

Andrew J Ryan

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Curriculum Vitae

Education

- 2018, 2013 **Ph.D. and M.S. in Geological Sciences**, School of Earth and Space Exploration, Arizona State University, Tempe, AZ. Advisor: Phil Christensen
- 2011 **B.S. in Environmental Geosciences** (physics minor), Department of Geography, Geology, and the Environment, Slippery Rock University, Slippery Rock, PA. *Magna Cum Laude*.

Professional Experience

- 2020– Staff Research Scientist
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ
- 2019–2020 Postdoctoral Research Associate
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ
- 2018–2019 Postdoctoral Researcher
Observatoire de la Côte d’Azur and Université Côte d’Azur, Nice, France
- 2012–2018 Graduate Research Assistant
Arizona State University, Tempe, AZ
- 2011–2012 Graduate Teaching Assistant
Arizona State University, Tempe, AZ
- 2011 Internship Program Staff Assistant, NASA Lunar and Planetary Science Academy, Goddard Space Flight Center, Greenbelt, MD
- 2010 Undergraduate Intern, NASA Lunar and Planetary Science Academy, Goddard Space Flight Center, Greenbelt, MD
- 2009 Undergraduate Intern, NASA Undergraduate Student Research Program (USRP), Johnson Space Center, Houston, TX

Space Mission Involvement

- OSIRIS-APEX** Mission Co-I, Thermal Analysis Lead (2023–2031)
- OSIRIS-REx** Mission Co-I (2021–2025), **Sample Analysis Working Group Lead**: Sample Physical and Thermal Analysis Working Group (SPTAWG, 2020–2025), **Instrument Operations Specialist**: OTES Instrument (2016–2017)
- Mars Exploration Rovers** **Payload Downlink Lead** (2015–2017)
Opportunity Rover – Pancam Instrument
- Mars Odyssey** **THEMIS Science Team Member** (2011–2018)
THEMIS calibration and data analysis

Grants and Fellowships

- 2021–2024 **Co-Investigator**, NASA Solar System Workings (SSW), *The spectral and thermophysical effects of thin dust coatings in a simulated airless body environment*, PI: Timothy Glotch
- 2021–2024 **Collaborator**, NASA New Frontiers Data Analysis Program (NFDAP), *Timescales for boulder evolution from thermal fatigue and impacts on asteroid (101955) Bennu*, PI: Jamie Molaro
- 2021–2024 **Co-Investigator**, NASA New Frontiers Data Analysis Program (NFDAP), *Integrated boulder properties on rubble pile asteroid (101955) Bennu as tracers of parent body history*, PI: Erica Jawin
- 2020–2024 **Principal Investigator**, NASA Solar System Workings (SSW), *Thermal Conductivity and Apparent Thermal Inertia of Coarse and Porous Planetary Regoliths*.
- 2015–2017 **Student Collaborator**, NASA OSIRIS-REx Mission, *OSIRIS-REx Regolith Thermal Conductivity Laboratory Experiment*, PI: Phil Christensen
- 2012–2016 **Student Collaborator**, NASA Mars Fundamental Research Program (MFRP), *Thermal Conductivity Laboratory Measurements of Complex Surfaces with Applications to Mars*, PI: Phil Christensen

Refereed Publications

- [30] Connolly, H.C. Jr., et al. (2025). An overview of the petrography and petrology of particles from aggregate sample from asteroid Bennu. *Meteoritics & Planetary Science*, doi: 10.1111/maps.14335.
- [29] Lauretta, D. S., et al. (2024). Asteroid (101955) Bennu in the laboratory: Properties of the sample collected by OSIRIS-REx. *Meteoritics & Planetary Science*, 59, 9, 2453–2486.
- [28] **Ryan, A.**, Rozitis, B., Pino Muñoz, D., et al. (2024). Rocks with extremely low thermal inertia at the OSIRIS-REx sample site on asteroid Bennu. *Planetary Science Journal*, 5:92.
- [27] Jawin, E., Ballouz, R., **Ryan, A.**, Kaplan, H., et al. (2023). Boulder Diversity in the Nightingale Region of Asteroid (101955) Bennu and Predictions for Physical Properties of the OSIRIS-REx Sample. *Journal of Geophysical Research: Planets* 128, e2023JE008019.
- [26] Tinker, C., Glotch, T., Breitenfeld, L., **Ryan, A.**, and Li, L. (2023). Experimental and analytical methods for thermal infrared spectroscopy of complex dust coatings in a simulated asteroid environment. *RAS Instrument Techniques* 2, 723–734.
- [25] DellaGiustina, D. N., et al. (2023). OSIRIS-APEX: An OSIRIS-REx Extended Mission to Asteroid Apophis. *Planetary Science Journal* 4, 198.
- [24] Gowman, G., Asphaug, E., **Ryan, A.**, Hoover, Christian, Cotto-Figueroa, D., and Garvie, L. (2023). Roughness and Angularity of Fragments from Meteorite Disruption Experiments. *Planetary Science Journal* 4, 187. DOI: 10.3847/PSJ/acf5e9
- [23] Clark, B.E. et al. (2023). Overview of the search for signs of space weathering on the low-albedo asteroid (101955) Bennu. *Icarus* 400. DOI: 10.1016/j.icarus.2023.115563

- [22] **Ryan, A.J.** et al., Full-Field Modeling of Heat Transfer in Asteroid Regolith 2: Effects of Porosity (2022). *Journal of Geophysical Research: Planets* 127, e2022JE007191. DOI: 10.1029/2022JE007191
- [21] Rozitis, B., **Ryan, A.J.**, Emery, J. P., et al. High-Resolution Thermophysical Analysis of the OSIRIS-REx Sample Site and Three Other Regions of Interest on Bennu (2022), *Journal of Geophysical Research: Planets* 127, e2021JE007153. DOI: 10.1029/2021JE007153
- [20] Lauretta et al. (2022). Spacecraft sample collection and subsurface excavation of asteroid (101955) Bennu, *Science*, DOI: 10.1126/science.abm1018.
- [19] Walsh et al. (2022b). Near-zero cohesion and loose packing of Bennu's near-subsurface revealed by spacecraft contact, *Science Advances*, abm6229.
- [18] Walsh et al. (2022). Assessing the sampleability of Bennu's surface for the OSIRIS-REx asteroid sample return mission, *Space Sci. Rev.* 218, 20. DOI: 10.1007/s11214-022-00887-2
- [17] Jawin, E.R., McCoy, T.J., Walsh, K.J., Connolly Jr., H.C., Ballouz, R.-L., **Ryan, A.J.**, et al. (2022), Global geologic map of asteroid (101955) Bennu indicates heterogeneous resurfacing in the past 500,000 years, *Icarus*, 114992. DOI: 10.1016/j.icarus.2022.114992
- [16] Cambioni, S., Delbo, M., Poggiali, G., Avdellidou, C., **Ryan, A.J.**, Deshapriya, J.D.P., et al. (2021), Fine-regolith production on asteroids controlled by rock porosity, *Nature* 598. DOI: 10.1038/s41586-021-03816-5
- [15] Golish, D.R. et al. (2021), Regional Photometric Modeling of Asteroid (101955) Bennu, *Planetary Science Journal* 2, 124.
- [14] Li, J.-Y. et al. (2021), Spectrophotometric Modeling and Mapping of (101955) Bennu, *Planetary Science Journal* 2, 117.
- [13] Rozitis, B., **Ryan, A.J.**, Emery, J.P., Christensen, P.R., et al. (2020), Asteroid (101955) Bennu's Weak Boulders and Thermally Anomalous Equator, *Science Advances* 6, eabc3699. DOI: 10.1126/sciadv.abc3699
- [12] DellaGiustina, D.N. et al. (2020) Variations in color and reflectance on the surface of asteroid (101955) Bennu, *Science* 370. DOI: 10.1126/science.abc3660
- [11] Simon, A.A. et al. (2020) Widespread carbon-bearing materials on near-Earth asteroid (101955) Bennu, *Science* 370. DOI: 10.1126/science.abc3522
- [10] Daly, M.G., et al., Hemispherical Differences in the Shape and Topography of Asteroid (101955) Bennu (2020), *Science Advances* 6, 41. DOI: 10.1126/sciadv.abd3649
- [9] Scheeres, D.J., et al., Heterogenous mass distribution of the rubble-pile asteroid (101955) Bennu (2020), *Science Advances* 6, 41. DOI: 10.1126/sciadv.abc3350
- [8] **Ryan, A.J.** and K.X. Whipple (2020), Amphitheater-headed canyons of southern Utah: Stratigraphic control of canyon morphology, *Earth Surface Processes and Landforms* 45. 3607–3622. DOI: 10.1002/esp.4987
- [7] **Ryan, A.J.**, Pino-Munoz, D., Bernacki, M., and M. Delbo (2020), Full-Field Modeling of Heat Transfer in Asteroid Regolith: Radiative thermal conductivity of polydisperse particulates, *Journal of Geophysical Research: Planets* 125, e2019JE006100.
- [6] Molaro, J.L. et al. (2020), In situ evidence of thermally induced rock breakdown widespread on Bennu's surface, *Nature Communications* 11, 2913.

- [5] DellaGiustina, D.N., Emery, J.P., et al. (2019), Properties of rubble-pile asteroid (101955) Bennu from OSIRIS-REx imaging and thermal analysis, *Nature Astronomy* 3, p. 341–351.
- [4] Walsh, K.J. et al. (2019), Craters, boulders and regolith of (101955) Bennu indicative of an old and dynamic surface, *Nature Geoscience* 12, p. 242–246.
- [3] Cambioni, S., Delbo, M., **Ryan, A.J.**, Furfaro, R., and E. Asphaug (2019), Constraining the Thermal Properties of Planetary Surfaces using Machine Learning: Application to Airless Bodies, *Icarus* 325, p. 16–30.
- [2] Kletetschka, G., Hooke, R. L., **Ryan, A. J.**, Fercana, G., McKinney, E., and K. P. Schwebler (2013), Sliding stones of Racetrack Playa, Death Valley, USA: The roles of rock thermal conductivity and fluctuating water levels, *Geomorphology* 195, p. 110 – 117.
- [1] **Ryan, A. J.** and P. R. Christensen (2012), Coils and Polygonal Crust in the Athabasca Valles Region, Mars, as Evidence for a Volcanic History, *Science* 336, p. 449–452.

Teaching and Mentorship

Advisor to undergraduate student employees and interns:

Savannah Smith (2024–2025)
 Zach Purdie (2022–2023)
 Laurinne Blanche (2022–2023)
 Derek Lee (2022–2023)
 Maanyaa Kapur (2021–2023)
 Jackson Barger (2021–2022)
 Zane Craddock (2021)
 Matthew Askins (2016)
 Jon Zaloumis (2013–2015)

- 2021–2022 **Project Sponsor**, Univ. of Arizona senior design Capstone project to design and build a gas pycnometer for OSIRIS-REx sample analysis. Mentor to 6 undergraduate engineering students.
- 2020–2021 **Project Sponsor**, Univ. of Arizona senior design Capstone project to develop a thermal conductivity measurement device for OSIRIS-REx returned samples. Mentor to 6 undergraduate engineering students.
- 2016–2017 **Phoenix Cubesat Mission Advisor**
 Arizona State University Sun Devil Satellite Laboratory
- 2014–2015 **Introduction to Geology Lecture (GLG-101) - Instructor**
 Mesa Community College, Mesa, AZ
- 2013 **Introduction to Exploration (SES-100) - Assistant**
 Arizona State University, Tempe, AZ
- 2011–2012 **Introduction to Geology Lab (GLG-103) - Instructor**
 Arizona State University, Tempe, AZ

Laboratory and Instrument Development

- 2024– Design lead for lunar thermal environmental chamber goniometer
- 2021–2024 Design co-lead of a *non-contaminating ideal gas pycnometer* for OSIRIS-REx sample analysis in curation clean room (with Robert Macke, S.J.)
- 2021–2023 Design lead of novel *spherical cell thermal conductivity analyzer* for measurement of OSIRIS-REx sample analysis.
- 2015–2018 Design, assembly, calibration, operation, and data analysis of thermal vacuum conductivity experiment for asteroid regolith simulants, Arizona State University, Tempe, AZ.
- 2016–2017 Thermal vacuum chamber instrument testing: Instrument operator for OSIRIS-REx Thermal Emission Spectrometer (OTES) for instrument tests at ASU and full spacecraft test at Lockheed Martin. Chamber operator for the student-led “Phoenix” CubeSat infrared camera instrument TVAC test.
- 2016–2017 Thermal infrared dispersion prism spectrometer design, assembly, and testing with SciSight LLC startup, Tempe, AZ.
- 2013–2017 Operation, calibration, and maintenance of Mars environmental vacuum chamber for thermal conductivity experiments, Arizona State University, Tempe, AZ.

Awards and Honors

- 2024 **Icarus Best Reviewers Award**
- 2024 **Robert J. Collier Trophy** – OSIRIS-REx Mission Team
- 2021 **Asteroid (31985) Andrewryan**
- 2018 **NASA Group Achievement Award** - OSIRIS-REx Earth Gravity Assist Team
- 2017 **NASA Group Achievement Award** - OSIRIS-REx OTES Development Team
- 2017 **NASA Group Achievement Award** - OSIRIS-REx Team
- 2016 **Edson Student Entrepreneurship Initiative Award Recipient** - Seed funding, resources, and mentorship for IR spectroscopy startup concept at Arizona State
- 2013 **Scholarship Recipient** - NASA Planetary Volcanology Field Workshop, Hawaii
- 2012 **Scholarship Recipient** - LPI/NLSI Sudbury, Ontario Impact Structure Camp
- 2012 **Dwornik Award – Best Graduate Poster (honorable mention)**
GSA Planetary Geology Division, 43rd Lunar and Planetary Sci. Conf.
- 2011 **University Graduate Fellowship** - School of Earth and Space Exploration and Graduate College, Arizona State University
- 2011 **Outstanding Senior Man** - Awarded to one male in graduating class by faculty nomination. Slippery Rock University.
- 2010 **Departmental Service Award** - Department of Geography, Geology, and the Environment, Slippery Rock University.

2008, 2009 **Presidential Scholar**, Awarded to top 20 students in each class, based on GPA. Slippery Rock University.

Planetary Analog Field Work

2015 Iceland - Laki 1783–84 and Haluhraun 2014–15 lava flows
2014 Hawaii - Dec. 1974 Kilauea fissure eruption
2012 Southern Utah - Escalante National Monument and Henry Mountains

Outreach and Invited Lectures

2022 **Invited Speaker**, Making Space: A Workshop on Space, SciArt, & Society
2022 **Colloquium Speaker**, Lunar and Planetary Laboratory Colloquium, University of Arizona (Tucson, AZ)
2021 **Invited Speaker**, Undergraduate seminar class “The Heritage and Traditions of the University of Arizona” (AED295b)
2021 **“Space Show” Guest**, Motherboard (Vice Magazine) *Space Show* – “How to Grab an Asteroid” (<https://www.youtube.com/watch?v=ASrjZImPavw>)
2020 **Invited Speaker**, Observatoire de la Côte d’Azur Planetary Science Seminar
2016, 2017 **Science Panelist**, Phoenix Comic Con (now Phoenix Fan Fusion)
2016–2017 **Mars Science Consultant**, “Port of Mars” Massive Multiplayer Online game, Arizona State University Interplanetary Initiative
Spring 2016 **Science Career Mentor**, ASU Sundial Mentoring Program.
Fall 2013 **Invited Speaker**, ASU College of Liberal Arts and Sciences Academy Forum
2012–2016 **Mars Science Educator**, ASU Earth and Space Open House, share recent Mars science with local families.
June 2012 **Assistant Field Guide**, NASA Lunar and Planetary Science Academy, assist in planning and leading planetary geology field trip in Arizona.
2011–2016 **Guest Instructor and Panel Member**, Mars Student Imaging Project, work with 5th-12th grade student scientists.
June 2011 **Assistant Field Guide**, NASA Lunar and Planetary Science Academy, assist in planning and leading planetary geology field trip in the Channeled Scablands.

Service to Scientific Community

Peer-Reviewer (Journals): *Astronomy and Astrophysics*; *Earth and Space Science*; *Geology*; *Geophysical Research Letters*; *Icarus*; *Journal of Geophysical Research - Planets*; *Monthly Notices of the Royal Astronomical Society*; *Nature Astronomy*; *Planetary Science Journal*; *Planetary and Space Science*

NASA ROSES reviews: Panelist, external reviewer, and executive secretary

PDS (Planetary Data System) Small Bodies Node - data peer-reviewer

Conference organization: 4th Workshop on Thermal Models for Planetary Science, TherMoPS IV (Science organizing committee member, 2023)

Technical Skills

Spacecraft and remote sensing data (high-level user):

Bennu: OSIRIS-REx Thermal Emission Spectrometer (OTES), OSIRIS-REx Camera Suite (OCAMS) data products, OSIRIS-REx Laser Altimeter (OLA) data products

Mars: Mars Global Surveyor Thermal Emission Spectrometer (TES), Mars Odyssey Thermal Emission Imaging System (THEMIS)

Computer languages and software:

Extensive experience: COMSOL Multiphysics (heat transfer), Cimlib FE library, UNIX/Linux, J-Mars/J-asteroid, LabView, Python, Davinci, Paraview, Dragonfly, ArcGIS, Netgen, OAR and TORQUE batch schedulers for cluster computing

Some experience: C/C++, MySQL, PostgreSQL, Matlab, Java, Solidworks, FreeCAD

Languages

English - Native

French - Intermediate-high proficiency

Conference Participation (lead author only)

[23] Ryan, A. J., Haberle, C. W., Emery, J. P., Kaplan, H. H. Farnocchia, D., Nolan, M. C. and DellaGiustina, D. N. (2025) Variations in Thermal Inertia Expected Due to Apophis' Tumbling Rotation. *Apophis T-4 Years workshop*.

[22] Ryan, A. J., et al. (2025). Bennu's Low Thermal Inertia: Insights from Multi-Scale Analysis of Returned Samples. *56th Lunar and Planetary Science Conference*, #1221.

[21] Ryan, A. J., Pino Muñoz, D., Bernacki, M., and Delbo, M. (2025) Surprising Regolith Thermal Behavior Revealed by 3D Modeling of Sphere Beds. *56th Lunar and Planetary Science Conference*, #2424.

[20] Ryan, A.J., Ballouz, R.-L., Macke, R. J., et al., (2024). Physical and Thermal Properties of OSIRIS-REx Samples: Insight into the Evolution of Bennu and its Regolith. *55th Lunar and Planetary Science Conference*, #1594 (talk).

[19] Ryan, A.J. and the OSIRIS-REx team (2022). Coordinated Thermal and Physical Analysis of OSIRIS-REx Samples of Asteroid Bennu. *Hayabusa Symposium 2022* (invited talk).

[18] Ryan, A.J., Craddock Z.A., Cherian S.K., Gibson M.N., McCommon A.T., Ochoa, A.D., Ouyang, J., Siegler, M., Lauretta, D.S. (2021), Thermal Conductivity Measurement Plan for Samples Returned by OSIRIS-REx. *84th Annual Meeting of the Meteoritical Society*, #6237 (talk)

[17] Ryan, A.J., Pino-Muñoz, D., Rozitis, B., Bernacki, M., Delbo, M., et al. (2020), Thermophysical Analysis of Regolith on (101955) Bennu: The Coarse Regolith Conundrum. *Euoplanet Science Congress ESPC2020* (invited talk).

- [16] Ryan, A.J.,** Pino-Muñoz, D., Rozitis, B., Emery, J., and others (2019), Physical Interpretation of Bennu's Thermal Inertia. *Joint meeting of the DPS/EPSC*, EPSC-DPS2019-324-1 (poster).
- [15] Ryan, A.J.,** Pino-Muñoz, D., Emery, J. P., Delbo, M., Rozitis, B., et al. (2019), Thermal Modeling to Determine the Existence and Nature of Layered Material on Bennu, *Asteroid Science in the Age of Hayabusa2 and OSIRIS-REx*, LPI Contrib. No. 2189, Abstract 2071 (talk).
- [14] Ryan, A.J.,** Pino-Muñoz, D., Bernacki, M., Delbo, M., Emery, J., and D. Lauretta (2019), Asteroid regolith thermophysical properties: Porosity and skin-depth effects, *Asteroid Science in the Age of Hayabusa2 and OSIRIS-REx*, LPI Contrib. No. 2189, Abstract 2070 (poster).
- [13] Ryan, A.J.,** Pino-Muñoz, D., Bernacki, M., Delbo, M., Emery, J., Christensen, P.R., and D. Lauretta (2019), Full-Field Modeling of Heat Transfer in Asteroid Regolith: Thermal Conductivity Results for Mono- and Polydisperse Particulates, *50th Lunar and Planetary Science Conference*, Abstract 2512 (Poster).
- [12] Ryan, A.J.,** Delbo, M., Pino-Muñoz, D., Bernacki, Christensen, P.R., Emery, J.P., and D.S. Lauretta (2018), Regolith Thermophysical Properties: Experimental Thermal Conductivity Results and a New Full-field Thermophysical Model, *TherMoPS III Meeting*, Budapest, Hungary (Talk).
- [11] Ryan, A.J.,** Pino-Muñoz, D., Bernacki, M., and M. Delbo, (2018), Full Field Modeling of Heat Transfer in Asteroid Regolith, *Programme National de Planétologie 2018*, Nice, France (poster).
- [10] Ryan, A.J.** and P.R. Christensen (2017), Measurements of Regolith Simulant Thermal Conductivity Under Asteroid and Mars Surface Conditions, *American Geophysical Union 2017 Fall Meeting*, P33H-05 (Talk).
- [9] Ryan, A.J.** and P.R. Christensen (2016), New laboratory technique to determine thermal conductivity of complex regolith simulants under high vacuum, *American Geophysical Union 2016 Fall Meeting*, P21A-2078 (Poster).
- [8] Ryan, A.J.,** and K.X. Whipple (2014), An Investigation of Amphitheater-Headed Canyon Distribution, Morphology Variation, and Longitudinal Profile Controls in Escalante and Tarantula Mesa, Utah, *American Geophysical Union 2014 Fall Meeting*, EP31D (Poster).
- [7] Ryan, A.J.,** Hamilton, C.W., and P.R. Christensen (2014), Coils in context: Dynamics of the Athabasca Valles Lava Flow, *8th International Conference on Mars*, 1404 (Poster).
- [6] Ryan, A.J.,** Piqueux, S., and P.R. Christensen (2014), Radiometric determination of thermal conductivity of complex particulate materials under Mars-like conditions, *45th Lunar and Planetary Science Conference*, 2220 (Poster).
- [5] Ryan, A.J.,** Salvatore, M. R., Smith, R. E., Edwards, C. S., and P. R. Christensen (2013), Solving for the Surface: An Automated Approach to THEMIS Atmospheric Correction, *American Geophysical Union 2013 Fall Meeting*, P51G (Poster).

[4] Ryan, A. J., Whipple, K. X., and J.P. Johnson (2012), Are amphitheater-headed canyons indicative of a particular formative process?, *American Geophysical Union 2012 Fall Meeting*, EP51A-0969 (Poster).

[3] Ryan, A. J. and P.R. Christensen (2012), Lava Coils and Drifting Polygonal Terrain in Cerberus Palus, Mars, *43rd Lunar and Planetary Science Conference*, abstract 2552 (Poster).

[2] Ryan, A.J. and 9 others (2011), Lifting of the Clast by Water and Ice: An Explanation for the Trails of the Racetrack and Bonnie Claire Playas, *Geological Society of America Abstracts with Programs* 43, p. 139.

[1] Ryan, A.J. and M.J. Zieg (2010), Petrographic and Geochemical Analysis of a Nipigon Diabase Sill. *Institute on Lake Superior Geology Proceedings* 56, p. 58-59.