Susan F. Redmond BEng, MEng, MASc, PhD

David and Ellen Lee Distinguished Scholar Fellow

1216 E California Blvd, Pasadena, California

sredmond@caltech.edu

+1 626 379-4271

Education

Princeton University **2018 – 2023**

Ph.D. in Mechanical and Aerospace Engineering

Advisors: Jeremy Kasdin, Egemen Kolemen, William Jones

Thesis topic: High Contrast Imaging for Direct Imaging of Exoplanets

University of Toronto Institute for Aerospace Studies **2015 – 2018**

Master of Applied Science in Aerospace Engineering (Sept. 2016 – Aug. 2018)

Thesis topic: Stratospheric Thermal Design for Balloon Telescopes

Advisors: Christopher Damaren, Barth Netterfield

Master of Engineering in Aerospace Engineering (Sept. 2015 - Aug. 2016)

Cumulative G.P.A.- 3.97

Memorial University of Newfoundland **2010 – 2015**

Bachelor of Mechanical Engineering

Cumulative G.P.A.- 3.93, Average- 88.5%

Research & Teaching Experience

Postdoctoral Research Scholar **Oct. 2023 – Present**

California Institute of Technology, USA

Jet Propulsion Laboratory, USA

- Expanded on dark zone maintenance algorithm to stabilize the electric field at the science camera in the presence of wavefront drifts for space-based high contrast imaging (dark zone maintenance) to perform real-time estimation of the residual starlight and planet light separately
- Demonstrated effectiveness of existing post-processing techniques with dark zone maintenance data sets and developed two novel post-processing techniques for extracting the planet signal
- Performed hardware upgrades for the In-Air Coronagraph Testbed at the Jet Propulsion Laboratory and implemented dark zone maintenance algorithm (ongoing)
- Participated in the data analysis of the 2023 Super-pressure Ballon-borne Imaging Telescope (SuperBIT) galaxy cluster data and the development of the next-generation Gigapixel Ballon-borne Imaging Telescope (GigaBIT)
- Aided in the development of the robustness analysis pipeline as part of the Coronagraph Design Survey team

PhD Student Active Optics Design & Control **Sept. 2018 – Sept. 2023**

Princeton University, USA

- Aided in the development of an algorithm to stabilize the electric field at the science camera in the presence of wavefront drifts for space-based high contrast imaging (dark zone maintenance)
- Implemented dark zone maintenance algorithm on the High Contrast Imager for Complex Aperture Telescopes testbed at the Space Telescope Science Institute and performed parameter study
- Participated in the 2019 & 2023 flight campaigns for the SuperBIT payload and the 2022 flight campaign for the SPIDER-II payload

Visiting Researcher **June 2022 – Sept. 2022**

Jet Propulsion Laboratory, USA

- Worked with High Contrast Imaging Laboratory to implement dark zone maintenance algorithm on two high-contrast testbeds
- Collaborated with the SuperBIT data analysis team in the Dark Sector group to perform a sensitivity study for redshift accuracy to decide filter bandwidths (ongoing)
- Delivered two talks through the Science Visitor and Colloquium Program
- Attended Roman Space Telescope project science meetings

Teaching Assistant (Heat Transfer, Space Flight) **Sept. 2020 – Dec. 2020**
Princeton University, USA **Sept. 2021 – Dec. 2021**

- Prepared and delivered supporting lecture each week to compliment topics covered in class and prepare students for assignments
- Graded and created solutions for assignments and tests
- Held weekly office hours to help students with assigned work and deal with any issues, including software debugging and managing testing environment accomodations

MASc Student SuperBIT Thermal Design **Sept. 2016 – Aug. 2018**
University of Toronto, CAN

- Developed program to determine required thermophysical and optical properties based on desired temperature profile
- Participated in the 2017 integration and testing pre-flight campaigns and the 2018 flight campaign for the SuperBIT payload
- Created PID gain auto-tuning algorithm for heater control on the SuperBIT payload
- Developed tool to determine distortion of primary mirror due to thermal loads based on temperature profile calculated in Thermal Desktop
- Structural redesign and rebuild of the Spider balloon-borne telescope in accordance with NASA requirements

Professional Experience

Mechanical Engineering Intern **Sept. 2014 – Dec. 2014**
European Space Agency (ESTEC), Noordwijk, NLD

- In partnership with the robotics division, developed a Matlab program to simulate and animate motion of new robotic arm in Large Space Simulator
- Commenced preliminary design for a test facility to determine dynamic mass of spacecraft components
- Participated in the Concurrent Design meetings for the Athena project

Mentoring of Students

2017	**Michael Stramenga**	4-month summer intern, undergraduate, co-advised by Barth Netterfield
2017	**Bryce Wu**	4-month summer intern, undergraduate, co-advised by Barth Netterfield
2017	**Doris Ye**	12-month undergraduate researcher, co-advised by Barth Netterfield
2018	**Celina Pasiecznik**	4-month summer intern, undergraduate, co-advised by Barth Netterfield
2018	**Julia Pasiecznik**	4-month summer intern, undergraduate, co-advised by Barth Netterfield
2022	**Nicholas Belsten**	MIT PhD candidate, supervisor: Kerri Cahoy
2022-2023	**Christine Page**	MIT PhD candidate, supervisor: Kerri Cahoy
2023	**Alex Meredith**	MIT PhD candidate, supervisor: Kerri Cahoy
2023	**Saikrishna Manojkumar**	MIT PhD candidate, supervisor: Kerri Cahoy

Software Proficiency & Other Skills

- Proficient in Python and Matlab/Simulink
- Experience with C/C++/Rust
- Expertise in high-contrast imaging & Fourier optics
- Optical testbed operation and alignment experience
- Mechanical/electrical hardware experience
- Skilled with SolidWorks and AutoCad
- Interdisciplinary leadership and teamwork skills
- GitHub expertise

Honors & Awards

- David and Ellen Lee Distinguished Scholar Fellow (2023)
- Martin Summerfield Graduate Fellowship recipient (2019-2020)
- CSME Gold Medal for Outstanding Academic Achievement (2015)

Outreach

- **2023** Interviewed with Luminus: Memorial University of Newfoundland Alumni Magazine, Princeton Alumni Weekly, CBC Newfoundland and Labrador, and the Princeton Department of Mechanical and Aerospace Engineering regarding my research
- **2016-2023** Yearly outreach talk to Grade 6 students at Cowan Heights Elementary School
- **2022** Organized and presented at event for the St. John's Centre of the Royal Astronomical Society of Canada
- **2021** Presented at the Mechanical and Aerospace Engineering research day at Princeton University
- **2021** Presented as part of the Women in STEM series organized by Oyster-Adams Bilingual School
- **2020** Organized virtual outreach event with Howard University
- **2019-2020** Presented as part of the Open Labs Science Cafe for local middle school students organized by Princeton University

Peer-Reviewed Publications

Susan F. Redmond, Laurent Pueyo, Emiel Por, Raphaël Pourcelot, Iva Laginja, Meiji M. Nguyen, Bryony Nickson, N. Jeremy Kasdin, Marshall D. Perrin, Leonid Pogorelyuk, and Rémi Soummer, "Exoplanet detection techniques for direct imaging dark zone maintenance data sets", *[Manuscript in preparation]*

Susan F. Redmond (2023), *Correcting for Quasi-static Wavefront Error Drifts in High-contrast and Wide-field Imaging Telescopes* [Doctoral dissertation], Princeton University

Susan F. Redmond, Laurent Pueyo, Leonid Pogorelyuk, Emiel Por, James Noss, Scott D. Will, Iva Laginja, Keira Brooks, Matthew Maclay, J. Fowler, N. Jeremy Kasdin, Marshall D. Perrin, and Rémi Soummer, "Implementation of a dark zone maintenance algorithm for speckle drift correction in a high contrast space coronagraph", *Journal of Astronomical Telescopes, Instruments, and Systems*, 2022

Ajay Gill, Steven J. Benton, (18 additional authors not shown), **Susan F. Redmond**, Jason D. Rhodes, Andrew Robertson, L. Javier Romualdez, Jürgen Schmoll, Mohammed M. Shabaan, Ellen Sirks, Georgios N. Vassilakis, and Sut-Ieng Tam. "SuperBIT superpressure flight performance: diffraction-limited astronomical imaging from the stratosphere," *[Manuscript submitted for publication]*

Scott D. Will, Marshall D. Perrin, Emiel H. Por, James Noss, Ananya Sahoo, Peter Petrone, Iva Laginja, Raphael Pourcelot, **Susan F. Redmond**, Laurent Pueyo, Tyler D. Groff, James R. Fienup, and Remi Soummer, "High-order coronagraphic wavefront control with algorithmic differentiation: first experimental demonstration," *Journal of Astronomical Telescopes, Instruments, and Systems*, 2023

Ellen Sirks, Richard Massey, Ajay Gill, Jason Anderson, Steven J. Benton, (27 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, (8 additional authors not shown), Georgios N. Vassilakis. "Data Downloaded via Parachute from a NASA Super-Pressure Balloon," *Aerospace*, 2023

Raphaël Pourcelot, Mamadou N'Diaye, Emiel H. Por, Iva Laginja, Marcel Carbillet, Hervé Benard, Gregory Brady, Ludovic Canas, Kjetil Dohlen, J. Fowler, Olivier Lai, Matthew Maclay, Evelyn McChesney, James Noss, Marshall D. Perrin, Peter Petrone, Laurent Pueyo, **Susan F. Redmond**, Ananya Sahoo, Arthur Vigan, Scott D. Will, and Rémi Soummer, "Low-order wavefront control using a Zernike sensor through Lyot coronagraphs for exoplanet imaging," *Astronomy & Astrophysics*, 2022

Ajay Gill, Steven J. Benton, Anthony M. Brown, (19 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, L. Javier Romualdez, Jürgen Schmoll, Mohammed M. Shabaan, Ellen Sirks, Suresh Sivanandam, and Sut-Ieng Tam. "Optical Night Sky Brightness Measurements from the Stratosphere," *The Astronomical Journal*, 2020

Ellen Sirks, Paul Clark, (20 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, L. Javier Romualdez, Jürgen Schmoll, Mohammed M. Shabaan, Ellen Sirks, and Sut-Ieng Tam. "Download by parachute: retrieval of assets from high altitude balloons," *The Journal of Instrumentation*, 2020

L. Javier Romualdez, Steven J. Benton, Anthony M. Brown, (19 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, Jürgen Schmoll, Mohammed M. Shabaan, Ellen Sirks, and Sut-Ieng Tam. "Robust diffraction-limited NIR-to-NUV wide-field imaging from stratospheric balloon-borne platforms - SuperBIT science telescope commissioning flight & performance," *Review of Scientific Instruments*, 2019

A.S. Bergman, P.A.R. Ade, (50 additional authors not shown), A.S. Rahlin, **S. Redmond**, C. Reintsema, L.J. Romualdez, J.E. Ruhl, M.C. Runyan, et al. (19 additional authors not shown). "280 GHz Focal Plane Unit Design and Characterization for the SPIDER-2 Suborbital Polarimeter," *Journal of Low Temperature Physics,* 2018

Conference Proceedings

Ruslan Belikov, Christopher Stark, Nick Siegler, Emiel Por, Bertrand Mennesson, Pin Chen, Kevin Fogarty, Olivier Guyon, Roser Juanola-Parramon, John Krist, Dimitri Mawet, Camilo Mejia Prada, Jeremy Kasdin, Laurent Pueyo, **Susan Redmond**, Garreth Ruane, Dan Sirbu, Karl Stapelfeldt, John Trauger, Neil Zimmerman, "Coronagraph design survey for future exoplanet direct imaging space missions: interim update," SPIE Optics + Photonics Conference, San Diego, USA, 2023

Raphaël Pourcelot, Emiel H. Por, Mamadou N'Diaye, Benjamin Buralli, Marcel Carbillet, Kjetil Dohlen, Sylvain Egron, Marc Ferrari, Rachel Fox, Rob Gontrum, Iva Laginja, Meiji M. Nguyen, Bryony Nickson, Marshall D. Perrin, Peter Petrone, Laurent Pueyo, **Susan F. Redmond**, Ananya Sahoo, Anand Sivaramakrishnan, Hari B. Subedi, Sam Weinstock, Scott D. Will, Rémi Soummer, John G. Hagopian, "High-contrast imager for complex aperture telescopes (HiCAT): 10. Broadband Zernike wavefront sensor under natural and artificial drifts," SPIE Optics + Photonics Conference, San Diego, USA, 2023

Ananya Sahoo, Emiel H. Por, Meiji M. Nguyen, Iva Laginja, Raphaël Pourcelot, **Susan F. Redmond**, Bryony Nickson, Sylvain Egron, Laurent Pueyo, Marshall D. Perrin, Peter Petrone, Rachel Fox, Marc Ferrari, Rob Gontrum, John Hagopian, Mamadou N'Diaye, Anand Sivaramakrishnan, Hari B. Subedi, Sam Weinstock, Scott D. Will, Rémi Soummer, "High-contrast imager for complex aperture telescopes (HiCAT): 9. Broadband dark zone demonstration with the APLC coronagraph," SPIE Optics + Photonics Conference, San Diego, USA, 2023

Susan F. Redmond, Laurent Pueyo, Leonid Pogorelyuk, Emiel Por, James Noss, Iva Laginja, Keira Brooks, Matthew Maclay, J. Fowler, N. Jeremy Kasdin, Marshall D. Perrin, and Rémi Soummer, "Dark zone maintenance for future coronagraphic space missions", SPIE Astronomical Telescopes + Instrumentation Conference, Montreal, CA 2022

Rémi Soummer, Emiel H. Por, Raphaël Pourcelot, **Susan Redmond**, Iva Laginja, Scott D. Will, Marshall D. Perrin, Laurent Pueyo, Ananya Sahoo, Peter Petrone, Keira J. Brooks, Rachel Fox, Alex Klein, (17 additional authors not shown), "High-contrast imager for complex aperture telescopes (HiCAT): 8. Dark zone demonstration with simultaneous closed-loop low-order wavefront sensing and control," SPIE Astronomical Telescopes + Instrumentation Conference, Montreal, CA 2022

Susan F. Redmond, Laurent Pueyo, Leonid Pogorelyuk, Emiel Por, James Noss, Scott D. Will, Iva Laginja, N. Jeremy Kasdin, Marshall D. Perrin, and Rémi Soummer, "Implementation of a broadband focal plane estimator for high-contrast dark zones", SPIE Optics + Photonics Conference, San Diego, USA, 2021

Scott D. Will, Marshall D. Perrin, Emiel H. Por, James Noss, Ananya Sahoo, Peter Petrone, Iva Laginja, Raphael Pourcelot, **Susan M Redmond**, Laurent Pueyo, Tyler D. Groff, James R. Fienup, and Remi Soummer, "Wavefront control with algorithmic differentiation on the HiCAT testbed," SPIE Optics + Photonics Conference, San Diego, USA, 2021

Rémi Soummer, Iva Laginja, Scott Will, Marshall D. Perrin, James Noss, Emiel H. Por, **Susan Redmond**, Raphaël Pourcelot, Ananya Sahoo, Peter Petrone, Keira Brooks, Laurent Pueyo, Bryony Nickson, (26 additional authors not shown), "High-contrast imager for complex aperture telescopes (HiCAT): 7. Dark zone demonstration with fully segmented aperture coronagraph," SPIE Optics + Photonics Conference, San Diego, USA, 2021

Susan F. Redmond, Laurent Pueyo, Leonid Pogorelyuk, Emiel Por, James Noss, Iva Laginja, Keira Brooks, Marshall D. Perrin, Rémi Soummer, and N. Jeremy Kasdin, "Dark zone maintenance results for segmented aperture wavefront error drift in a high contrast space coronagraph", SPIE Optics + Photonics Conference, San Diego, USA, 2021

Susan F. Redmond, N. Jeremy Kasdin, Leonid Pogorelyuk, Rémi Soummer, Laurent Pueyo, Marshall D. Perrin, Matthew Maclay, James Noss, Iva Laginja, Scott D. Will, and Julia Fowler, "Implementation of a dark hole maintenance algorithm for speckle drift in a high contrast space coronagraph", SPIE Astronomical Telescopes + Instrumentation Conference, Virtual, 2020

Elle C. Shaw, Peter A.R. Ade, Scott Akers, Mandana Amiri, (54 additional authors not shown), **Susan F. Redmond**, Carl Reintsema, Marcus Runyan, L. Javier Romualdez, (18 additional authors not shown), Ed Y. Young, "Design and pre-flight performance of SPIDER 280 GHz receivers," SPIE Astronomical Telescopes + Instrumentation Conference, Virtual, 2020

Susan Redmond, Steven J. Benton, Paul Clark, Christopher J. Damaren, Tim Eifler, Aurelien A. Fraisse, Mathew N. Galloway, John W. Hartley, William C. Jones, Lun Li, Thuy Vy T. Luu, Richard J. Massey, C. Barth Netterfield, Ivan Padilla, Jason D. Rhodes, L. Javier Romualdez, and Jürgen Schmoll. "Auto-tuned Thermal Control on Balloon-borne Experiments," SPIE Astronomical Telescopes + Instrumentation Conference, Austin, USA, 2018

L. Javier Romualdez, Steven J. Benton, Paul Clark, (11 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, and Jürgen Schmoll. "Overview, design, and flight results from SuperBIT: a high-resolution, wide-field, visible-to-near-UV balloon-borne astronomical telescope," SPIE Astronomical Telescopes + Instrumentation Conference, Austin, USA, 2018

Mathew N. Galloway, Steven J. Benton, (12 additional authors not shown), **Susan Redmond**, Jason D. Rhodes, L. Javier Romualdez, Jürgen Schmoll. "Diffraction Limited Visible/Near UV Imaging from the Stratosphere," presented at the CASCA Annual Meeting, Edmonton, Canada, 2017