Andrew J Ryan

University of Arizona, Tucson, AZ, USA
ajryan@orex.lpl.arizona.edu; ajryan4@arizona.edu

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=ASrjZlmPavw)

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 5^{th}-12^{th} 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: 4^{th} 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. *Europlanet 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.