

Earl Patrick Bellinger, Ph.D.

Department of Astronomy, Yale University

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Pulsating Stars ★ Stellar Astrophysics ★ Machine Learning ★ Artificial Intelligence

Position

2024 – *Assistant Professor*
Department of Astronomy, Yale University

Education

2015 – 2018 Ph.D. Computer Science / Astrophysics
• Max Planck Institute for Solar System Research, Germany
• Department of Astronomy, Yale University, USA
• Institute of Computer Science, University of Göttingen, Germany

2012 – 2014 M.Sc. Computer Science, minor: Bioinformatics
School of Informatics & Computing, Indiana University, USA
Graduate Fellow of the National Physical Science Consortium

2008 – 2012 B.Sc. Applied Mathematics, concentration: Scientific Computing
B.Sc. Computer Science, concentration: Artificial Intelligence
State University of New York at Oswego, USA
GPA: 3.81/4.0, summa cum laude
Rank #1 overall in Department of Computer Science

Postdoctoral Positions

2021 – 2023 *Postdoctoral Research Fellow*
Max Planck Institute for Astrophysics, Garching, Germany

2018 – 2021 *Postdoctoral Research Fellow*
Stellar Astrophysics Centre, Aarhus University, Denmark

06/2018 – 08/2018 *Postdoctoral Researcher*
Max Planck Institute for Solar System Research, Göttingen, Germany

Research Positions

2019 – 2020 *Visiting Fellow*
School of Physics, UNSW Sydney, Australia

2016 – 2017 *Visiting Assistant in Research*
Department of Astronomy, Yale University, USA

2015 – 2018 *Research Assistant / Doktorand*
Max Planck Institute for Solar System Research, Germany

2013 – 2015 *Research Assistant & Associate Instructor*
School of Informatics and Computing, Indiana University, USA

2013 – 2014	<i>Guest Researcher</i> National Institute of Standards and Technology (NIST), USA
2013	<i>Research Student</i> National Institute of Informatics, Tokyo, Japan
2012	<i>Research Fellow</i> NASA Jet Propulsion Laboratory, USA
2011	<i>IRES/NSF Research Student</i> Federal University of Alagoas, Brazil
2010	<i>IRES/NSF Research Student</i> Federal University of Santa Catarina, Brazil

Teaching

2024	Assistant Professor, Department of Astronomy, Yale University ASTR 330 — <i>Scientific Computing in Astrophysics</i> ASTR 356 — <i>Astrostatistics & Data Mining</i>
2018 – 2021	Assistant, Department of Physics and Astronomy, Aarhus University E20 — <i>Advanced Stellar Structure and Evolution</i> F19 — <i>Advanced Projects in Stellar Evolution</i>
2017	Assistant, Department of Astronomy, Yale University ASTR 550 — <i>Stellar Astrophysics</i>
2016	Assistant, Institut für Astrophysik, Georg-August-Universität Göttingen M.Phys.552 — <i>Numerical Experiments in Stellar Physics</i>
2012	Associate Instructor, School of Informatics and Computing, Indiana University CSCI-C211/A591 — <i>Introduction to Computer Science</i>
2010	Seminar Leader, Honors Program, SUNY Oswego HON 150 — <i>Introduction to Honors</i>

Other Teaching Activities

2023	Organizer, MESA Summer School, Konkoly Observatory, Hungary
2022	Organizer & Lecturer, MESA Summer School, UC Santa Barbara
2022	Invited tutorial, MESA & GYRE, TASC6/KASC13
2022	Invited instructor, MESA@ESO workshop
2023	Research advisor, Kavli summer astrophysics program, MPA (2 students)
2022	Research advisor, MPA internship (3 students)
2021	Research advisor, Kavli summer astrophysics program, virtual (COVID)
2016	Research advisor, MPS internship

Presentations

Invited Talks

- 2024 IAIFI Summer Workshop
MIT
- 2023 11th Applied Inverse Problems Conference
Göttingen, Germany
- 2022 TASC6/KASC13 – TESS/Kepler Asteroseismic Science Consortium
KU Leuven, Belgium
- 2019 TASC5/KASC12 – TESS/Kepler Asteroseismic Science Consortium
MIT
- 2019 Dynamics of the Sun & Stars: Honoring the Life & Work of Michael Thompson
High Altitude Observatory, USA

Invited Seminars/Colloquia

- 2024 Harvard ITC
- 2024 University of Illinois Urbana-Champaign
- 2024 Illinois State University
- 2024 State University of New York at Oswego
- 2023 Heidelberg Institute for Theoretical Studies, Heidelberg, Germany
- 2022 Czech Academy of Sciences, Prague, Czechia
- 2021 KU Leuven, Belgium
- 2021 University of Victoria, British Columbia, Canada
- 2020 Macquarie University, Sydney, Australia
- 2020 Monash University, Melbourne, Australia
- 2019 University of Sydney, Australia
- 2018 Stellar Astrophysics Centre, Aarhus University, Denmark
- 2017 University of Wisconsin–Madison
- 2013 Kyoto University, Japan

Contributed Talks

- 2023 MIAPbP: Stellar Astrophysics in the Era of Gaia, Spectroscopic, and Asteroseismic Surveys
- 2023 Black Hole & Gravitational Wave Day, Garching, Germany
- 2023 VLT-FLAMES Tarantula Survey (VFTS) Collaboration Meeting, Garching, Germany
- 2023 11th Applied Inverse Problems Conference, Göttingen, Germany
- 2022 European Astronomical Society, Valencia, Spain
- 2022 Fundamental stellar parameters from asteroseismology, Aarhus, Denmark
- 2019 Stars in Melbourne, Monash University, Melbourne, Australia
- 2019 Annual Danish Astronomy Meeting (ADAM) 2019, Nyborg, Denmark
- 2018 TESS Asteroseismic Science Consortium 4, Aarhus University, Denmark
- 2017 ERES-III: Emerging Researchers in Exoplanet Science, Yale University, USA
- 2015 RR Lyrae 2015, Visegrád, Hungary

2015 American Astronomical Society, Washington, USA

Workshops (*Invited talk)

- 2023 Flatiron Sun-as-a-star Workshop
- 2021 *PLATO WP122 Liege Workshop #4
- 2021 *MPA–Potsdam Workshop on Hot Subdwarfs, Garching, Germany
- 2020 TESS Ninja 3, University of Sydney, Australia
- 2019 8th Aarhus Red Giants Workshop, Astronomical Observatory of Catania, Italy
- 2017 7th Aarhus Red Giants Workshop, Max Planck Institute for Astrophysics
- 2016 *6th Aarhus Red Giants Workshop, Max Planck Institute for Solar System Research
- 2015 *Indo-US Science Workshop on Variable Stars, Delhi University, Delhi, India
- 2014 *Indo-US Science Workshop on Variable Stars, St. Thomas College, Kerala, India

Awards & Funding

- 2023 Flanders Research Foundation Postdoctoral Fellowship (KU Leuven, deferred)
- 2021 Max Planck Institute for Astrophysics Postdoctoral Fellowship
- 2018 NVIDIA GPU Grant
- 2018 Stellar Astrophysics Centre Postdoctoral Fellowship
- 2012 National Physical Science Consortium Graduate Fellowship
- 2012 SUNY Chancellor's Award for Student Excellence
- 2012 Oebele Van Dyk Outstanding Computer Science Senior Award
- 2008 SUNY Oswego Presidential Scholarship

Professional Activities

Associations

- 2020 – Developer, MESA Stellar Evolution Code
- 2019 – Junior Member, International Astronomical Union

Observing Time

- 2018 δ Eridani – the first SONG-TESS simultaneous target (P.I.)
Instrument: SONG telescope (50 nights)
- 2018 Simultaneous observations of oscillations in Procyon with SONG and TESS (co-P.I.)
Instrument: SONG telescope (30 nights)

Refereeing

The Astrophysical Journal Letters

The Astronomical Journal

Astronomy & Astrophysics

Monthly Notices of the Royal Astronomical Society

Frontiers in Astronomy and Space Sciences

Scientific Organizing

2023	Scientific Organizer, MESA Summer School 2023, Konkoly, Hungary
2022	Organizer and Lecturer, MESA Summer School 2022, UC Santa Barbara
2022	Scientific Organizer, European Astronomical Society 2022 Special Session <i>"Stellar characterization, large data sets, and Machine Learning"</i>
2022	Organizer and Leader, MPA Hackathon, MPI for Astrophysics
2022 –	Organizer, Seminar on Stellar Astrophysics (SESTAS), MPI for Astrophysics
2019 – 2021	Organizer, Stellar Astrophysics Centre Seminar, Aarhus University
2015 – 2018	Organizer, SAGE Seminar Series, Max Planck Institute for Solar System Research

Languages

Human	English (native) German (B2/near fluent) Spanish (A2) Portuguese (A2)
Computer	Expert: Python, R, Bash, LaTeX, CLISP, Scheme, Java, MATLAB Proficient: C, Javascript, HTML, CSS, Perl, SQL, FORTRAN 77/95/08 Familiar: ActionScript, Assembly, BASIC, C++, Haskell, Mathematica, ML, PHP, Prolog, Ruby, VB

Publications – Earl Patrick Bellinger

Number of publications = 64 || first author = 21 || citations = 1282 || h-index = 20

Google Scholar: https://scholar.google.com/citations?user=Woj_Tu4AAAAJ

Publications in peer-reviewed scientific journals

(45, first author = 12, single author = 2, student-led = 16)

1. **Bellinger, E. P.**, de Mink, S. E., van Rossem, W. E., Justham, S. (2024). The Potential of Asteroseismology to Resolve the Blue Supergiant Problem. *The Astrophysical Journal Letters*.
2. **Bellinger, E. P.**, Caplan, M. E., Ryu, T., Bollimpalli, D., Ball, W. H., Kühnel, F., Farmer, R., de Mink, S. E., Christensen-Dalsgaard, J. (2023). Solar evolution models with a central black hole. *The Astrophysical Journal*.
3. **Bellinger, E. P.** & Christensen-Dalsgaard, J. (2022). Towards solar measurements of nuclear reaction rates. *Monthly Notices of the Royal Astronomical Society*.
4. **Bellinger, E. P.**, Basu, S., Hekker, S., Christensen-Dalsgaard, J., Ball, W. (2021). Asteroseismic Inference of the Central Structure in a Subgiant Star. *The Astrophysical Journal*.
5. **Bellinger, E. P.** (2020). A seismic scaling relation for stellar age II. The red giant branch. *MNRAS Letters*.
6. **Bellinger, E. P.**, Kanbur, S. M., Bhardwaj, A., Marconi, M. (2020). When a Period Is Not a Full Stop: Light Curve Structure Reveals Fundamental Parameters of Cepheid and RR Lyrae Stars. *Monthly Notices of the Royal Astronomical Society*.
7. **Bellinger, E. P.** & Christensen-Dalsgaard, J. (2019). Asteroseismic constraints on the cosmic-time variation of the gravitational constant from an ancient main-sequence star. *The Astrophysical Journal Letters*.
8. **Bellinger, E. P.**, Basu, S., Hekker, S., Christensen-Dalsgaard, J. (2019). Testing stellar evolution with asteroseismic inversions of a main sequence star harboring a small convective core. *The Astrophysical Journal*.
9. **Bellinger, E. P.** (2019). A seismic scaling relation for stellar age. *Monthly Notices of the Royal Astronomical Society*.
10. **Bellinger, E. P.**, Hekker, S., Angelou, G. C., Stokholm, A., Basu, S. (2019). Stellar ages, masses and radii from asteroseismic modeling are robust to systematic errors in spectroscopy. *Astronomy & Astrophysics*.
11. **Bellinger, E. P.**, Basu, S., Hekker, S., Ball, W. (2017). Model-independent Measurement of Internal Stellar Structure in 16 Cygni A and B. *The Astrophysical Journal*.
12. **Bellinger, E. P.**, Angelou, G. C., Hekker, S., Basu, S., Ball, W., Guggenberger, E. (2016). Fundamental Parameters of Main-Sequence Stars in an Instant with Machine Learning. *The Astrophysical Journal*.

* denotes the paper was led by a student or postdoc

13. *Ma, L., Johnston, C., **Bellinger, E. P.**, de Mink, S. E. (2024). Variability of Blue Supergiants in the LMC with TESS. *The Astrophysical Journal*.
14. *Deka, M., **Bellinger, E. P.**, Kanbur, S. M., Deb, S., Bhardwaj, A., Randall, R. H., Kalici, S., Das, S. (2024). Bridging theory and observations in stellar pulsations: The impact of convection and metallicity on the instability strips of Classical and Type-II Cepheids. *Monthly Notices of the Royal Astronomical Society*.
15. *Farag, E., Fontes, C. J., Timmes, F.X., **Bellinger, E. P.** et al. (2024). An Expanded Set of Los Alamos OPLIB Tables in MESA: Type-1 Rosseland-mean Opacities and Solar Models. *The Astrophysical Journal*.
16. *Bhuyan, G., Deb, S., Kanbur, S. M., **Bellinger, E. P.**, Deka, M., Bhardwaj, A. (2024). Geometry of the LMC based on multi-phase analysis of multi-wavelength Cepheid light curves using OGLE-IV and Gaia DR3 data. *Monthly Notices of the Royal Astronomical Society*.
17. *Buchele, L., **Bellinger, E. P.**, Hekker, S., Basu, S., Ball, W., Christensen-Dalsgaard, J. (2024). Asteroseismic Inversions for Internal Sound Speed Profiles of Main-sequence Stars with Radiative Cores. *The Astrophysical Journal*.
18. *Wagg, T., Johnston, C., **Bellinger, E. P.**, Renzo, M., Townsend, R., de Mink, S. E. (2024). The Asteroseismic Imprints of Mass Transfer: A Case Study of a Binary Mass Gainer in the SPB Instability Strip. *Astronomy & Astrophysics*.
19. *Santarelli, A. D., Caplan, M. E., **Bellinger, E. P.** (2024). Formation of Sub-Chandrasekhar Mass Black Holes and Red Stragglers via Hawking Stars in Ultra-Faint Dwarf Galaxies. *The Astrophysical Journal*.
20. *Ahlborn, F., **Bellinger, E. P.**, Hekker, S., Basu, S., Mokrytska, D (2024). The robustness of inferred envelope and core rotation rates of red-giant stars from asteroseismology. *Astronomy & Astrophysics*.
21. Caplan, M. E., **Bellinger, E. P.**, Santarelli, A. D. (2024). Is there a black hole in the center of the Sun? *Astrophysics & Space Science* invited article.
22. Lund, Mikkel N. et al. including **Bellinger, E. P.** (2024). The K2 Asteroseismic KEYSTONE sample of Dwarf and Subgiant Solar-Like Oscillators. I: Data and Asteroseismic parameters. *Astronomy & Astrophysics*.
23. *Vanlaer, V., Aerts, C., **Bellinger, E. P.**, Christensen-Dalsgaard, J. (2023). On the feasibility of structure inversions for gravity-mode pulsators. *Astronomy & Astrophysics*.
24. *Wilson, T. A., Casey, A. R., Mandel, I., Ball, W. H., **Bellinger, E. P.**, Davies, G. R. (2023). Constraining the Rotation Profile in a Low-Luminosity Subgiant with a Surface Rotation Measurement. *Monthly Notices of the Royal Astronomical Society*.

25. Farmer, R., Renzo, M., Götberg, Y., **Bellinger, E. P.**, Justham, S., de Mink, S. E. (2023). Observational predictions for Thorne-Żytkow objects. *Monthly Notices of the Royal Astronomical Society*.
26. *Ahlborn, F., **Bellinger, E. P.**, Hekker, S., Basu, S., Mokrytska, D (2022). Improved asteroseismic inversions for red-giant surface rotation rates. *Astronomy & Astrophysics*.
27. *Deka, Kanbur, Deb, Das, Kurbah, **Bellinger, Bhardwaj** (2022). Period-Colour and Amplitude-Colour relations for OGLE δ Scuti stars in the Galactic Bulge and LMC. *Monthly Notices of the Royal Astronomical Society*.
28. *Vynatheya, P., Hamers, A. S., Mardling, R. A., **Bellinger, E. P.** (2022). Algebraic and machine learning approach to hierarchical triple-star stability. *Monthly Notices of the Royal Astronomical Society*.
29. Jermyn, Bauer, Schwab, Farmer, Ball, **Bellinger**, et al. (2022). Modules for Experiments in Stellar Astrophysics (MESA): Time-Dependent Convection, Energy Conservation, Automatic Differentiation, and Infrastructure. *The Astrophysical Journal Supplement Series*.
30. Caplan, M. E., Freeman, I. F., Horowitz, C. J., Cumming, A., **Bellinger, E. P.** (2021). Cooling Delays from Iron Sedimentation and Iron Inner Cores in White Dwarfs. *The Astrophysical Journal Letters*, 919 (1).
31. Grunblatt, S. et al. including **Bellinger, E. P.** (2021). Age-Dating Red Giant Stars Associated with Galactic Disk and Halo Substructures. *The Astrophysical Journal*, 916 (2).
32. Plachy, E. et al. including **Bellinger, E. P.** (2021). TESS observations of Cepheid stars: first light results. *The Astrophysical Journal Supplement Series*, 253 (1).
33. *Hon, M., **Bellinger, E. P.**, Hekker, S., Stello, D., Kuzlewicz, J. S. (2020). Asteroseismic Ages of Subgiant Stars with Deep Learning, *Monthly Notices of the Royal Astronomical Society*, 499 (2).
34. *Ahlborn, F., **Bellinger, E. P.**, Hekker, S., Basu, S., Angelou, G. C. (2020). On the asteroseismic sensitivity to internal rotation along the red-giant branch. *Astronomy & Astrophysics*, 639, A98.
35. Angelou, G. C., **Bellinger, E. P.**, Hekker, S., Mints, A., Elsworth, Y., Basu, S., Weiss, A. (2020). Convective boundary mixing in low- and intermediate-mass stars I. Core properties from pressure-mode asteroseismology. *Monthly Notices of the Royal Astronomical Society*, 493 (4).
36. Angelou, G. C., **Bellinger, E. P.**, Hekker, S., Basu, S. (2017). On the Statistical Properties of the Lower Main Sequence. *The Astrophysical Journal*, 839 (2), 116.
37. Glover, M., **Bellinger, E. P.**, Radivojac, P., Clemmer, D. (2015). Penultimate Proline in Neuropeptides. *Analytical Chemistry*, 87 (16), 8466–8472.
38. *Das, S., Kanbur, S. M., **Bellinger, E. P.**, Bhardwaj, A., Singh, H. P., Meerdink, B., Proietti, N.,

- Chalmers, A., Jordan, R. (2020). The stellar photosphere-hydrogen ionization front interaction in Classical Pulsators: a theoretical explanation for observed period-colour relations. *Monthly Notices of the Royal Astronomical Society*, 493 (1).
39. Bo Nielsen, M. et al. including **Bellinger, E. P.** (2020). TESS asteroseismology of the known planet host star λ^2 Fornacis, *Astronomy & Astrophysics*, 641, A25.
 40. Christensen-Dalsgaard, J. et al. including **Bellinger, E. P.** (2020). The Aarhus Red Giants Challenge II: Stellar oscillations in the red giant branch phase. *Astronomy & Astrophysics*, 635, A165.
 41. Silva Aguirre, V. et al. including **Bellinger, E. P.** (2020). The Aarhus Red Giants Challenge I: Stellar structures in the red giant branch phase. *Astronomy & Astrophysics*, 635, A164.
 42. Tang, Y., Basu, S., Davies, G. R., **Bellinger, E. P.**, Gai, Ning (2018). Asteroseismology of KIC 8263801: Is it a member of NGC 6866 and a red clump star? *The Astrophysical Journal*, 866 (1), 59.
 43. Guggenberger, E., Hekker, S., Basu, S., Angelou, G. C., **Bellinger, E. P.** (2017). Mitigating the mass dependence in the $\Delta\nu$ scaling relation of red-giant stars. *Monthly Notices of the Royal Astronomical Society*, 470 (2).
 44. Guggenberger, E., Hekker, S., Basu, S., **Bellinger, E. P.** (2016). Significantly improving stellar mass and radius estimates: A new reference function for the $\Delta\nu$ scaling relation. *Monthly Notices of the Royal Astronomical Society*, 461 (2).
 45. Ji, C., Li, Y. F., **Bellinger, E. P.**, Li, S., Arnold, R. J., Radivojac, P., Tang, H. (2015). A maximum-likelihood approach to absolute protein quantification in mass spectrometry. In refereed proceedings of the 6th ACM Conference on Bioinformatics, Computational Biology and Health Informatics (pp. 296-305).
 46. Ngeow, C. C., Kanbur, S. M., **Bellinger, E. P.**, Marconi, M., Musella, I., Cignoni, M., & Lin, Y. H. (2012). Period-luminosity relations for Cepheid variables: from mid-infrared to multi-phase. *Astrophysics & Space Science*, 341(1), 105-113.

Publications in conference proceedings
(13, first author = 6)

47. **Bellinger, E. P.**, Basu, S., Hekker, S. (2020). Inverse analysis of asteroseismic data: a review. *Dynamics of the Sun & Stars*.
48. **Bellinger, E. P.**, Angelou, G. C., Hekker, S., Basu, S., Ball, W., Guggenberger, E. (2017). Fundamental Parameters in an Instant with Machine Learning: Application to Kepler LEGACY Targets. *Seismology of the Sun and Distant Stars*, EPJ Web of Conferences, Volume 160, id.05003.

49. **Bellinger, E. P.**, Wysocki, D., Kanbur, S. M. (2015). Measuring amplitudes of harmonics and combination frequencies in variable stars. *Communications from the Konkoly Observatory of the Hungarian Academy of Sciences*, 105.
50. **Bellinger, E. P.**, Kanbur, S. M., & Ngeow, C.-C. (2012). New insights into the Cepheid PL Relation through the use of multiphase relations. *Proceedings of the 20th Stellar Pulsations Conference*.
51. **Bellinger, E. P.** (2012). Multiphase Relations of Magellanic Cloud Cepheids. *Proceedings of the 2012 National Conference on Undergraduate Research*.
52. **Bellinger, E. P.**, Kanbur, S. M., & Ngeow, C.-C. (2011). Multiphase Comparison of Period-Luminosity Relations for Magellanic Cloud Cepheids. *Proceedings of the 9th Pacific Rim Conference on Stellar Astrophysics*, 451, 311.
53. Kanbur, S. M., **Bellinger, E. P.**, Bhardwaj, A., Marconi, M. (2020). Light Curve Structure Reveals Fundamental Parameters of Cepheid and RR Lyrae Stars. *Proceedings of RR Lyrae 2019*.
54. *Das, S., Kanbur, S. M., **Bellinger, E. P.**, Bhardwaj, A., Singh, H. P. (2020). A study of the stellar photosphere-hydrogen ionisation front interaction in pulsating variables using period-color relations. *ASP Conference Series*, 529.
55. *Ahlborn, F., **Bellinger, E. P.**, Hekker, S., Basu, S., Angelou, G. C. (2020). Rotational inversions along the lower part of the red-giant branch. *Stars and their Variability Observed from Space*.
56. Kanbur, S. M., **Bellinger, E. P.**, Bhardwaj, A., Marconi, M. (2020). Light Curve Structure Reveals Fundamental Parameters of Cepheid and RR Lyrae Stars. *RR Lyrae 2019*.
57. Reyner, S., **Bellinger, E. P.**, & Kanbur, S. M. (2012). The approximation of RR Lyrae and eclipsing binary light curves using cubic polynomials. *Proceedings of the 20th Stellar Pulsations Conference*.
58. Bhardwaj, A., Kanbur, S. M., Marconi, M., Das, S., **Bellinger, E. P.**, Singh, H. P., Rejkuba, M., Ngeow, C.-C. (2018). Time-series analyses of Cepheid and RR Lyrae variables in the wide-field variability surveys. *LAUS347: Early Science with ELTs*.
59. Hekker, S., Elsworth, Y., Basu, S., **Bellinger, E. P.** (2017). Evolutionary states of red-giant stars from grid-based modelling. *Seismology of the Sun and Distant Stars*, EPJ Web of Conferences, Volume 160, id.04006.

Additional publications
(total = 5, first author = 3)

60. Heike Rauer et al. including **Bellinger, E. P.** (2024). The PLATO Mission.
61. The MSE Science Team et al. including **Bellinger, E. P.** (2019). The Detailed Science Case for the Maunakea Spectroscopic Explorer.
62. **Bellinger, E. P.** (2019). An idea to an image: the prediction and confirmation of black holes. Invited book review, *Metascience*, 29 (1), Cambridge: Harvard University Press.
63. **Bellinger, E. P.** (2018). Inverse Problems in Asteroseismology. Doctoral thesis, *International Max Planck Research School*.
64. **Bellinger, E. P.**, Conner, D., Mittman, D., Magee, K., & Heventhal, B. (2012). CASSIUS: the Cassini Uplink Scheduler. *Jet Propulsion Laboratory: National Aeronautics and Space Administration*, hdl:2014/43122.