**Professional Development Program*** ISEE (as team leader, with A. Lanz, S. Uddin) — 2019
**Professional Development Program*** ISEE (with R. McGurk, D. French) — 2018
**Workshop** Carnegie, Scientific Writing Workshop for Undergraduates (with J. Teske) — 2017
**Teaching Assistant** MIT, 8.282/8.284: Intro to Astronomy/Modern Astrophysics — 2014/2016/2017
**Head Teaching Assistant** Stanford, Physics 25/26: Modern Physics — 2012
**Teaching Assistant** Stanford, Physics 63: Electricity, Magnetism, and Waves — 2012
**Teaching Assistant*** Stanford, Physics 62: Classical Mechanics Laboratory — 2010/2011
**Instructor*** Stanford, Physics 91SI: Practical Computing for Scientists — 2011
**Teaching Assistant** Stanford, Physics 24: Electricity and Optics Laboratory — 2011
**Resident Tutor** Stanford CTL, Math, science, and engineering tutoring — 2009 - 2010
**Section Leader** Stanford, CS 106A/B: Programming Methods/Abstractions — 2008 - 2009

* Led or assisted in curriculum development

## SELECTED OUTREACH AND SERVICE

**Referee** for ApJ, MNRAS, A&A
**Public Talk** "Glimpses of the Cosmic Dawn", Huntington Library Astronomy Lectures — Mar 2019
**Public Talk** "Glimpses of the Cosmic Dawn", Carnegie Lunch with an Astronomer — Nov 2017
**Public Talk** "Searching for the First Stars", Carnegie Open House — Oct 2017
**Public Talk** "Glimpses of the Cosmic Dawn", Whitin Observatory at Wellesley — Apr 2017
**Public Talk** "The First Stars", MIT IAP — Jan 2017
**Einstein in the Classroom Instructor** Cambridge Science Festival — Apr 2015
**Public Talk** "The First Stars", MIT IAP — Jan 2015
**Public Talk** "The Universe in a Box", MIT IAP — Jan 2014

## TELESCOPE AND COMPUTING ALLOCATIONS

**Magellan/MIKE** High-resolution spectroscopy, >20 nights (PI)
**Magellan/M2FS** Multi-object spectroscopy, 3 nights (PI)
**Magellan/IMACS** Multi-object spectroscopy, 2 nights (PI)
**VLT/FLAMES** Multi-object spectroscopy, 1.6 nights (PI)
**Gemini/GRACES** High-resolution spectroscopy, 3.4 nights (PI)
**Keck/HIRES** High-resolution spectroscopy, 1 night (Co-I)
**Hubble/ACS** 29 orbits (Co-I)
**XSEDE/Stampede, Comet** 10 million CPU hours (Co-I)

## STUDENT COLLABORATORS

**Graduate Students** Kaley Brauer (MIT, 2017-present, stellar halo models)

**Undergraduates** Fernando Barcelo (Pomona, 2019, Pop III mass function); Jose Arizmendi, Allen Marquez, Ernesto Oropeza (ELAC, 2019, metal-poor star abundances); Sergio Escobar (Caltech, 2018, stellar halo kinematics); Maude Gull (MIT, 2016-2018, r-process star abundances); Madelyn Cain (MIT, 2016-2018, r-process star abundances); Lizhou Sha (MIT, 2016-2017, dark matter simulations; now TESS Quick-Look Pipeline Engineer)

## COLLABORATION MEMBERSHIP

The Southern Stellar Stream Spectroscopic Survey ($S^5$, `https://s5collab.github.io/`, Project Builder)
The *Caterpillar* Project (`https://www.caterpillarproject.org/`, Project Builder)
The Magellanic Satellites Survey (MagLiteS)
The R-Process Alliance (RPA)
DECam Local Volume Exploration Survey (DELVE, `https://delve-survey.github.io/`)

## PRIMARY AUTHOR PUBLICATIONS

First-author papers, or papers where I performed a major part of analysis, writing, and/or advising.

15. **Ji, A. P.**, Drout, M. R., & Hansen, T. T., *The Lanthanide Fraction Distribution in Metal-poor Stars: a Test of Neutron Star Mergers as the Dominant r-process Site*, submitted (arXiv:1905.01814)

14. Frebel, A., **Ji, A. P.**, Ezzeddine, R., Hansen, T. T., Chiti, A., Thompson, I. B., Merle, T. *Chemical abundance Signature of J0023+0307 – A Second-Generation Main-Sequence Star with [Fe/H] $< -6$*, 2019, ApJ, 871, 146

13. Brauer, K., **Ji, A. P.**, Frebel, A., Dooley, G. A., Gomez, F. A., O'Shea, B. W. *The Origin of r-process Enhanced Metal-Poor Halo Stars In Now-Destroyed Ultra-Faint Dwarf Galaxies*, 2019, ApJ, 871, 2

12. **Ji, A. P.**, Simon, J. D., Frebel, A., Venn, K. A., Hansen, T. T. *Chemical Abundances in the Ultra-Faint Dwarf Galaxies Grus I and Triangulum II: Neutron-Capture Elements as a Defining Feature of the Faintest Dwarfs*, 2019, ApJ, 870, 83

11. **Ji, A. P.** & Frebel, A. *From Actinides to Zinc: Using the full abundance pattern of the brightest star in Reticulum II to distinguish between different r-process sites*, 2018, ApJ, 856, 138

10. Safarzadeh, M., **Ji, A. P.**, Dooley, G., Frebel, A., Scannapieco, E., Gomez, F., O'Shea, B. W. *Selecting ultra-faint dwarf candidate progenitors in cosmological N-body simulations at high redshifts*, 2018, MNRAS, 476, 5006

9. Griffen, B. F., Dooley, G., **Ji, A. P.**, O'Shea, B. W., Gomez, F., Frebel, A., *Tracing the origin of the first stars and galaxies within the hierarchical assembly history of the Milky Way*, 2018, MNRAS, 474, 443

8. **Ji, A. P.**, Frebel, A., Ezzeddine, R., Casey, A. R. *Chemical Diversity in the Ultra-faint Dwarf Galaxy Tucana II*, 2016, ApJL, 832, 1

7. **Ji, A. P.**, Frebel, A., Simon, J. D., Chiti, A. *Complete element abundances of nine stars in the r-process galaxy Reticulum II*, 2016, ApJ, 830, 93

6. **Ji, A. P.**, Frebel, A., Chiti, A., Simon, J. D. *R-process enrichment from a single event in an ancient dwarf galaxy*, 2016, Nature, 531, 610

5. Griffen, B. F., **Ji, A. P.**, Dooley, G. A., Gomez, F. A., Vogelsberger, M., O'Shea, B. W., Frebel, A., *The Caterpillar Project: A Large Suite of Milky Way Sized Halos*, 2016, ApJ, 818, 10

4. **Ji, A. P.**, Frebel, A., Simon, J. D., Geha, M., *High-resolution spectroscopy of extremely metal-poor stars in the least evolved galaxies: Bootes II*, 2016, ApJ, 817, 41

3. Frebel, A., Chiti, A., **Ji, A. P.**, Jacobson, H. R., Placco, V. M., *SD 1313–0019 — another second generation star with [Fe/H] = -5.0, observed with the Magellan telescope*, 2015, ApJL, 810, 27

2. **Ji, A. P.**, Frebel, A., Bromm, V., *Preserving chemical signatures of primordial star formation in the first low-mass stars*, 2015, MNRAS, 454, 659

1. **Ji, A. P.**, Frebel, A., Bromm, V., *The chemical imprint of silicate dust on the most metal-poor stars*, 2014, ApJ, 782, 95

## N-TH AUTHOR PUBLICATIONS

I provided telescope resources/data, code, advising, comments, and/or other minor contributions.

12. Kozlowski, S., Bañados, E., . . . , **Ji, A. P.**, . . . , *Discovery of two quasars at $z = 5$ from the OGLE survey*, 2019, ApJ, 878, 115

11. Placco, V., Santucci, R. M., ..., **Ji, A. P.**, ..., *The R-Process Alliance: Spectroscopic Follow-up of Low-metallicity Star Candidates from the Best & Brightest Survey*, 2019, ApJ, 870, 122

10. Kemp, A., Casey, A., ..., **Ji, A. P.**, ..., *On the discovery of K-enhanced and possibly Mg-depleted stars throughout the Milky Way*, 2018, MNRAS, 480, 1384

9. Cain, M. G., Frebel, A., Gull, M., **Ji, A. P.**, ..., *The R-Process Alliance: Chemical Abundances for a Trio of R-Process-Enhanced Stars*, 2018, ApJ, 864, 43

8. Gull, M., Frebel, A., Cain, M. G., Placco, V., **Ji, A. P.**, ..., *The R-Process Alliance: discovery of the first metal-poor star with a combined r- and s-process element signature*, 2018, ApJ, 862, 174

7. Chiti, A., Frebel, A., **Ji, A. P.**, Jerjen, H., Kim, D., Norris, J. E., *Chemical Abundances of New Member Stars in the Tucana II Dwarf Galaxy*, 2018, ApJ, 857, 74

6. Li, T. S., Simon, J. D., ..., **Ji, A. P.**, ..., *Ships Passing in the Night: Spectroscopic Analysis of Two Ultra-Faint Satellites in the Constellation Carina*, 2018, ApJ, 851, 145

5. Hartwig, T., Yoshida, N., ..., **Ji, A. P.**, ..., *Descendants of the first stars: the distinct chemical signature of second generation stars*, 2018, MNRAS 478, 1795

4. Drout, M. R., Piro, A. L., ..., **Ji, A. P.**, ..., *Light Curves of the Neutron Star Merger GW170817/SSS17a: Implications for R-Process Nucleosynthesis*, 2017, Science, 358, 1570

3. Shappee, B. J., Simon, J. D., ..., **Ji, A. P.**, ..., *Early Spectra of the Gravitational Wave Source GW170817: Evolution of a Neutron Star Merger*, 2017, Science, 358, 1574

2. Placco, V. M., Holmbeck, E. M., ..., **Ji, A. P.**, ..., *RAVE J203843.2−002333: The first highly r-process enhanced star identified in the RAVE survey*, 2017, ApJ, 844, 18

1. Dooley, G., Griffen, B. F., Zukin, P., **Ji, A. P.**, Vogelsberger, M., Hernquist, L., Frebel, A., *The effects of varying cosmological parameters on halo substructure*, 2014, ApJ, 786, 50

## UNREFEREED MANUSCRIPTS

4. **Ji, A. P.** et al., *Local Dwarf Galaxy Archaeology*, White Paper submitted to the Astro 2020 Decadal Survey

3. Simon, J. D. et al., *Dynamical Masses for a Complete Census of Local Dwarf Galaxies*, White Paper submitted to the Astro 2020 Decadal Survey

2. Roederer, I. U. et al., *The First Stars and the Origin of the Elements*, White Paper submitted to the Astro 2020 Decadal Survey

1. Roederer, I. U. et al., *The astrophysical r-process and the origin of the heaviest elements*, White Paper submitted to the Astro 2020 Decadal Survey