

# Eli Visbal

University of Toledo  
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<https://evisbal.bitbucket.io/>

## EDUCATION

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### Harvard University

Ph.D., Physics

A.M., Physics

Thesis Advisor: Prof. Abraham Loeb

Cambridge, MA

May 2013

June 2009

### Carnegie Mellon University

B.S., Physics

Research Advisor: Prof. Rupert Croft

Pittsburgh, PA

May 2007

## RESEARCH INTERESTS

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I am a theoretical astrophysicist and cosmologist primarily working to understand the first stars and galaxies, supermassive black hole formation, and cosmic reionization. I utilize numerical simulations, semi-analytic methods, and analytic calculations to make observational predictions for instruments such as the *James Webb Space Telescope*, 21cm observatories, and galaxy line-intensity mapping experiments.

## HONORS AND AWARDS

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Blavatnik Awards For Young Scientists Finalist (\$10,000 unrestricted prize) (2016)

Flatiron Research Fellowship (2016)

Columbia Prize Postdoctoral Fellowship in the Natural Sciences (2013)

Harvard Department of Physics White Teaching Prize (2011)

Harvard University Certificate of Distinction in Teaching (2011)

Phi Beta Kappa (2007)

Carnegie Mellon Senior Leadership Award (2007)

## POSITIONS

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- Assistant Professor, Department of Physics and Astronomy, University of Toledo, September 2019-present

- Flatiron Research Fellow, Center for Computational Astrophysics, Flatiron Institute, September 2016-September 2019
- Columbia Prize Postdoctoral Fellow in the Natural Sciences, Columbia University, July 2013-September 2016
- Research Assistant, Harvard University, January 2008-May 2013, Advisors: Prof. Abraham Loeb & Prof. Lars Hernquist
- Research Assistant, Tel Aviv University, August 2011, Advisor: Prof. Rennan Barkana
- Undergraduate Researcher, Carnegie Mellon, 2005-2007, Advisor: Prof. Rupert Croft
- Columbia University REU, June-August 2005 and 2006, Advisor: Prof. Stefan Westerhoff
- Wright State University REU, June-August 2004, Advisor: Dr. John Ferguson

## GRANTS AWARDED

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Program: National Science Foundation Astronomy and Astrophysics Research Grants

Title: Modeling the Abundance and Distribution of the First Stars and Galaxies

Amount: \$227,367 (3 years, awarded 8/15/2020)

Role: Sole PI, no CO-Is

Program: NASA Astrophysics Theory Program

Title: Modeling Supermassive Black Hole Seed Formation and Growth on Cosmological Scales

Amount: \$241,102 (3 years, awarded 5/16/2022)

Role: Sole PI, no CO-Is

## PUBLICATIONS

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Total papers (refereed or in review): 37

First Author: 18

Second/Third Author: 11

h-index: 25 (Google Scholar, July 2023)

Total Citations: 2,290 (Google Scholar, July 2023)

2 papers published in *Nature*, 1 paper published in *Nature Astronomy*, 1 paper in *Annual Reviews of Astronomy and Astrophysics*

1. Feathers, C., Kulkarni, M., **Visbal, E.**, & Hazlett, R. “A Global Semi-Analytic Model of the First Stars and Galaxies Including Dark Matter Halo Merger Histories”, Submitted to *ApJ*.
2. Shao, H. et al. (including **Visbal, E.**). “A universal equation to predict  $\Omega_m$  from halo and galaxy catalogs”, submitted to *ApJ*.
3. **Visbal, E.**, & McQuinn, M. “Cross Correlation of Pencil-Beam Galaxy Surveys and

- Line-Intensity Maps: An Application of the James Webb Space Telescope”, *ApJ in press* (2023).
4. Shao, H. et al. (including **Visbal, E**). “Robust field-level inference of cosmological parameters with dark matter halos”, *ApJ*, 944, 27 (2023).
  5. Kulkarni, M., **Visbal, E.**, Bryan, G., Li, X. “If Dark Matter is Fuzzy, the First Stars Form in Massive Pancakes”, *ApJL*, 941, L18 (2022).
  6. Gondolo, P., Sandick, P., Shams Es Haghi, B., **Visbal, E.** “Reionization in the Light of Dark Stars”, *ApJ*, 935, 1 (2022)
  7. Vikaeus, A., Zackrisson, E., Schaerer, D., **Visbal, E.**, Fransson, E., Malhotra, S., Rhoads, J., Sahlen, M. “Conditions for detecting lensed Population III galaxies in blind surveys with the James Webb Space Telescope, the Roman Space Telescope and Euclid”, *MNRAS*, 512, 2 (2022).
  8. Essinger-Hileman, T. et al. (including **Visbal, E**). “Experiment for Cryogenic Large-Aperture Intensity Mapping: Instrument design”, *J. of Astronomical Telescopes, Instruments, and Systems*, 7(4), 044004 (2021).
  9. Inayoshi, K., Kashiyama, K., **Visbal, E.**, Haiman, Z. “Gravitational wave backgrounds from coalescing black hole binaries at cosmic dawn: an upper bound”, *ApJ*, 919, 41 (2021).
  10. Kulkarni, M., **Visbal, E.**, & Bryan, G. “The critical dark matter halo mass for Population III star formation: dependence on Lyman-Werner radiation, baryon-dark matter streaming velocity, and redshift”, *ApJ*, 917, 40 (2021).
  11. **Visbal, E.**, Bryan, G., & Haiman, Z. “Self-Consistent Semi-analytic Modeling of Feedback During Primordial Star Formation and Reionization”, *ApJ*, 897, 95 (2020).
  12. Elias, L., Genel, S., Sternberg, A., Devriendt, J., Slyz, A., **Visbal, E.**, Bouché, N., “Detecting the Cosmic Web: Ly $\alpha$  Emission from Simulated Filaments at  $z=3$ ”, *MNRAS*, 494, 5439 (2020).
  13. Inayoshi, K., **Visbal, E.**, & Haiman, Z. “The Assembly of the First Massive Black Holes”, *ARA&A*, Volume 58 (2020).
  14. Kulkarni, M., **Visbal, E.**, & Bryan, G. “Fragmentation in Population III galaxies formed through ionizing radiation”, *ApJ*, 882, 178 (2019).
  15. **Visbal, E.**, & Haiman, Z. “Identifying direct collapse black hole seeds through their small host galaxies”, *ApJL*, 865, L9 (2018).
  16. **Visbal, E.**, & McQuinn, M. “The impact of neutral intergalactic gas on Ly $\alpha$  intensity mapping during reionization”, *ApJL*, 863, L6 (2018).
  17. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “Self-consistent semi-analytic models of the first stars”, *MNRAS*, 475, 5246 (2018).
  18. **Visbal, E.**, Bryan, G. L., & Haiman, Z. “What is the maximum mass of a Population III galaxy?”, *MNRAS*, 469, 1456 (2017).
  19. Regan, J., **Visbal, E.**, Wise, J., Haiman, Z., Johansson, P., & Bryan G. L. “Rapid

- formation of massive black holes near star-bursting proto-galaxies”, *Nature Astronomy*, 1, 0075 (2017).
20. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “Formation of massive Population III galaxies through photoionization feedback: a possible explanation for CR7”, *MNRAS: Letters*, 460, L59 (2016).
  21. Inayoshi, K., Kashiyama, K., **Visbal, E.**, & Haiman, Z. “Gravitational wave background from Population III binary black holes consistent with cosmic reionization”, *MNRAS*, 461, 2722 (2016).
  22. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “Limits on Population III star formation in minihaloes implied by Planck”, *MNRAS*, 453, 4456 (2015).
  23. Inayoshi, K., **Visbal, E.**, & Kashiyama, K. “Direct collapse black hole formation via high-velocity collisions of protogalaxies”, *MNRAS*, 453, 1692 (2015).
  24. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “Looking for Population III stars with He II line intensity mapping”, *MNRAS*, 450, 2503 (2015).
  25. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “Direct collapse black hole formation from synchronized pairs of atomic cooling halos”, *MNRAS*, 445, 1056 (2014).
  26. **Visbal, E.**, Haiman, Z., Terrazas, B., Bryan, G. L., & Barkana, R. “High-redshift star formation in a time-dependent Lyman-Werner background”, *MNRAS*, 445, 107 (2014).
  27. **Visbal, E.**, Haiman, Z., & Bryan, G. L. “A no-go theorem for direct collapse black holes without a strong ultraviolet background”, *MNRAS: Letters*, 442, L100 (2014).
  28. Fialkov, A., Barkana, R., & **Visbal, E.** “The observable signature of late heating of the Universe during cosmic reionization”, *Nature*, 506, 197 (2014).
  29. Fialkov, A., Barkana, R., Pinhas, A., & **Visbal, E.** “Complete history of the observable 21 cm signal from the first stars during the pre-reionization era”, *MNRAS: Letters*, 437, L36 (2014).
  30. Fialkov, A., Barkana, R., **Visbal, E.**, Tseliakhovich, D., & Hirata, C. M. “The signature of the first stars during the Lyman-Werner feedback era”, *MNRAS*, 432, 2909 (2013).
  31. **Visbal, E.**, Barkana, R., Fialkov, A., Tseliakhovich, D., & Hirata, C. M. “The signature of the first stars in atomic hydrogen at redshift 20”, *Nature*, 487, 70 (2012).
  32. **Visbal, E.**, & Loeb, A. “Gauging the contribution of X-ray sources to reionization through the kinetic Sunyaev-Zel’dovich effect”, *JCAP*, 5, 007, (2012).
  33. **Visbal, E.**, Trac, H., & Loeb, A. “Demonstrating the feasibility of line intensity mapping using mock data of galaxy clustering from simulations”, *JCAP*, 08, 10 (2011).
  34. **Visbal, E.**, & Loeb, A. “Measuring the 3D clustering of undetected galaxies through cross correlation of their cumulative flux fluctuations from multiple spectral lines”, *JCAP*, 11, 016 (2010).
  35. **Visbal, E.**, Loeb, A., & Wyithe, J. S. W. “Cosmological constraints from 21cm surveys after reionization”, *JCAP*, 10, 30 (2009).
  36. **Visbal, E.**, & Croft, R. A. C. “On the search for quasar light echoes”, *ApJ*, 674, 660

(2008).

37. Benzvi, S. Y., Connolly, B. M., Matthews, J. A. J., Prouza, M., **Visbal, E.**, & Westerhoff, S. “Measurement of the aerosol phase function at the Pierre Auger Observatory”, *Astroparticle Physics*, 23, 312 (2007).

Preprints:

1. Kovetz, E. et al. (including **Visbal, E.**). “Line-Intensity Mapping: 2017 Status Report”, submitted to *Physics Reports*, arXiv:1709.09066.

Conference Proceedings:

1. Essinger-Hileman, T. et al. (including **Visbal, E.**). “Optical design of the EXperiment for Cryogenic Large-Aperture Intensity Mapping (EXCLAIM)”, *SPIE Proceedings Vol. 11453* (2020).

## TEACHING EXPERIENCE

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- University of Toledo Physics 4130 - Computational Physics, Spring 2020, 2021, 2022, 2023
- University of Toledo Astronomy 2010 - Solar System Astronomy, Fall 2021
- Teaching Fellow, Harvard University, Physics 15a/16 (lab) - Mechanics and Relativity, Spring 2011 & Fall 2012
- Teaching Fellow, Harvard University, Physics 15b - Electricity and Magnetism, Spring 2010
- Teaching Fellow, Harvard University, Physics 15a - Mechanics and Relativity, Fall 2009
- Teaching Fellow, Harvard Summer School, Physics-1ab, Summer 2009
- Teaching Fellow, Harvard University, Physical Sciences 3 - Electromagnetism, Circuits, Waves, Optics, and Imaging, Spring 2009
- Teaching Fellow, Harvard University, Physics 151 - Advanced Classical Mechanics, Fall 2008
- Teaching Fellow, Harvard Summer School, Physics-1ab, Summer 2008
- Physics Upper Class Tutor, Carnegie Mellon University, August 2006 - May 2007
- Teaching Assistant's Assistant, Carnegie Mellon University, Physics I for Science Students, January 2004 - December 2004

## STUDENTS ADVISED

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PhD:

- Ryan Hazlett, University of Toledo, December 2020-present
- Abigail Ambrose, University of Toledo, September 2020-present

- Colton Feathers, University of Toledo, March 2020-present

Undergraduate:

- Thomas Behling, University of Toledo, June 2023-present
- Trevor Blodgett, University of Toledo, August 2022-present
- Willam Jackson, University of Toledo, January 2021-May 2022
- Harish Hemming, University of Toledo, September 2019-June 2022 (now physics PhD student at Arizona State University)
- Jerry Ortiz, Staten Island College, May 2017-May 2018
- Isaac Bautista, Columbia University, May 2016-January 2018

High School:

- Maxwell Chandar-Kouba, Ottawa Hills High School, August 2022-present

## POSTDOCTORAL FELLOWS ADVISED

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- Mihir Kulkarni, University of Toledo, September 2021-present

## PHD THESIS COMMITTEE MEMBER

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University of Toledo: Victor Johnston, James Agostino, Samuel Federman, Matthew Floyd, Grant Donnelly

Other: Mihir Kulkarni (Columbia University)

## PROFESSIONAL ACTIVITIES

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- Science Team Member: *Experiment for Cryogenic Large-aperture Intensity Mapping (EXCLAIM)*, instrument to measure CO and CII line emission from  $z=0-3.5$  galaxies
- Member: *SMAUG (Simulating Multi-scale Astrophysics to Understand Galaxies)*
- Organizer: Joint CCA-STScI *James Webb Space Telescope* Workshops, April/June 2018
- Organizer: CCA 21cm Workshop, December 2016
- Referee: The Astrophysical Journal, Monthly Notices of the Royal Astronomical Society, Physical Review D
- National Science Foundation Astronomy and Astrophysics Grants Panel Member

## SELECTED TALKS

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Invited talks denoted with \*.

- \*University of Washington Dark Science Center Seminar, UW, Seattle, WA. June 2023.
- First Light Conference, MIT, Cambridge, MA. June 2023.
- Present and Future of Line-Intensity Mapping Conference, MPA, Garching, Germany,

April 2023.

- \*University of Notre Dame Astrophysics Seminar, Southbend, IN. December 2022.
- \*Penn State University Astronomy Colloquium, State College, PA. November 2022.
- \*PAX 2022 at MIT, Cambridge, MA. August 2022.
- Reionization and Cosmic Dawn: Looking Forward To the Past, UCB, Berkeley, CA. March 2022.
- SAZERAC 21cm, Virtual Conference. March (2022).
- \*University Of Science And Technology(Bangladesh), Astronomy Club, Web Seminar, October 2021.
- \*College of Wooster Physics Colloquium, Wooster, OH. October 2021.
- \*International Physics Webinar, Pabna University of Science and Technology, Bangladesh, July 2021.
- American Astronomical Society, AAS Meeting 237, Virtual. January 2021.
- SAZERAC SIPS: The First Stars, Virtual Conference, October 2020.
- American Astronomical Society, AAS Meeting 235, Honolulu, HI. January 2020.
- \*University of Alabama Physics Colloquium, Tuscaloosa, AL. March 2019.
- \*University of Toledo Physics Colloquium, Toledo, OH. February 2019.
- \*University of Missouri-Kansas City Physics Colloquium, Kansas City, MO. February 2019.
- \*University of Kansas Physics Colloquium, Lawrence, KS. February 2019.
- \*Southern Methodist University Physics Colloquium, Dallas, TX. January 2019.
- \*University of Washington Astronomy Dept. Seminar, Seattle, WA. August 2018.
- \*Carnegie Mellon Astrophysics Seminar, Pittsburgh, PA. July 2018.
- \*Rutgers University Astrophysics Seminar, Piscataway, NJ. February 2018.
- Cosmological Signal from Cosmic Dawn to the Present, Aspen, CO. February 2018.
- Spectroscopic Surveys with the ELT: A Gigantic Step into the Deep Universe, Toledo, Spain. October 2017.
- Chemical Evolution of the Universe, Tarrytown, NY. September 2017.
- \*Blavatnik Science Symposium, New York, NY. July 2017.
- The Reionization Epoch: New Insights and Future Prospects, Aspen, CO. March 2016.
- \*UPenn Astro Seminar, Philadelphia, PA. February 2016.
- IAU XXIX General Assembly, Honolulu, HI. August 2015.
- European Week of Astronomy and Space Science, Tenerife, Spain. June 2015.
- First Stars, Galaxies, and Black Holes: Now and Then, Groningen, Netherlands. June 2015.
- \*Unsolved Problems in Astrophysics and Cosmology, Budapest, Hungary. July 2014.
- \*Brookhaven National Laboratory Seminar, Upton, NY. January 2013.
- \*UCSB Astrophysics Colloquium, Santa Barbara, CA. March 2012.
- American Astronomical Society, AAS Meeting #218, Boston, MA. May 2011.

- \*Harvard ITC Luncheon, Cambridge, MA. April 2011.
- \*Carnegie Mellon Astrophysics Seminar, Pittsburgh, PA. November 2010.
- Great Lakes Cosmology Workshop, Pittsburgh, PA. June 2008.

## **OUTREACH AND PUBLIC TALKS**

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- Public lecture: “The Puzzle of the First Supermassive Black Holes”, Toledo Astronomical Association, March 2023.
- Public lecture: “The Puzzle of the First Supermassive Black Holes”, Way Library, Perrysburg, OH, September 2022.
- Public lecture: “Unraveling the Mystery of the First Stars and Supermassive Black Holes”, Way Library, Perrysburg, OH, February 2021.
- Public lecture: “The First Stars in the Universe”, Toledo Astronomical Association, October 2019.
- Expert panelist for Q&A following planetarium viewing by local high school students, National Lab Day, University of Toledo, October 2019.