

**Eric J. Zirnststein**  
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Department of Astrophysical Sciences  
Princeton University  
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## **Curriculum Vitae**

### ***EDUCATION***

Ph.D., Physics, University of Alabama in Huntsville, 2014  
M.S., Physics, University of Alabama in Huntsville, 2012  
B.S., Physics, University of Alabama in Huntsville, 2010

### ***PROFESSIONAL CHRONOLOGY***

Research Scholar, Princeton University, July 2021 – Present  
Associate Research Scholar, Princeton University, Oct. 2016 – June 2021  
Research Scientist, Southwest Research Institute, May 2016 – Sept. 2016  
Postdoctoral Researcher, Southwest Research Institute, Sept. 2014 – May 2016  
Research Assistant, University of Alabama in Huntsville, Aug. 2011 – Aug. 2014  
Teaching Assistant, University of Alabama in Huntsville, Aug. 2010 – Aug. 2011

### ***SUMMARY***

Dr. Zirnststein is a research scientist specializing in the simulation and analysis of hydrogen energetic neutral atom (ENA) emission from the solar wind-local interstellar medium interaction. He received his B.S., M.S., and Ph.D. in Physics at the University of Alabama in Huntsville, specializing in Space Science. He developed a numerical code that computes hydrogen ENA fluxes at 1 au for NASA's Interstellar Boundary Explorer (IBEX) mission by post-processing 3D MHD-plasma/kinetic-neutral simulation results of the heliosphere, including the development of time-independent and -dependent algorithms, employing MPI and distributed/shared memory algorithms in C that run on multi-node computer clusters, and simulation/data analysis and visualization/analysis in IDL, MATLAB, and Mathematica. His current research continues the simulation and analysis of observations made by the IBEX mission, as well as supporting the analysis of New Horizon's Solar Wind Around Pluto (SWAP) instrument measurements at the Pluto plasma environment and in the solar wind. He is lead data analyst for the Solar Wind And Pickup Ion (SWAPI) instrument and serves on the science teams for the IMAP-Lo, IMAP-Hi, and IMAP-Ultra instruments, all in development for the Interstellar Mapping and Acceleration Probe (IMAP) mission to be launched in 2025.

Dr. Zirnststein is actively involved with presenting talks/posters at conferences and meetings, convening conference sessions, and refereeing journal articles and NASA proposals. He is co-editor of *Heliosphere News*. He currently serves on the Heliophysics Advisory Committee (2023-2026) for NASA's Science Mission Directorate. As of June 2023, he has authored/co-authored 90 refereed publications (30 first author), 4 Decadal Survey white papers (1 first author), with over 2900 citations and an h-index of 30 (Google Scholar).

## MANUSCRIPTS UNDER REVIEW

- **Zirnstein, E. J.**, Kumar, R., Swaczyna, P., Dayeh, M. A., Heerikhuisen, J., Shrestha, B. L., Szalay, J. R., *Global Heliospheric Termination Shock Strength in the Solar-Interstellar Interaction*, NatAs, under review.
- Rahmanifard, F., Swaczyna, P., **Zirnstein, E. J.**, Heerikhuisen, J., Galli, A., Sokół, J. M., Schwadron, N. A., Möbius, E., McComas, D. J., Fuselier, S. A., *The Effect of Angular Scattering Imposed by Charge Exchange and Elastic Collisions on Interstellar Neutral Hydrogen Atoms*, ApJ, under review.
- Beesley, L. J., Osthus, D., Moran, K. R., Stricklin, M. A., Meadors, G. D., Janzen, P. H., **Zirnstein, E. J.**, Weaver, B. P., Reisenfeld, D. B., *Statistical methods for partitioning ribbon and globally-distributed flux using data from the Interstellar Boundary Explorer*, JASA, under review.

## PUBLICATIONS

### 2023 (11 total, 1 first author)

- Osthus, D., Weaver, B., Beesley, L. J., Moran, K. R., Stricklin, M. A., **Zirnstein, E. J.**, Janzen, P., Reisenfeld, D. B., *Towards Improved Heliosphere Sky Map Estimation with Theseus*, Technometrics, in press, 2023.
- Swaczyna, P., Bzowski, M., Heerikhuisen, J., Kubiak, M. A., Rahmanifard, F., **Zirnstein, E. J.**, Fuselier, S. A., Galli, A., McComas, D. J., Möbius, E., Schwadron, N. A., *Interstellar Conditions Deduced from Interstellar Neutral Helium Observed by IBEX and Global Heliosphere Modeling*, ApJ, 953, 107, doi:10.3847/1538-4357/ace719, 2023.
- Dayeh, M. A., **Zirnstein, E. J.**, Swaczyna, P., McComas, D. J., *Investigating the IBEX Ribbon Structure a Solar Cycle Apart*, ApJ, 952, 19, doi:10.3847/1538-4357/acda8b, 2023.
- Livadiotis, G., McComas, D. J., **Zirnstein, E. J.**, *Temperature of the Polar Inner Heliosheath: Connection to Solar Activity*, ApJ, 951, 21, doi:10.3847/1538-4357/acd1e1, 2023.
- Swaczyna, P., Dayeh, M. A., **Zirnstein, E. J.**, *Spherical Harmonic Representation of Energetic Neutral Atom Flux Components Observed by IBEX*, ApJS, 266, 26, doi:10.3847/1538-4365/accf0f, 2023.
- **Zirnstein, E. J.**, Swaczyna, P., Dayeh, M. A., Heerikhuisen, J., *Constraints on the IBEX Ribbon's Origin from its Evolution over a Solar Cycle*, ApJ, 949, 45, doi:10.3847/1538-4357/acc577, 2023.
- Dayeh, M. A., **Zirnstein, E. J.**, McComas, D. J., *Determining the IBEX Ribbon Transverse Profile from ENA Temporal Variations: A Proof-of-concept for IMAP Observations*, ApJL, 945, L33, doi:10.3847/2041-8213/acbe00, 2023.
- Rankin, J. S., McComas, D. J., **Zirnstein, E. J.**, Burlaga, L. F., Heerikhuisen, J., *Unified Picture of the Local Interstellar Magnetic Field from Voyager and IBEX*, ApJL, 945, L31, doi:10.3847/2041-8213/acbd4e, 2023.
- Brandt, P. C., Bale, S., Cocoros, A., DeMajistre, R., Dialynas, K., Eriksson, S., Fields, B., Galli, A., Hill, M. E., Horanyi, M., Horbury, T., Kollmann, P., Kinnison, J., Fountain, G., Krimigis, S. M., Kurth, W. S., Linsky, J., Lisse, C. M., Mandt, K. E., Magnes, W., McNutt, R. L., Miller, J., Moebius, E., Mostafavi, P., Opher, M., Paxton, L., Plaschke, F., Poppe, A., Provornikova, E., Roelof, E. C., Runyon, K., Redfield, S., Schwadron, N., Sterken, V., Swaczyna, P., Szalay, J., Turner, D., Wimmer-Schweingruber, R., Wurz, P., **Zirnstein, E. J.**, *Future Exploration of the Outer Heliosphere and Very Local Interstellar Medium by Interstellar Probe*, SSRv, 219, 18, doi:10.1007/s11214-022-00943-x, 2023.

- Swaczyna, P., Rahmanifard, F., **Zirnstein, E. J.**, Heerikhuisen, J., *Filtration of Interstellar Neutral Helium by Elastic and Charge Exchange Collisions in Heliospheric Boundaries*, ApJ, 943, 74, doi:10.3847/1538-4357/aca36, 2023.
- Shrestha, B. L., **Zirnstein, E. J.**, McComas, D. J., *Tracking the Rapid Opening and Closing of Polar Coronal Holes through IBEX ENA Observations*, ApJ, 943, 34, doi:10.3847/1538-4357/aca891, 2023.

**2022 (9 total, 3 first author)**

- Livadiotis, G., McComas, D. J., Funsten, H. O., Schwadron, N. A., **Zirnstein, E.**, *Thermodynamics of the Inner Heliosheath*, ApJS, 262, 53, doi:10.3847/1538-4365/ac8b88, 2022.
- **Zirnstein, E. J.**, Shrestha, B. L., McComas, D. J., Dayeh, M. A., Heerikhuisen, J., Reisenfeld, D. B., Sokół, J. M., Swaczyna, P., *Oblique and rippled heliosphere structures from the Interstellar Boundary Explorer*, NatAs, doi:10.1038/s41550-022-01798-6, 2022.
- **Zirnstein, E. J.**, Kim, T. K., Dayeh, M. A., Rankin, J. S., McComas, D. J., Swaczyna, P., *Explanation of Heliospheric Energetic Neutral Atom Fluxes Observed by the Interstellar Boundary Explorer*, ApJL, 937, L38, doi:10.3847/2041-8213/ac92e2, 2022.
- McComas, D. J., Shrestha, B. L., Swaczyna, P., Rankin, J. S., Weidner, S. E., **Zirnstein, E. J.**, Elliott, H. A., Singer, K. N., Spencer, J., Stern, S. A., Weaver, H. A., *First High-resolution Observations of Interstellar Pickup Ion Mediated Shocks in the Outer Heliosphere*, ApJ, 934, 147, doi:10.3847/1538-4357/ac7956, 2022.
- Dayeh, M. A., **Zirnstein, E. J.**, Fuselier, S. A., Funsten, H. O., McComas, D. J., *Evolution of the Heliotail Lobes over a Solar Cycle as Measured by IBEX*, ApJS, 261, 27, doi:10.3847/1538-4365/ac714e, 2022.
- **Zirnstein, E. J.**, Möbius, E., Zhang, M., Bower, J., Elliott, H. A., McComas, D. J., Pogorelov, N. V., Swaczyna, P., *In Situ Observations of Interstellar Pickup Ions from 1 au to the Outer Heliosphere*, SSRv, 218, 28, doi:10.1007/s11214-022-00895-2, 2022.
- Szalay, J. R., Smith, H. T., **Zirnstein, E. J.**, McComas, D. J., Begley, L. J., Bagenal, F., Delamere, P. A., Wilson, R. J., Valek, P. W., Poppe, A. R., Nénon, Q., Allegrini, F., Ebert, R. W., Bolton, S. J., *Water-Group Pickup Ions From Europa-Genic Neutrals Orbiting Jupiter*, GRL, 49, e2022GL098111, doi:10.1029/2022GL098111, 2022.
- Frisch, P. C., Berdyugin, A. B., Piirola, V., Heiles, C., Cole, A. A., Hill, K., Magalhães, A. M., Wiktorowicz, S. J., Bailey, J., Cotton, D. V., Kedziora-Chudczer, L., Schwadron, N. A., Bzowski, M., McComas, D. J., **Zirnstein, E. J.**, Funsten, H. O., Harlington, C., *Whence the Interstellar Magnetic Field Shaping the Heliosphere?*, ApJS, 259, 48, doi:10.3847/1538-4365/ac5750, 2022.
- Swaczyna, P., Eddy, T. J., **Zirnstein, E. J.**, Dayeh, M. A., McComas, D. J., Funsten, H. O., Schwadron, N. A., *IBEX Ribbon Separation Using Spherical Harmonic Decomposition of the Globally Distributed Flux*, ApJS, 258, 6, doi:10.3847/1538-4365/ac2f47, 2022.

**2021 (11 total, 3 first author)**

- Sokół, J. M., Dayeh, M. A., Fuselier, S. A., Nicolaou, G., McComas, D. J., **Zirnstein, E. J.**, *Breathing of the Heliosphere*, ApJ, 922, 250, doi:10.3847/1538-4357/ac21cd, 2021.
- Kornbleuth, M., Opher, M., Baliukin, I., Dayeh, M. A., **Zirnstein, E. J.**, Gkioulidou, M., Dialynas, K., Galli, A., Richardson, J. D., Izmodenov, V., Zank, G. P., Fuselier, S., *Signature of a heliotail organized by the solar magnetic field and the role of non-ideal processes in modeled IBEX ENA maps: A comparison of the BU and Moscow MHD models*, ApJ, 921, 164, doi:10.3847/1538-4357/ac1e2a, 2021.

- **Zirnstein, E. J.**, Kumar, R., Bandyopadhyay, R., Dayeh, M. A., Heerikhuisen, J., McComas, D. J., *Turbulent Acceleration of Interstellar Pickup Ions at the Heliospheric Termination Shock Forms the Global ENA Spectrum*, ApJL, 916, L21, doi:10.3847/2041-8213/ac12cc, 2021.
- Bagenal, F., McComas, D. J., Elliott, H. A., **Zirnstein, E. J.**, McNutt Jr., R. L., Lisse, C. M., Kollmann, P., Delamere, P. A., Barnes, N. P., *Solar Wind Interaction with the Pluto System*, in *The Pluto System After New Horizons*, pp. 379-392, doi:10.2458/azu\_uapress\_9780816540945-ch016, 2021.
- Fuselier, S. A., Galli, A., Richardson, J. D., Reisenfeld, D. B., **Zirnstein, E. J.**, Heerikhuisen, J., Dayeh, M. A., Schwadron, N. A., McComas, D. J., Elliott, H. A., Gomez, R. G., Starkey, M. J., Kornbleuth, M. Z., Opher, M., Dialynas, K., *Energetic Neutral Atom Fluxes from the Heliosheath: Constraints from in situ Measurements and Models*, ApJL, 915, L26, doi:10.3847/2041-8213/ac0d5c, 2021.
- Reisenfeld, D. B., Bzowski, M., Funsten, H. O., Heerikhuisen, J., Janzen, P. H., Kubiak, M. A., McComas, D. J., Schwadron, N. A., Sokół, J. M., Zimorino, A., **Zirnstein, E. J.**, *A Three-Dimensional Map of the Heliosphere from IBEX*, ApJS, 254, 40, doi:10.3847/1538-4365/abf658, 2021.
- Shrestha, B., L., **Zirnstein, E. J.**, Heerikhuisen, J., Zank, G. P., *Strength of the Termination Shock Inferred from the Globally Distributed Energetic Neutral Atom Flux from IBEX*, ApJS, 254, 32, doi:10.3847/1538-4365/abf659, 2021.
- McComas, D. J., Swaczyna, P., Szalay, J. R., **Zirnstein, E. J.**, Rankin, J. S., Elliott, H. A., Singer, K., Spencer, J., Stern, S. A., Weaver, H., *Interstellar Pickup Ion Observations Halfway to the Termination Shock*, ApJS, 254, 19, doi:10.3847/1538-4365/abee76, 2021.
- Swaczyna, P., Rahmanifard, F., **Zirnstein, E. J.**, McComas, D. J., Heerikhuisen, J., *Slowdown and Heating of Interstellar Neutral Helium by Elastic Collisions Beyond the Heliopause*, ApJL, 911, L36, doi:10.3847/2041-8213/abf436, 2021.
- **Zirnstein, E. J.**, Dayeh, M. A., Heerikhuisen, J., *Dependence of the IBEX Ribbon Geometry on Pitch Angle Scattering Outside the Heliopause*, ApJ, 908, 35, doi:10.3847/1538-4357/abd4e8, 2021.
- **Zirnstein, E. J.**, Dayeh, M. A., Heerikhuisen, J., McComas, D. J., Swaczyna, P., *Heliosheath Proton Distribution in the Plasma Reference Frame*, ApJS, 252, 26, doi:10.3847/1538-4365/abd092, 2021.

**2020 (9 total, 4 first author)**

- Swaczyna, P., McComas, D. J., **Zirnstein, E. J.**, Sokół, J. M., Elliott, H. A., Bzowski, M., Kubiak, M. A., Richardson, J. D., Kowalska-Leszczynska, I., Stern, S. A., Weaver, H. A., Olkin, C. B., Spencer, J., *Density of Neutral Hydrogen in the Sun's Interstellar Neighborhood*, ApJ, 903, 48, doi:10.3847/1538-4357/abb80a, 2020.
- Dayeh, M. A., Szalay, J. R., Ogasawara, K., Fuselier, S. A., McComas, D. J., Funsten, H. O., Petrinec, S. M., Schwadron, N. A., **Zirnstein, E. J.**, *First Global Images of Ion Energization in the Terrestrial Foreshock Region by the Interstellar Boundary Explorer (IBEX)*, GRL, 47, e2020GL088188, doi:10.1029/2020GL088188, 2020.
- **Zirnstein, E. J.**, Dayeh, M. A., McComas, D. J., Sokół, J. M., *Distance to the Energetic Neutral Hydrogen Source in the Heliotail*, ApJ, 897, 138, doi:10.3847/1538-4357/ab9605, 2020.
- McComas, D. J., Bzowski, M., Dayeh, M. A., DeMajistre, R., Funsten, H. O., Janzen, P. H., Kowalska-Leszczynska, I., Kubiak, M. A., Schwadron, N. A., Sokół, J. M., Szalay, J. R., Tokumaru, M., **Zirnstein, E. J.**, *Solar Cycle of Imaging the Global Heliosphere: Interstellar*

*Boundary Explorer (IBEX) Observations from 2009–2019*, ApJS, 248, 26, doi:10.3847/1538-4365/ab8dc2, 2020.

- Shrestha, B. L., **Zirnstein, E. J.**, Heerikhuisen, J., *Energetic Neutral Atom Flux from the Inner Heliosheath and its Connection to Termination Shock Properties*, ApJ, 894, 102, doi:10.3847/1538-4357/ab893b, 2020.
- **Zirnstein, E. J.**, Dayeh, M. A., McComas, D. J., Sokół, J. M., *Asymmetric Structure of the Solar Wind and Heliosphere from IBEX Observations*, ApJ, 894, 13, doi:10.3847/1538-4357/ab8470, 2020.
- **Zirnstein, E. J.**, Kim, T. K., Mostafavi, P., Heerikhuisen, J., McComas, D. J., Pogorelov, N. V., *Response of Pickup Ions in the Very Local Interstellar Medium to Solar Variations: Implications for the Evolution of the IBEX Ribbon and Interstellar Helium*, ApJ, 891, 56, doi:10.3847/1538-4357/ab744b, 2020.
- **Zirnstein, E. J.**, Giacalone, J., Kumar, R., McComas, D. J., Dayeh, M. A., Heerikhuisen, J., *Turbulence in the Local Interstellar Medium and the IBEX Ribbon*, ApJ, 888, 29, doi:10.3847/1538-4357/ab594d, 2020.
- Czechowski, A., Bzowski, M., Sokół, J. M., Kubiak, M. A., Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V., Schwadron, N. A., Hilchenbach, M., Grygorczuk, J., Zank, G. P., *Heliospheric Structure as Revealed by the 3 – 88 keV H ENA Spectra*, ApJ, 888, 1, doi:10.3847/1538-4357/ab5b14, 2020.

**2019 (11 total, 2 first author)**

- Swaczyna, P., McComas, D. J., **Zirnstein, E. J.**, Heerikhuisen, J., *Angular Scattering in Charge Exchange Collisions: Issues and Implications for Secondary Interstellar Hydrogen*, ApJ, 887, 223, doi:10.3847/1538-4357/ab5440, 2019.
- **Zirnstein, E. J.**, Swaczyna, P., McComas, D. J., Heerikhuisen, J., *Parallax of the IBEX Ribbon Indicates a Spatially Retained Source*, ApJ, 879, 106, doi:10.3847/1538-4357/ab2633, 2019.
- Elliott, H. A., McComas, D. J., **Zirnstein, E. J.**, Randol, B. M., Delamere, P. A., Livadiotis, G., Bagenal, F., Barnes, N. P., Stern, S. A., Young, L. A., Olkin, C. B., Spencer, J., Weaver, H. A., Ennico, K., Gladstone, G. R., Smith, C. W., *Slowing of the Solar Wind in the Outer Heliosphere*, ApJ, 885, 2, doi:10.3847/1538-4357/ab3e49, 2019.
- Bzowski, M., Czechowski, A., Frisch, P. C., Fuselier, S. A., Galli, A., Grygorczuk, J., Heerikhuisen, J., Kubiak, M. A., Kucharek, H., McComas, D. J., Möbius, E., Schwadron, N. A., Slavin, J., Sokół, J. M., Swaczyna, P., Wurz, P., **Zirnstein, E. J.**, *Interstellar Neutral Helium in the Heliosphere from IBEX Observations: VI. The He<sup>+</sup> Density and the Ionization State in the Very Local Interstellar Matter*, ApJ, 882, 60, doi:10.3847/1538-4357/ab3462, 2019.
- Mostafavi, P., Zank, G. P., **Zirnstein, E. J.**, McComas, D. J., *Inner Heliosheath Shocks and Their Effect on Energetic Neutral Atom Observations by IBEX*, ApJL, 878, L24, doi:10.3847/2041-8213/ab25f4, 2019.
- **Zirnstein, E. J.**, McComas, D. J., Schwadron, N. A., Dayeh, M. A., Heerikhuisen, J., Swaczyna, P., *Strong Scattering of ~keV Pickup Ions in the Local Interstellar Magnetic Field Draped Around Our Heliosphere: Implications for the IBEX Ribbon's Source and IMAP*, ApJ, 876, 92, doi:10.3847/1538-4357/ab15d6, 2019.
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- Dayeh, M. A., **Zirnstein, E. J.**, Desai, M. I., Funsten, H. O., Fuselier, S. A., Heerikhuisen, J., McComas, D. J., Schwadron, N. A., Szalay, J. R., *Variability in the Position of the IBEX*

*Ribbon over Nine Years: More Observational Evidence for a Secondary ENA Source*, ApJ, 879, 84, doi:10.3847/1538-4357/ab21c1, 2019.

- Desai, M. I., Dayeh, M. A., Allegrini, F., McComas, D. J., Funsten, H., Heerikhuisen, J., Fuselier, S. A., Pogorelov, N. V., Schwadron, N. A., Zank, G. P., **Zirnstein, E. J.**, Sokół, J. M., Tokumaru, M., Bzowski, M., Kubiak, M. A., Reisenfeld, D. B., *Temporal Evolution of the Latitude and Energy Dependence of the Energetic Neutral Atom Spectral Indices Measured by the Interstellar Boundary Explorer (IBEX) Over the First Nine Years*, ApJ, 875, 91, doi:10.3847/1538-4357/ab0f37, 2019.
- Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V., Zank, G. P., Desai, M. I., *The Effect of Suprathermal Protons in the Heliosheath on the Global Structure of the Heliosphere and Heliotail*, ApJ, 874, 76, doi:10.3847/1538-4357/ab05e3, 2019.
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**2018 (10 total, 5 first author)**

- Zank, G. P., Adhikari, L., Zhao, L.-L., Mostafavi, P., **Zirnstein, E. J.**, McComas, D. J., *The Pickup Ion-mediated Solar Wind*, ApJ, 869, 23, doi:10.3847/1538-4357/aeabfe, 2018.
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- **Zirnstein, E. J.**, Kumar, R., Heerikhuisen, J., McComas, D. J., Galli, A., *Constraining the Evolution of the Proton Distribution Function in the Heliotail*, ApJ, 865, 150, doi:10.3847/1538-4357/aadb98, 2018.
- **Zirnstein, E. J.**, McComas, D. J., Kumar, R., Elliott, H. A., Szalay, J. R., Olkin, C. B., Spencer, J., Stern, S. A., Young, L. A., *In Situ Observations of Preferential Pickup Ion Heating at an Interplanetary Shock*, PRL, 121, 075102, doi:10.1103/PhysRevLett.121.075102, 2018.
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#### **2012 (1 total, 1 first author)**

- **Zirnstein, E.**, Heerikhuisen, J., Pogorelov, N., *Numerical simulations of primary and secondary hydrogen ENA fluxes at 1 AU*, AIP Conf. Proc., 1500, 262, doi:10.1063/1.4768776, 2012.

#### **WHITE PAPERS (4 total, 1 first author)**

- **Zirnstein, E. J.**, Reisenfeld, D. B., DeMajistre, R., Janzen, P. H., *Revealing the 3D Structure of the Heliosphere through Long Baseline ENA Parallax and Tomography*, Heliophysics Decadal Survey 2024-2034.
- Swaczyna, P., Rankin, J. S., Shrestha, B. L., **Zirnstein, E. J.**, Hill, M. E., Kucharek, H., Mostafavi, P., Spitzer, S. A., Turner, D. L., *Ubiquitous Nature of Pickup Ions in the Outer Heliosphere and Beyond*, Heliophysics Decadal Survey 2024-2034.
- Mostafavi, P., Zank, G. P., Brandt, P., Burlaga, L., Chen, T., Decker, R., DeMajistre, B., Dialynas, K., Florinski, V., Hill, M. E., McNutt, R., Merkin, V. G., Opher, M., Provornikova, E., Rankin, J., Richardson, J., Roelof, E., Turner, D. L., **Zirnstein, E. J.**, Heliophysics Decadal Survey 2024-2034.
- Brandt, P. C., **Zirnstein, E. J.**, and The Interstellar Probe Study Team, *Pushing the Frontier of Solar & Space Physics: Exploration of the Heliosphere and the Very Local Interstellar Medium by an Interstellar Probe*, Heliophysics Decadal Survey 2024-2034.

#### **HONORS & AWARDS**

- NASA Outstanding Achievement Award, Parker Solar Probe IS<sup>⊙</sup>IS Team, 2022

- NASA Group Achievement Award, New Horizons Team, 2016
- NASA Certificate in Recognition of the Outstanding Contribution to the IBEX Star Tracker Anomaly Diagnosis and Recovery, 2016
- College of Science Outstanding GRA Award, University of Alabama in Huntsville, 2013-2014
- NASA Earth and Space Science Fellowship in Heliophysics, 2011-2014
- Science and Engineering Scholarship, Von Braun Astronomical Society, 2010-2011
- Air, Space and Missile Defense Association (ASMDA) Loretta Spencer Scholarship, 2009

### ***MISSION & INSTRUMENT EXPERIENCE***

- **IBEX** – IBEX-Lo and IBEX-Hi
- **New Horizons** – Solar Wind Around Pluto (SWAP)
- **Voyager 1 and 2** – Plasma Science (PLS) and Magnetometer (MAG)
- **PSP** – Integrated Science Investigation of the Sun (IS $\odot$ IS)
- **IMAP** –Solar Wind and Pickup Ion (SWAPI), IMAP-Lo, IMAP-Hi

### ***MISSION ORGANIZATION***

- Coauthors IBEX Senior Review proposals
- Coauthors IBEX annual grant reports
- Coauthors IBEX annual GPRAMA reports
- Co-organizes and chairs the annual IBEX/IMAP Science Team Meetings
- SWAPI lead in IMAP Science Data Working Group

### ***MISSION GUEST INVESTIGATOR***

- Interstellar Mapping and Acceleration Probe (IMAP), Outer Heliosphere Guest Investigators Program (2020-2023)
- Interstellar Boundary Explorer (IBEX), Outer Heliosphere Guest Investigators Program (2020-2023)

### ***RESEARCH GRANT SELECTIONS***

- Los Alamos Laboratory Directed Research & Development: “Discovering the Structure and Dynamics of the Sun-Interstellar Medium System” (**Co-I**, 2021-2024)
- NASA ROSES Heliophysics Supporting Research Program: “Mapping the Heliospheric Termination Shock with IBEX Observations and Modeling” (**PI**, 2021-2024)
- NASA ROSES Outer Heliosphere Investigators Program: “Identifying the Origin of Energetic Neutral Atoms Measured by IBEX along the Voyager Directions” (**PI**, 2020-2023)
- NASA ROSES Outer Heliosphere Investigators Program: “Angular Scattering of Neutral Atoms: Observations and Interpretation from IBEX and Consequences for IMAP” (**Co-I**, 2020-2023)
- NASA ROSES Phase I DRIVE Program: “Our Heliospheric Shield” (**Co-I**, 2020-2021)
- NASA ROSES Heliophysics Supporting Research Program: “Helium and the Heliosphere” (**Co-I**, 2018-2021)
- NASA ROSES Heliophysics Supporting Research Program: “Understanding Pickup Ion Processes outside the Heliopause: Modeling and Analysis of the *IBEX* Ribbon Observables” (**PI**, 2017-2020)
- NASA ROSES Heliophysics Supporting Research Program: “Pick-Up Ions and Energetic

Neutral Atoms: Implications for the Termination Shock” (Co-I, 2016-2019)

### ***IN THE PRESS (main features only)***

- The DemystifySci Podcast, March 9, 2023: “Journey to the Edge: Structure of the Heliosphere – Dr. Eric Zirnstein, Princeton University” (<https://podcasts.apple.com/us/podcast/the-demystifysci-podcast/id1523643420?i=1000603498851>)
- NASA, February 17, 2023: “The Heliosphere Has Ripples!” (<https://twitter.com/NASASun/status/1626630947528376340?cxt=HHwWqICwgdCO-pItAAAA>)
- VICE, October 13, 2022: “Scientists Discover Unexplained Structures at Boundary to Interstellar Space” (<https://www.vice.com/en/article/epzm7m/scientists-discover-unexplained-structures-at-boundary-to-interstellar-space>)
- APS *Physics* Feature, August 17, 2018: “Solar Wind Shockwave Gives Ions a Push” (<https://physics.aps.org/articles/v11/83>)
- NASA Feature, June 6, 2018: “As Solar Wind Blows, Our Heliosphere Balloons” (<https://www.nasa.gov/feature/goddard/2018/as-solar-wind-blows-our-heliosphere-balloons>)
- NASA’s Voyager Spacecraft 40<sup>th</sup> Anniversary Celebration, Panel Discussion, September 5, 2017 (<https://www.nasa.gov/press-release/nasa-and-iconic-museum-honor-voyager-spacecraft-40th-anniversary>)
- AAS NOVA Highlight, May 25, 2016: “Clues from Pluto’s Ions” (<http://aasnova.org/2016/05/25/clues-from-plutos-ions/>)
- NASA Feature, Feb. 26, 2016: “NASA’s IBEX Observations Pin Down Interstellar Magnetic Field” (<http://www.nasa.gov/feature/goddard/2016/nasa-s-ibex-observations-pin-down-interstellar-magnetic-field>)

### ***INVITED CONFERENCE/MEETING PRESENTATIONS***

#### ***2023***

- *The IBEX Ribbon and its Relation to the Solar-Interstellar Interaction*, **Zirnstein, E. J.**, (CRA-2023, Oral, May 2023)
- *Oblique and Rippled Heliosphere Structures from the Interstellar Boundary Explorer*, **Zirnstein, E. J.**, Shrestha, B. L., McComas, D. J., Dayeh, M. A., Heerikhuisen, Reisenfeld, D. B., Sokół, J. M., Swaczyna, P. (Outer Heliosphere and VLISM Seminar, Oral, February 2023)
- *Oblique and Rippled Heliosphere Structures from the Interstellar Boundary Explorer*, **Zirnstein, E. J.**, Shrestha, B. L., McComas, D. J., Dayeh, M. A., Heerikhuisen, Reisenfeld, D. B., Sokół, J. M., Swaczyna, P. (NH STM, Oral, January 2023)

#### ***2022***

- *Observations of Interstellar Pickup Ions in the Heliosphere*, **Zirnstein, E. J.**, Moebius, E., Zhang, M., Bower, J., Elliott, H. A., McComas, D. J., Pogorelov, N. V., Swaczyna, P. (NH STM, Oral, September 2022)
- *Differentiating the Ribbon and Globally Distributed ENA Flux in IBEX Observations*, **Zirnstein, E. J.** (EGU, Oral, May 2022)

#### ***2021***

- *Proton Distribution in the Heliosheath: From Particle Acceleration to ENA Observation*, **Zirnstein, E. J.** (AGU, Oral, December 2021)

- *Proton Distribution in the Heliosheath: From Particle Acceleration at the Termination Shock to Energetic Neutral Atom Observation near Earth*, **Zirnstein, E. J.** (APS-DPP, Oral, November 2021)

#### 2020

- *Insights into the Heliospheric Energetic Neutral Atom Source with Modeling*, **Zirnstein, E. J.** (AGU, Oral, December 2020)

#### 2019

- *Pickup Ions in the Outer Heliosphere: New Horizons, Voyager, IBEX, and the Upcoming IMAP Mission*, **Zirnstein, E. J.** (AGU, Oral, December 2019)

#### 2018

- *Pickup Ions in the Outer Heliosphere: Revelations by IBEX and the Upcoming IMAP Mission*, **Zirnstein, E. J.** (AGU, Oral, December 2018)

#### 2017

- *IBEX Observations and Simulations of the Ribbon: Implications for the Very Local Interstellar Medium*, **Zirnstein, E. J.** (AGU, Oral, December 2017)
- *What We've Learned from IBEX ENA Imaging of the Heliosheath*, **Zirnstein, E. J.** (AGU, Oral, December 2017)

#### 2014

- *Distinguishing Tests of the Interstellar Boundary Explorer Ribbon through Numerical Modeling: Current Results and Future Prospects*, **Zirnstein, E. J.** (AGU, Oral, December 2014)

### CONFERENCE/MEETING PRESENTATIONS

#### 2023

- *Constraints on the IBEX Ribbon's Origin from its Evolution over a Solar Cycle*, **Zirnstein, E. J.**, Swaczyna, P., Dayeh, M. A., Heerikhuisen, J. (EGU, Oral, April 2023)

#### 2022

- *Oblique and Rippled Heliosphere Structures from the Interstellar Boundary Explorer*, **Zirnstein, E. J.**, Shrestha, B. L., McComas, D. J., Dayeh, M. A., Heerikhuisen, Reisenfeld, D. B., Sokół, J. M., Swaczyna, P. (AGU, Oral, December 2022)
- *Theseus: An Advanced Method for rendering Interstellar Boundary Explorer ENA Sky Maps*, Reisenfeld, D. B., Osthus, D., Janzen, P. H., Weaver, B. P., **Zirnstein, E. J.** (AGU, Poster, December 2022)
- *Turbulence and Waves in the Heliosphere-Interstellar Medium Interaction Regions and Implications for the IBEX Ribbon*, Guo, F., Li, H., **Zirnstein, E. J.**, Huang, Y., Reisenfeld, D. B. (AGU, Oral, December 2022)
- *A Numerical Model for Understanding Pickup-Ion Dynamics in the Outer Heliosphere and IBEX Observations of the ENA Ribbon* (AGU, Poster, December 2022)
- *Water-group ions from Europa and Ganymede: A window into surface ice evolution*, Szalay, J. R., Allegrini, F., Bagenal, F., Bolton, S. J., Mogan, S. C., Delamere, P. A., Ebert, R. W., Fatemi, S., McComas, D. J., Nenon, Q., Poppe, A. R., Sarkango, Y., Smith, H. T., Valek, P. W., Vance, S., Vorburger, A., Wilson, R. J., Wurz, P., **Zirnstein, E. J.** (AGU, Oral, December 2022)
- *The Evolution of Polar Coronal Holes Observed by IBEX*, Shrestha, B. L., **Zirnstein, E. J.**, McComas, D. J., Szalay, J. R. (AGU, Poster, December 2022)
- *High-resolution Heliosphere Boundary Structures from IBEX*, **Zirnstein, E. J.**, Shrestha, B.

L., McComas, D. J., Dayeh, M. A., Heerikhuisen, Reisenfeld, D. B., Sokół, J. M., Swaczyna, P. (IBEX/IMAP STM, Oral, June 2022)

- *Explaining the Origin of IBEX ENA Observations with a Dynamic Heliosphere Model*, **Zirnstein, E. J.**, Dayeh, M. A., Rankin, J. S., McComas, D. J., Swaczyna, P. (IBEX/IMAP STM, Oral, June 2022)

## 2021

- *Narrowing Down the Physical Mechanisms Governing the IBEX Ribbon*, **Zirnstein, E. J.**, Dayeh, M. A., Heerikhuisen, J., Giacalone, J., Kumar, R., McComas, D. J., Schwadron, N. A., Swaczyna, P. (AGU, Poster, December 2021)
- *A comparison of heliotail configurations arising from different treatments of non-ideal MHD effects with ENA maps at IBEX energies*, Kornbleuth, M. Z., Opher, M., Baliukin, I., Dayeh, M., **Zirnstein, E. J.**, Gkioulidou, M., Dialynas, K., Galli, A., Richardson, J. D., Izmodenov, V., Zank, G. P., Fuselier, S. A., Michael, A., Toth, G., Tenishev, V., Alexashov, D., Drake, J. F. (AGU, Oral, December 2021)
- *Return of the IBEX Ribbon*, McComas, D. J., Funsten, H. O., Schwadron, N. A., Swaczyna, P., Szalay, J. R., **Zirnstein, E. J.** (AGU, Oral, December 2021)
- *Complete Solar Cycle Observations of Interstellar Neutral Helium with IBEX: Consequences of Modulation in Heliospheric Boundaries*, Swaczyna, P., Bower, J., Bzowski, M. A., Fuselier, S. A., Galli, A., Heerikhuisen, J., Heitzler, D., Kubiak, M. A., McComas, D. J., Moebius, E., Rahmanifard, F., Schwadron, N., **Zirnstein, E. J.** (AGU, Oral, December 2021)
- *Whence the Interstellar Magnetic Field Shaping the Heliosphere*, Frisch, P. C., Piirola, V., Berdyugin, A., Heiles, C., Cole, A., Hill, K., Magalhaes, A. M., Wiktorowicz, S., Cotton, D., Bailey, J., Kedziora-Chudczer, L., Schwadron, N., Bzowski, M. A., McComas, D. J., **Zirnstein, E. J.**, Funsten, H. O., Harlinton, C. (AGU, Oral, December 2021)
- *Breathing of the Heliosphere*, Sokol, J. M., Dayeh, M., Fuselier, S. A., Nicolaou, G., McComas, D. J., **Zirnstein, E. J.** (AGU, Oral, December 2021)
- *Pickup Ion Spectrum Downstream of the Termination Shock Inferred from IBEX ENA observations and Comparison with Kinetic Simulations*, Shrestha, B. L., Zank, G. P., **Zirnstein, E. J.**, Heerikhuisen, J., Giacalone, J., McComas, D. J. (AGU, Oral, December 2021)
- *A Three-Dimensional Map of the Heliosphere from IBEX*, Reisenfeld, D. B., Bzowski, M. A., Funsten, H. O., Heerikhuisen, J., Janzen, P. H., Kubiak, M. A., McComas, D. J., Schwadron, N., Sokol, J. M., Zomorino, A., **Zirnstein, E. J.** (AGU, Poster, December 2021)
- *Evolution of the Heliotail Lobes over a Solar Cycle as Measured by IBEX*, Dayeh, M. A., **Zirnstein, E. J.**, McComas, D. J., Funsten, H. O. (AGU, Poster, December 2021)
- *Higher-resolution IBEX-Hi Sky Maps*, Janzen, P. H., Maldonado, C., Osthus, D., Reisenfeld, D. B., Weaver, B. P., **Zirnstein, E. J.** (AGU, Poster, December 2021)
- *Kinetic Simulations of the Solar Wind Termination Shock*, Kumar, R., **Zirnstein, E. J.** (AGU, Poster, December 2021)
- *Factors Influencing a Model Heliosphere*, Heerikhuisen, J., Pogorelov, N. V., **Zirnstein, E. J.**, Swaczyna, P., Fraternali, F. (AGU, Poster, December 2021)
- *Heliosheath Proton Distribution in the Plasma Reference Frame*, **Zirnstein, E. J.**, Dayeh, M. A., Heerikhuisen, J., McComas, D. J., Swaczyna, P. (IBEX/IMAP STM, Oral, August 2021)
- *Turbulent Acceleration of Interstellar Pickup Ions at the Heliospheric Termination Shock Forms the Global ENA Spectrum*, **Zirnstein, E. J.**, Kumar, R., Bandyopadhyay, R., Dayeh, M. A., Heerikhuisen, J., McComas, D. J. (IBEX/IMAP STM, Oral, August 2021)

## 2020

- *The Impact of Helium on Simulations of the Heliosphere*, Heerikhuisen, J., Pogorelov, N. V., **Zirnstein, E. J.**, Bzowski, M., Moebius, E. (AGU, Poster, December 2020)
- *Higher Density of Interstellar Hydrogen from Pickup Ion Observations in the Outer Heliosphere*, Swaczyna, P., McComas, D. J., **Zirnstein, E. J.**, Sokół, J. M., Elliott, H. A., Bzowski, M., Kubiak, M. A., Richardson, J. D., Kowalska-Leszczynska, I., Stern, S. A., Weaver, H. A., Olkin, C., Singer, K. N., Spencer, J. R. (AGU, Oral, December 2020)
- *Inferring the IBEX ribbon shape from ENA temporal variations: A proof-of-concept for IMAP observations*, Dayeh, M. A., **Zirnstein, E. J.** (AGU, Oral, December 2020)
- *Strength of the Termination Shock Inferred from the Inner Heliosheath ENA Flux*, Shrestha, B. L., **Zirnstein, E. J.**, Heerikhuisen, J., Zank, G. P. (AGU, Poster, December 2020)
- *Building a 3-D Map of the Heliosphere with IBEX*, Reisenfeld, D. B., Bzowski, M., Funsten, H. O., Heerikhuisen, J., Janzen, P. H., Kubiak, M. A., McComas, D. J., Schwadron, N. A., Sokół, J. M., **Zirnstein, E. J.** (AGU, Poster, December 2020)

## 2019

- *Termination Shock Properties Inferred from the Inner Heliosheath ENA Flux*, Shrestha, B. L., Heerikhuisen, J., **Zirnstein, E. J.**, Zank, G. P. (AGU, Poster, December 2019)
- *Using Simulations to Understand the Impact of Physical Processes on the Global Heliosphere*, Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V., Shrestha, B. L., Zank, G. P., Desai, M. I., Bzowski, M. (AGU, Oral, December 2019)
- *Angular Scattering in Charge Exchange: Issues and Implications for Secondary Interstellar Hydrogen*, Swaczyna, P., McComas, D. J., **Zirnstein, E. J.**, Heerikhuisen, J. (AGU, Poster, December 2019)
- *First Global Images of Ion Energization in the Terrestrial Foreshock Region by the Interstellar Boundary Explorer (IBEX)*, Dayeh, M. A., Szalay, J. R., Ogasawara, K., Fuselier, S. A., McComas, D. J., Funsten, H. O., Petrinc, S. M., Schwadron, N., **Zirnstein, E. J.** (AGU, Oral, December 2019)
- *Properties of the Energetic Neutral Atom Emission from the Ribbon*, Funsten, H. O., Bzowski, M., Dayeh, M. A., Fernandes, P. A., Frisch, P. C., Janzen, P. H., McComas, D. J., Reisenfeld, D. B., Schwadron, N., Theiler, J. P., Zank, G. P., **Zirnstein, E. J.** (AGU, Oral, December 2019)
- *Parallax of the IBEX Ribbon Indicates a Spatially Retained Source*, **Zirnstein, E. J.**, Swaczyna, P., McComas, D. J., Heerikhuisen, J. (IBEX/IMAP SWT, Oral, June 2019)
- *Turbulence in the VLISM and the IBEX Ribbon*, **Zirnstein, E. J.**, Giacalone, J., Kumar, R., McComas, D. J., Dayeh, M. A., Heerikhuisen, J. (IBEX/IMAP SWT, Oral, June 2019)
- *The Solar Wind, Pickup Ion, Energetic Particle, Cosmic Ray, and Dust Space Environment at 2014 MU69 (Ultima Thule)*, Elliott, H. A., McComas, D. J., McNutt Jr., R. L., Horanyi, M., Gladstone, G. R., Bagenal, F., Hill, M. E., Kollmann, P., Bernardoni, E., Piquette, M., Young, L. A., **Zirnstein, E.**, Parker, J. W., Stern, S. A., Weaver, H. A., Spencer, J. R., Olkin, C. B., Verbiscer, A. (LPSC, Poster, March 2019)
- *Strong Scattering of  $\sim$ keV Pickup Ions in the Interstellar Magnetic Field Draped Around Our Heliosphere: Implications for the IBEX Ribbon's Source and IMAP*, **Zirnstein, E. J.**, McComas, D. J., Schwadron, N. A., Dayeh, M. A., Heerikhuisen, J., Swaczyna, P. (AIAC, Oral, February 2019)

## 2018

- *In Situ Observations of Preferential Pickup Ion Heating at an Interplanetary Shock*, **Zirnstein, E. J.**, McComas, D. J., Kumar, R., Elliott, H. A., Szalay, J. R., Olkin, C. B., Spencer, J., Stern, S. A., Young, L. A. (AGU, Poster, December 2018)

- *Energetic Neutral Atom Emission from the Heliospheric Nose*, Funsten, H. O., Bzowski, M., Fernandes, P. A., Frisch, P. C., Janzen, P. H., Larsen, B., McComas, D. J., Reisenfeld, D. B., Schwadron, N., Theiler, J. P., Zank, G. P., **Zirnstein, E. J.** (AGU, Poster, December 2018)
- *The Ionization State of the Local Interstellar Matter Revealed by IBEX Observations of Interstellar Neutral Atoms*, Bzowski, M., Czechowski, A., Frisch, P. C., Fuselier, S. A., Galli, A., Grygorczuk, J., Heerikhuisen, J., Kubiak, M. A., Kucharek, H., McComas, D. J., Moebius, E., Schwadron, N. A., Slavin, J. D., Sokół, J. M., Swaczyna, P., Wurz, P., **Zirnstein, E. J.** (AGU, Oral, December 2018)
- *Variations of the IBEX ENA Ribbon Properties and their Correlation with Solar Wind Observations*, Dayeh, M. A., **Zirnstein, E. J.**, Sokół, J. M., Desai, M. I., Fuselier, S. A., McComas, D. J., Schwadron, N. A., Szalay, J. R. (AGU, Oral, December 2018)
- *The Pickup Ion Mediated Solar Wind*, Zank, G. P., Zhao, L., Adhikari, L., Mostafavi, P., **Zirnstein, E. J.**, McComas, D. J. (AGU, Oral, December 2018)
- *Enhancement of Pickup Ion Pressure in the Inner Heliosheath and Possible Implications for Energetic Neutral Atom (ENA) Observations by IBEX*, Mostafavi, P., Zank, G. P., McComas, D. J., **Zirnstein, E. J.** (AGU, Poster, December 2018)
- *Population of He<sup>+</sup> Ions Co-moving with the Solar Wind in the Outer Heliosphere*, Swaczyna, P., McComas, D. J., **Zirnstein, E. J.** (AGU, Poster, December 2018)
- *The Distribution Function of ISN He Outside and Inside the Heliopause*, Kubiak, M. A., Bzowski, M., Sokół, J. M., Heerikhuisen, J., **Zirnstein, E. J.** (AGU, Poster, December 2018)
- *Coupling suprathermal protons in the heliosheath to the plasma through charge-exchange with neutral hydrogen*, Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V., Zank, G. P., Desai, M. I., DeStefano, A. (AGU, Poster, December 2018)
- *ENA Flux from the Inner Heliosheath and its Connection to Termination Shock Properties*, Shrestha, B. L., Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V. (AGU, Poster, December 2018)
- *Stochastic Acceleration of Pickup Ions in the Heliotail*, **Zirnstein, E. J.**, Kumar, R., Heerikhuisen, J., McComas, D. J., Galli, A. (IBEX/IMAP STM, Oral, August 2018)
- *The Solar Wind Interaction with Pluto's Atmosphere as Observed by New Horizons*, Bagenal, F., McComas, D., McNutt, R., Elliott, H., Hill, M., **Zirnstein, E. J.**, Gladstone, R., Strobel, D., Stern, A., Weaver, H., Young, L., Olkin, C., Ennico, K. (COSPAR, Oral, July 2018)
- *Identifying Solar Wind Structures in the New Horizons Solar Wind Around Pluto (SWAP) Observations Between 20 and 40 AU*, Elliott, H., Valek, P., McComas, D., **Zirnstein, E. J.**, Bagenal, F., Stern, A., Weaver, H., Young, L., Olkin, C., Ennico, K. (COSPAR, Oral, July 2018)
- *The Role of Pickup Ion Dynamics Outside of the Heliopause in the Limit of Weak Pitch Angle Scattering: Implications for the Source of the IBEX Ribbon*, **Zirnstein, E. J.** (AIAC, Oral, March 2018)
- *Diagnosing the Local Interstellar Medium Using the Warm Breeze and IBEX Ribbon*, Bzowski, M., Kubiak, M. A., Heerikhuisen, J., Czechowski, A., Grygorczuk, J., Swaczyna, P., **Zirnstein, E.**, Sokół, J. M. (AIAC, Oral, March 2018)
- *Exploring IBEX Observations through Global Simulations*, **Zirnstein, E. J.**, Dayeh, M. A., Funsten, H. O., Heerikhuisen, J., McComas, D. J., Pogorelov, N. V., Reisenfeld, D. B., Schwadron, N. A., Zank, G. P. (Voyager/NH STM, Oral, January 2018)

- *Spectral Properties of ENAs in the Presence of Multiple PUI Populations*, Shrestha, B. L., Heerikhuisen, J., **Zirnstein, E.** (AGU, Poster, December 2017)
- *Reduced Solar Wind Speeds at New Horizons Beyond 30 AU*, Elliott, H. A., McComas, D. J., **Zirnstein, E.**, Delamere, P. A., Bagenal, F., Stern, A., Weaver, H. A. Jr., Young, L. A., Ennico, K., Olkin C., and New Horizons Plasma and Particles Theme Team (AGU, Poster, December 2017)
- *Observational Evidence for The Comet-Like Heliosphere*, Bzowski, M., Czechowski, A., Funsten, H. O., Grygorczuk, J., Heerikhuisen, J., Kubiak, M. A., Moebius, E., McComas, D. J., Schwadron, N., Sokół, J. M., Swaczyna, P., **Zirnstein, E.** (AGU, Oral, December 2017)
- *Spatial, temporal, and circularity variations of the ENA ribbon over seven years of IBEX observations*, Dayeh, M. A., **Zirnstein, E.**, Funsten, H. O., Fuselier, S. A., McComas, D. J., Schwadron, N. A., Szalay, J. R. (AGU, Poster, December 2017)
- *How does the presence of suprathermal protons impact the heliosheath on global scales?*, Heerikhuisen, J., **Zirnstein, E.**, Zank, G. P., Pogorelov, N. V., Desai, M. I. (AGU, Poster, December 2017)
- *Observations of the Very Local Interstellar Medium with the IBEX and Voyager Spacecraft*, **Zirnstein, E. J.** (TeVPA, Oral, August 2017)
- *Imprint of the Sun's Evolving Polar Winds on IBEX ENA All-Sky Maps*, **Zirnstein, E. J.**, Dayeh, M. A., McComas, D. J., Sokół, J. M. (IBEX STM, Oral, June 2017)
- *Structure of the Heliotail from IBEX Observations: Implications for the 11 Year Solar Cycle and Pickup Ions in the Heliosheath*, **Zirnstein, E. J.**, Heerikhuisen, J., Zank, G. P., Pogorelov, N. V., Funsten, H. O., McComas, D. J., Reisenfeld, D. B., Schwadron, N. A. (AIAC, Oral, March 2017)

## 2016

- *Multi-Fluid MHD study of the solar wind interaction with Pluto*, Dong, C., Ma, Y., McComas, D. J., Bhattacharjee, A., **Zirnstein, E.**, Toth, G., Luhmann, J. G., Wang, L. (AGU, Poster, December 2016)
- *Structure and Dynamics of the IBEX Ribbon of Enhanced ENA Emission: The Role of ENA Transport in the Interstellar Medium*, Funsten, H. O., Demajistre, R., Fernandes, P. A., Frisch, P. C., Heerikhuisen, J., Janzen, P. H., McComas, D. J., Pittman, K. T., Reisenfeld, D. B., Schwadron, N., Theiler, J. P., **Zirnstein, E.**, Larsen, B. (AGU, December 2016)
- *Neutral atom distributions in the direction of the ribbon from global simulations*, Heerikhuisen, J., Gamayunov, K. V., **Zirnstein, E.**, Pogorelov, N. (AGU, December 2016)
- *Structure of the Heliotail from Interstellar Boundary Explorer (IBEX) Observations: Implications for the 11 Year Solar Cycle and Pickup Ions in the Heliosheath*, **Zirnstein, E.**, Heerikhuisen, J., Zank, G. P., Pogorelov, N., Funsten, H. O., McComas, D. J., Reisenfeld, D. B., Schwadron, N. (AGU, Poster, December 2016)
- *Evolution of heliospheric energetic neutral atom emissions over seven years of IBEX observations*, Dayeh, M. A., Desai, M. I., Fuselier, S. A., Heerikhuisen, J., McComas, D. J., Schwadron, N., Szalay, J., **Zirnstein, E.** (AGU, December 2016)
- *Structure and Characteristics of the Heliotail from ENAs*, **Zirnstein, E. J.**, Funsten, H. O., Heerikhuisen, J., McComas, D. J., Pogorelov, N. V., Reisenfeld, D. B., Schwadron, N. A., Zank, G. P. (IBEX STM, Oral, August 2016)
- *Local Interstellar Magnetic Field Determined from the IBEX Ribbon*, **Zirnstein, E. J.**, Heerikhuisen, J., Funsten, H. O., Livadiotis, G., McComas, D. J., Pogorelov, N. V. (AIAC,



Oral, April 2016)

## 2015

- *Observational Constraints on a Pluto Torus of Circumsolar Neutral Gas*, Hill, M. E., Kollmann, P., McNutt, R. L., Jr., Smith, H. T., Bagenal, F., Brown, L. E., Elliott, H. A., Haggerty, D. K., Horanyi, M., Krimigis, S. M., Kusterer, M. B., Lisse, C. M., McComas, D. J., Piquette, M. R., Sidrow, E. J., Strobel, D. F., Szalay, J., Vandegriff, J. D., **Zirnstein, E.**, Ennico Smith, K., Olkin, C.; Weaver, H. A., Jr., Young, L. A., Stern, S. A. (AGU, December 2015)
- *Escape of Pluto's Atmosphere: In Situ Measurements from New Horizons and Remote Observations from Chandra*, McNutt, R. L., Jr., Hill, M. E., Kollmann, P., Krimigis, S. M., Brown, L. E., Kusterer, M. B., Lisse, C. M., Mitchell, D. G., Vandegriff, J. D., McComas, D. J., Bagenal, F., Elliott, H. A., Ennico Smith, K., Horanyi, M., Olkin, C., Piquette, M. R., Stern, A., Strobel, D. F., Szalay, J., Valek, P. W., Weaver, H. A., Jr., Weidner, S., Young, L. A., **Zirnstein, E.**, Wolk, S. J. (AGU, December 2015)
- *Energetic Particles in the far and near Environment of Pluto*, Kollmann, P., Hill, M. E., McNutt, R. L., Jr., Brown, L. E., Kusterer, M. B., Vandegriff, J. D., Smith, H. T., Mitchell, D. G., Haggerty, D. K., Bagenal, F., Krimigis, S. M., Lisse, C. M., Delamere, P. A., Elliott, H. A., Horanyi, M., McComas, D. J., Piquette, M. R., Poppe, A. R., Sidrow, E. J., Strobel, D. F., Szalay, J., Valek, P. W., Weidner, S., **Zirnstein, E.**, Ennico Smith, K., Olkin, C., Weaver, H. A., Jr., Young, L. A., Stern, A. (AGU, December 2015)
- *Properties of ENA Source Regions Outside the Heliopause*, Heerikhuisen, J., **Zirnstein, E.**, Gamayunov, K. V., Pogorelov, N., Funsten, H. O., Florinski, V., Ernst, A. E. (AGU, December 2015)
- *The Local Interstellar Magnetic Field Determined from the IBEX Ribbon*, **Zirnstein, E.**, Funsten, H. O., Heerikhuisen, J., Livadiotis, G., McComas, D. J., Pogorelov, N. V. (AGU, December 2015)
- *Spectral Modulation of the IBEX Ribbon Flux by the Dynamic Draping of the Interstellar Medium over the Heliosphere*, Funsten, H. O., Pittman, K. T., Frisch, P. C., Heerikhuisen, J., Janzen, P. H., McComas, D. J., Reisenfeld, D. B., Schwadron, N., **Zirnstein, E.** (AGU, December 2015)
- *Pluto, Near and Far: PEPSSI Measurements of Energetic Particles During the New Horizons Flyby and Investigating a Pluto Torus of Circumsolar Neutral Gas*, Hill, M. E., Kollmann, P., McNutt, R. L., Smith, H. T., Bagenal, F., Brown, L. E., Elliott, H. A., Haggerty, D. K., Horanyi, M., Krimigis, S. M., Kusterer, M., Lisse, C. M., McComas, D. J., Piquette, M., Strobel, D., Szalay, J., Vandegriff, J., **Zirnstein, E.**, Ennico, K., Olkin, C. B., Weaver, H. A., Young, L. A., Stern, S. A. (DPS, November 2015)
- *First Results on Pluto's Energetic Particle Environment from the PEPSSI Instrument*, Kollmann, P., Hill, M. E., McNutt, R., Smith, H. T., Vandegriff, J., Kusterer, M., Brown, L., Haggerty, D. K., Lisse, C. M., Elliott, H. A., Strobel, D., Bagenal, F., Sidrow, E., McComas, D. J., Horanyi, M., **Zirnstein, E.**, Krimigis, S. M., Ennico, K., Young, L. A., Weaver, H. A., Olkin, C. B., Stern, S. A. (DPS, November 2015)
- *The Local Interstellar Magnetic Field Determined from the IBEX Ribbon*, **Zirnstein, E. J.**, McComas, D. J., Livadiotis, G., Heerikhuisen, J., Pogorelov, N. V., Funsten, H. O. (IBEX SWT, Oral, August 2015)
- *The Effects of Slow, Intermediate, and Fast SW Speeds on the IBEX Ribbon*, **Zirnstein, E. J.**, Funsten, H. O., Heerikhuisen, J., McComas, D. J. (AIAC, March 2015)

## 2014

- *How Do  $\kappa$ -Distributed Protons in the Heliosheath Affect Energetic Neutral Atoms*, Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V. (AGU, December 2014)
- *Simulating a Dynamic Solar Cycle and Its Effects on the Interstellar Boundary Explorer Ribbon*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V., McComas, D. J., Dayeh, M. A. (AGU, Poster, December 2014)
- *Heliospheric Structure: The Bow Wave and the Hydrogen Wall*, Zank, G. P., Heerikhuisen, J., Wood, B. E., Pogorelov, N. V., **Zirnstein, E.**, McComas, D. J. (ASPC, May 2014)
- *Global Properties of the Heliospheric Termination Shock as Inferred from Energetic Neutral Atoms Measured by the Interstellar Boundary Explorer (IBEX)*, Desai, M., Heerikhuisen, J., McComas, D., Pogorelov, N., Zank, G., Dayeh, M., Schwadron, N., Allegrini, F., **Zirnstein, E.** (COSPAR, Oral, August 2014)
- *Latest Modeling Results from the Alabama Group*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V., Zank, G. P. (IBEX SWT, Oral, August 2014)
- *A Time-Dependent Simulation of the IBEX Ribbon Flux*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V. (AIAC, Oral, March 2014)

## 2013

- *Spectral properties of  $\sim 0.03$ -6 keV Energetic Neutral Atoms Measured by the Interstellar Boundary Explorer (IBEX) Along the Lines-of-Sight of Voyager*, Desai, M. I., Allegrini, F., Dayeh, M. A., Funsten, H. O., Heerikhuisen, J., McComas, D. J., Pogorelov, N. V., Schwadron, N. A., Fuselier, S. A., Zank, G. P., **Zirnstein, E. J.** (AGU, Oral, December 2013)
- *Spectral Properties of Energetic Neutral Atoms Measured by the Interstellar Boundary Explorer (IBEX) Along the Lines-of-Sight of Voyager*, Desai, M.; McComas, D., Fuselier, S., Dayeh, M., Funsten, H., Heerikhuisen, J., **Zirnstein, E.**, Pogorelov, N., Zank, G. (EGU, Oral, April 2013)
- *Numerical Simulations of the Compton-Getting Effect for H ENAs*, **Zirnstein E. J.**, Heerikhuisen, J. (IBEX SWT, Oral, March 2013)

## 2012

- *Global Modeling of the Heliosphere and the IBEX Ribbon*, Heerikhuisen, J., **Zirnstein, E. J.**, Pogorelov, N. V., Zank, G. P. (AGU, Poster, December 2012)
- *Numerical Simulations of Primary and Secondary Hydrogen ENA Fluxes at 1 AU*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V. (AGU, Poster, December 2012)
- *Numerical Simulations of Primary and Secondary Hydrogen ENA Fluxes at 1 AU*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V. (AIAC, Oral, March 2012)

## 2011

- *Numerical simulations of hydrogen ENAs from 1 AU to the heliopause*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V. (AGU, Poster, December 2011)

## 2010

- *Simulations of Energetic Neutral Hydrogen Within the Heliosphere: Creation, Transport, and Loss*, **Zirnstein, E. J.**, Heerikhuisen, J., Pogorelov, N. V. (AGU, Poster, December 2010)

## STUDENT COMMITTEES

- Ph.D. Committee for Graduate Student Bishwas Lal Shrestha, University of Alabama in Huntsville, Spring 2019-Summer 2021
- Ph.D. Senior Thesis Advisor for Graduate Student Tyler Eddy, Princeton University, Spring

2020

### **COMMITTEES**

- Serving member of NASA's Heliophysics Advisory Committee, 2023-2026

### **PROPOSAL PANELS**

- NASA Postdoctoral Program, Heliophysics and Astrophysics, Primary, Fall 2022
- NASA Postdoctoral Program, Heliophysics and Astrophysics, Primary, Spring 2023

### **SEMINARS & COLLOQUIA**

#### **2022**

- *Observations of Interstellar Pickup Ions in the Heliosphere*, **Zirnstein, E. J.** (Space Sciences Lab, UC Berkeley, October 2022)

#### **2017**

- *IBEX Observations and Simulations of Energetic Neutral Hydrogen from the Heliosphere*, **Zirnstein, E. J.** (Los Alamos National Lab, Theory Seminar, August 2017)

#### **2016**

- *IBEX Observations and Simulations of Energetic Neutral Hydrogen from the Heliosphere*, **Zirnstein, E. J.** (Princeton University, Astroplasmas Seminar, December 2016)

#### **2015**

- *The IBEX Ribbon and the Local Interstellar Magnetic Field*, **Zirnstein, E. J.** (Southwest Research Institute, Space Science Seminar, June 2015)

#### **2014**

- *Simulating Hydrogen Energetic Neutral Atom Flux Measurements for NASA's IBEX Mission*, **Zirnstein, E. J.** (Los Alamos National Lab, Theory Seminar, June 2014)
- *Interpretation of Hydrogen Energetic Neutral Atom Emission Observed by NASA's IBEX Mission*, **Zirnstein, E. J.** (Southwest Research Institute, Space Science Seminar, August 2014)

### **WORKSHOPS**

#### **2021**

- *Role of Pickup Ions in the Outer Heliosphere – Shock Modification*, **Zirnstein, E. J.** (Outer Heliosphere Workshop, Boulder, CO, July 2021)
- *Topical Questions for “Low Energy ENA” Science (<10 keV)*, **Zirnstein, E. J.** (Heliophysics 2050 Workshop, “Outer Heliosphere and Local Interstellar Medium” Session, May 2021)
- *Pickup Ions and Energetic Neutrals: New Horizons' SWAP and IBEX (and then IMAP)*, **Zirnstein, E. J.** (International Space Science Institute, “The Heliosphere in the Local Interstellar Medium 2.020”, Team Workshop, February 2021)

#### **2018**

- *Modeling the IBEX Ribbon in the 3D Heliosphere: An Update*, **Zirnstein, E. J.** (International Space Science Institute, “The Physics of the Very Local Interstellar Medium and its Interaction with the Heliosphere”, Team Workshop, September 2018)

#### **2017**

- *IBEX Observations and Simulations of the Ribbon: Implications for the VLISM*, **Zirnstein, E. J.** (International Space Science Institute, “The Physics of the Very Local Interstellar Medium and its Interaction with the Heliosphere”, Team Workshop, May 2017)

### ***JOURNAL/PROPOSAL REVIEWER***

- *The Astrophysical Journal, The Astrophysical Journal Letters, The Astrophysical Journal Supplement Series, Nature Astronomy, Space Science Reviews, Monthly Notices of the Royal Astronomical Society, Journal of Geophysical Research, Geoscience Letters, Journal of Physics: Conference Series*
- *NASA ROSES – Heliophysics, NASA NESSF – Heliophysics, NASA PP – Heliophysics, Astrophysics*

### ***MEMBERSHIPS***

American Geophysical Union (AGU), American Physical Society (APS) Division of Plasma Physics (DPP), European Geosciences Union (EGU), Sigma Pi Sigma Physics Honor Society (SPS)