YANG LIU

Lunar and Planetary Institute
3600 Bay Area Blvd
Houston, TX 77058

Cell: (314) 954-5634
Office: (281)486-2149
Email: liu@lpi.usra.edu

EDUCATION

Ph.D. Earth and Planetary Sciences, *Washington University in St. Louis*, St. Louis, MO 2013

Dissertation: Spectral Identification and Analyses of Hydrous Mineral Deposits: Implication for the Aqueous History of Aram Chaos and Melas Chasma, Mars

M.S. Earth and Planetary Sciences, *Washington University in St. Louis*, St. Louis, MO 2010

B.S. Physics, *Shandong University*, Shandong, China 2008

PROFESSIONAL & RESEARCH EXPERIENCE

Postdoctoral Fellow, *Lunar and Planetary Institute* 2017-present

- Visible and near infrared (VNIR) study of Mars
- Far ultraviolet (FUV) study of the Moon

Postdoctoral Fellow, *Southwest Research Institute* 2015-2017

- LAMP far ultraviolet (FUV) data calibration and data analysis
- FUV study of the Moon (photometry, impact, and space weathering)
- The LRO Lyman-Alpha Mapping Project (LAMP) map production and PDS delivery
- Southwest Ultraviolet Reflectance Chamber (SwURC) calibration

Postdoctoral Researcher, *Stony Brook University* 2013-2014

- Quantitatively spectral unmixing analysis of Mars near-infrared hyperspectral remote sensing data

Graduate Research and Teaching Assistant, *Washington University in St. Louis* 2008-2013

- Remote sensing image and spectroscopic studies of mineralogy, morphology, and stratigraphy of hydrated deposits on Mars
- Radiative transfer modeling with applications to Mars
- Laboratory study of Martian analog materials using FTIR, mid-Infrared, and laser Raman spectroscopy

SPACECRAFT MISSIONS PARTICIPATION

NASA LRO LAMP: Team member and co-investigator 2015-present

NASA MRO CRISM: Graduate student team member 2009-2013

ESA Mars Express OMEGA: Graduate student team member 2009-2013

PROFESSIONAL SERVICE

Panel for LPI Career Development Award (2018)

External reviewer for NASA ROSES Lunar Data Analysis Program (2017)

External reviewer for NASA ROSES Earth and Space Science Fellowship Program (2017)

Reviewer for NASA Postdoctoral Program (2016)

Journal reviewer for *Journal of Geophysics Research-Planets, Icarus, Planetary and Space Science*

Conference session chair for 11th International GeoRaman Conference, Saint Louis, Missouri, June, 2014.

Conference poster and oral presentation judge for AGU, LPSC

FUNDING

#Funded

1. **Title:** LAMP co-investigator during NASA LRO's Third Extended Mission
   PI: Kurt Retherford **Co-I:** Yang Liu **Agency:** NASA

#Pending

1. **Title:** Constraining the Aqueous History of Jezero Crater and NE Syrtis, Mars Using Quantitative Compositional Analyses
   PI: Yang Liu **Agency:** NASA/ROSES MDAP
2. **Title:** Refining far-ultraviolet (FUV) assessment of lunar hydration from LRO-LAMP observations through laboratory studies and radiative transfer modeling
   PI: Ujjwal Raut **Co-I**: Yang Liu **Agency:** NASA/ROSES LDAP
   Agency: NASA/ROSES LDAP
3. **Title:** Solar Wind Interaction with Lunar Magnetic Anomalies and Relationship to Regolith Composition and Spectral Properties
   PI: Georgiana Kramer **Co-I**: Yang Liu **Agency:** NASA/ROSES LDAP

PEER REVIEWED PUBLICATIONS

Liu, Y., K. D. Retherford, T. K. Greathouse, U. Raut, A. R. Hendrix, K. E. Mandt, G. R. Gladstone, J. T. Cahill, A. F. Egan, D. E. Kaufmann, C. Grava, W. R. Pryor et al. (2018), The wavelength dependence of lunar phase curve as seen by LRO LAMP, *J. Geophys. Res. Planets*, in revision.

Raut, U., P. L. Karnes, K. D. Retherford, M. W. Davis, **Y. Liu**, G. R. Gladstone, E. L. Patrick Thomas K. Greathouse, A. R. Hendrix, P. Mokashi (2018), Far-Ultraviolet photometric response of Apollo soil 10084, *J. Geophys. Res. Planets*, 123, https://doi.org/10.1029/2018JE005567

Liu, Y. (2018), Raman, Mid-IR, and NIR Spectroscopic Study of Calcium Sulfates and a Case Study on Mapping Gypsum Abundance on Mars, *Planet. Space Sci.*, https://doi.org/10.1016/j.pss.2018.04.010

Liu, Y., T. A. Goudge, J. G. Catalano, and A. Wang (2017), Spectral and stratigraphic mapping of hydrated minerals associated with interior layered deposits near the southern wall of Melas Chasma, Mars, *Icarus*, 302, 62–79. https://doi.org/10.1016/j.icarus.2017.11.006.

Liu, Y., T. D. Glotch, N. A. Scudder, M. L. Kraner, T. Condus, R. E. Arvidson, E. A. Guinness, M. J. Wolff, and M. D. Smith (2016), End-member identification and spectral mixture analysis of CRISM hyperspectral data: A case study on southwest Melas Chasma, Mars, *J. Geophys. Res. Planets, 121*, doi:10.1002/2016JE005028.

Liu, Y. and J. G. Catalano (2016), Implications for the aqueous history of southwest Melas Chasma, Mars as revealed by interbedded hydrated sulfate and Fe/Mg-smectite deposits, *Icarus*, *271*, p. 283-291, doi:10.1016/j.icarus.2016.02.015.

Wang, A., B. L. Jolliff, **Y. Liu**, and K. Connor (2016), Setting constraints on the nature and origin of the two major hydrous sulfates on Mars: Monohydrated and polyhydrated sulfates, *J.*

Geophys. Res. Planets, *121*, doi:10.1002/2015JE004889.

Liu, Y. and A. Wang (2015), Dehydration of Na-jarosite, ferricopiapite, and rhomboclase at temperatures of 50 and 95 °C: implications for Martian ferric sulfates. *J. Raman Spectrosc.*, 46, 493-500, doi: 10.1002/jrs.4655.

Liu, Y., R. E. Arvidson, M. J. Wolff, M. T. Mellon, J. G. Catalano, A. Wang, and J. L. Bishop (2012), Lambert albedo retrieval and analyses over Aram Chaos from OMEGA hyperspectral imaging data, *J. Geophys. Res. Planets*, *117*, E000J11, doi:10.1029/2012JE004056.

MANUSCRIPTS IN PREPARATION

Liu, Y., K. D. Retherford, T. K. Greathouse, K. E. Mandt, U. Raut, J. T. Cahill, A. A. R. Hendrix, G. R. Gladstone, F. Egan, D. E. Kaufmann, W. R. Pryor, et al. (2018), LAMP FUV characteristics of the new impacted crater on the Moon, *manuscript in prep.*

Liu, Y. et al. (2018), Hydration state and mineral abundances of Gale crater as inferred from the OMEGA and CRISM hyperspectral data, *manuscript in prep*.

CONFERENCE PAPERS AND ABSTRACTS

1. **Y. Liu**, K. D. Retherford, T. K. Greathouse, K. E. Mandt, J. T. S. Cahill, A. R. Hendrix, U. Raut, C. Grava, D. M. Hurley, B. Byron, L. O. Magana, A. F. Egan, D. E. Kaufmann, C. Grava, G. R. Gladstone, W. R. Pryor, LRO LAMP Photometric Corrections and Far-UV Investigations of New Impact Craters, Cold Spots, and Space Weathering on the Moon, *New Views of the Moon 2 – Asia*, The University of Aizu, Japan, April 18-20, 2018.
2. **Liu, Y**., K. D. Retherford, T. K. Greathouse, A. R. Hendrix, K. E. Mandt, G. R. Gladstone, J. T. Cahill, A. F. Egan, D. E. Kaufmann, C. Grava, W. R. Pryor, A Far Ultraviolet Photometric Correction for LRO LAMP, *49rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 19-23 March, 2018.
3. Retherford K. D., T. K. Greathouse, G. R. Gladstone, K. E. Mandt, A. R. Hendrix, J. T. S. Cahill, **Y. Liu**, C. Grava, D. M. Hurley, A. F. Egan, D. E. Kaufmann, U. Raut, B. D. Byron, L. O., Magana, A. M. Stickle, D. Y. Wyrick, W. R. Pryor, LRO Lyman Alpha Mapping Project (LAMP) Far-UV Investigations of Lunar Composition, Porosity, and Space Weathering, *American Geophysical Union Fall meeting*, New Orleans, LA, 11-15 Dec, 2017.
4. Raut, U., P. L. Karnes, K. D. Retherford, M. W. Davis, **Y. Liu**, E. L. Patrick, P. Mokashi (2017), Far-ultraviolet bidirectional photometry of Apollo soil 10084: new results from the Southwest Ultraviolet Reflectance Chamber (SwURC), American Geophysical Union Fall Meeting, New Orleans, LA, 11-15 Dec, 2017.
5. Mandt, K. E., E. Mazarico, T. K. Greathouse, B. Byron, K. D. Retherford, G. R. Gladstone, **Y. Liu**, A. R. Hendrix, D. M., Hurley, A. F. Egan, D. E. Kaufmann, P. O. Hayne, S. A. Stern, J. Wm. Parker, M. W. Davis, C. Grava, D. M. Hurley, A. M. Stickle, G. W. Patterson, J. T. S. Cahill, J.-P. Williams, LRO-LAMP Observations of Illumination Conditions in the Lunar South Pole: Implications for Volatile Retention, *49th Meeting of the AAS Division for Planetary Sciences*, Provo, UT, 15-20 October 2017
6. **Liu, Y**., K. D. Retherford, T. K. Greathouse, A. R. Hendrix, J. T. Cahill, K. E. Mandt, G. R.

Gladstone, A. F. Egan, D. E. Kaufmann, C. Grava, W. R. Pryor, The wavelength dependence of lunar phase curve as seen by LRO LAMP, *The 2017 Annual Meeting of the Lunar Exploration Analysis Group (LEAG 2017)*, Columbia, Maryland, 10-12 October, 2017.

7. **Liu, Y**., K. D. Retherford, T. K. Greathouse, A. R. Hendrix, K. E. Mandt, G. R. Gladstone, J. T. Cahill, A. F. Egan, D. E. Kaufmann, C. Grava, W. R. Pryor, The wavelength dependence of lunar phase curve as seen by LRO LAMP, *48rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 20-24 March, 2017.
8. Cahill J. T. S., A. A. Wirth, A. R. Hendrix, K. D Retherford, B. W. Denevi, A. M. Stickle, D. M. Hurley, K. E. Mandt, **Y. Liu**, T. K. Greathouse, F. Vilas, and D. Blewett, The widening distribution and extent of lunar swirls as observed by LAMP, *48rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 20-24 March, 2017.
9. Wirth, A. A., J. T. S. Cahill, A. R. Hendrix, K. E. Mandt, **Y. Liu**, K. D Retherford, B. T. Greenhagen, B. W. Denevi, A. M. Stickle, D. M. Hurley, T. K. Greathouse, F. Vilas, and D. Blewett, Discrete lunar nearside anomalies in nighttime Lyman-α albedo maps, *48rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 20-24 March, 2017.
10. Raut U., P. L. Karnes, K. D. Retherford, M. W. Davis, **Y. Liu**, E. L. Patrick, P. Mokashi, Exploring reflectance standards in the far ultraviolet: precursor calibration studies for lunar simulants and apollo soils in the Southwest Ultraviolet Reflectance Chamber (SwURC), *48rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 20-24 March, 2017.
11. **Liu, Y**., K. D. Retherford, T. K. Greathouse, A. R. Hendrix, K. E. Mandt, G. R. Gladstone, J. T. Cahill, A. F. Egan, D. E. Kaufmann, C. Grava, W. R. Pryor, The wavelength dependence of lunar phase curve as seen by LRO LAMP, *American Geophysical Union Fall meeting*, San Francisco, CA, 12-17 Dec, 2016.
12. Retherford K. D., T. K. Greathouse, G. R. Gladstone, A. R. Hendrix, K. E. Mandt, A. F. Egan, D. E. Kaufmann, P. O. Hayne, S. A. Stern, J. Wm. Parker, M. W. Davis, C. Grava, D. M. Hurley, J. T. S. Cahill, A. M. Stickle, **Y. Liu**, M. A. Bullock, W. R. Pryor, P. D. Feldman, J. Mukherjee, P. Mokashi, C. J. Seifert, and M. H. Versteeg, LRO Lyman Alpha Mapping Project (LAMP) Far-UV albedo maps: A new view of the Moon, *the New Views of the Moon 2*, Houston, Texas, 24-26 May, 2016.
13. Cahill, J. T. S., A. R. Hendrix, K. D. Retherford, B. W. Denevi, A. M. Stickle, D. M. Hurley, T. K. Greathouse, **Y. Liu**, and K. E. Mandt, New global observation of Lunar regolith maturation in the far-ultraviolet, *the New Views of the Moon 2*, Houston, Texas, 24-26 May, 2016.
14. Retherford K. D., T. K. Greathouse, G. R. Gladstone, A. R. Hendrix, K. E. Mandt, A. F. Egan, D. E. Kaufmann, P. O. Hayne, S. A. Stern, J. Wm. Parker, M. W. Davis, C. Grava, D. M. Hurley, J. T. S. Cahill, A. M. Stickle, **Y. Liu**, M. A. Bullock, W. R. Pryor, P. D. Feldman, J. Mukherjee, P. Mokashi, C. J. Seifert, and M. H. Versteeg, LRO Lyman Alpha Mapping Project (LAMP) Far-UV albedo maps: A new view of the Moon, *47rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 21-25 March, 2016.
15. Cahill, J. T. S., A. R. Hendrix, K. D. Retherford, B. W. Denevi, A. M. Stickle, D. M. Hurley, T. K. Greathouse, **Y. Liu**, and K. E. Mandt, Far-ultraviolet mapping of lunar swirls and other enigmatic low-albedo features, *47rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 21-25 March, 2016.

16. **Liu, Y.**, T. D. Glotch, N. A. Scudder, M. L. Kraner, T. Condus, R. E. Arvidson, E. A. Guinness, M. J. Wolff and M. D. Smith, Spectral unmixing of CRISM hyperspectral data over southwest Melas Chasma, Mars, *47rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 21-25 March, 2016.
17. **Liu, Y.**, K. D. Retherford, M. W. Davis, P. S. Mokashi, E. L. Patrick, P. L. Karnes, and G. R. Gladstone, The SwRI ultraviolet reflectance chamber (SwURC): progress toward a far ultraviolet surface reflectance library, *47rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 21-25 March, 2016.
18. Retherford, K. D., **Y. Liu**, A. R. Hendrix, T. K. Greathouse, G. R. Gladstone, K. E. Mandt, E. L. Patrick, A. F. Egan, D. E. Kaufmann, D. M. Hurley, J. T. S. Cahill, and W. R. Pryor, Lunar Reconnaissance Orbiter LAMP Investigations of Space Weathering, *Workshop on Space Weathering of Airless Bodies*, Houston, TX, 2-4 November, 2015.
19. **Liu, Y.,** K. D. Retherford, M. W. Davis, T. K. Greathouse, G. R. Gladstone, , J. R. Dickinson, and D. E. George, SwRI's Lyman Alpha Vision Analyzer (LAVA) Cubesat Concept: A far-UV imager system for lunar water frost and volatile transport investigations, *5th International Workshop on LunarCubes*, San Jose, CA, 6-9 October, 2015.
20. **Liu, Y.**, K. D. Retherford, and G. R. Gladstone, LRO-Lyman alpha mapping project (LAMP) far-UV maps of the lunar poles, *Lunar and Small Bodies Graduate Conference*, NASA Ames, Mountain View, California, July, 2015.
21. **Liu, Y.** and T. D. Glotch, Implication on aqueous history of Mars as revealed by hydrous minerals in southwest Melas Chasma, *Eighth International Conference on Mars*. Abstract# 1438, Pasadena, Los Angeles, 14-17 July, 2014.
22. **Liu, Y.** and A. Wang (2014), Dehydration of Mars relevant ferric sulfates at high temperatures studied by laser Raman spectroscopy, *11th International GeoRaman Conference*. Abstract# 5036, Saint Louis, Missouri, 15-19, June, 2014.
23. **Liu, Y.** and T. D. Glotch (2014), Spectral mixture analysis of hydrated minerals in southwest Melas Chasma. *45rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 17-21 March, 2014.
24. Glotch, T. D, J. L. Bandfield, M. J. Wolff, J. A. Arnold, C. Che, and **Y. Liu** (2013), Composition and physical properties of salt-bearing surfaces on Mars. *45th Meeting of the American Astronomical Society's Division for Planetary Sciences (DPS)*, Denver, Colorado, 6-11 October, 2013
25. **Liu, Y.,** R. E. Arvidson, and J. G. Catalano (2013), Spectral and stratigraphic mapping phyllosilicates and hydrated sulfates in southwest Melas Chasma and environmental implications on Mars. *44rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 18-22 March, 2013.
26. **Liu, Y.** and R. E. Arvidson (2012), Identification of phyllosilicates and sulfates near the southern wall of Melas Chasma on Mars. *American Geophysical Union Fall meeting*, San Francisco, CA, 3-7 December, 2012.
27. **Liu, Y.,** R. E. Arvidson, R. Li, and W. Wang (2012), Hydrated minerals associated with interior layered deposits near the southern wall of Melas Chasma, Valles Marineris, Mars. *43rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 19-23 March, 2012.
28. **Liu, Y.** and A. Wang (2012), Dehydration of jarosite, ferricopiapite, and rhomboclase at high T and implications on Martian ferric sulfates. *43rd Lunar and Planetary Science Conference*, The

Woodlands, Texas, 19-23 March, 2012.

29. **Liu, Y.** and R. E. Arvidson (2011). Hydrated sulfates associated with interior layered deposits near the southern wall of Melas Chasma. *American Geophysical Union Fall meeting*, San Francisco, CA, 5-9 December, 2011.
30. **Liu, Y.** and R. E. Arvidson (2011). Spectroscopic and stratigraphic mapping of hydrated mineral in Aram Chaos and Melas Chasma, Mars. *CRSIM Team Meeting*, Denver, CO, 2-3 November, 2011.
31. **Liu, Y.**, R. E. Arvidson, M. J. Wolff, and M. T. Mellon (2010), Retrieval and interpretation of 0.4 to 4.0 μm Lambert albedos over Aram Chaos from Mars Express OMEGA data. *American Geophysical Union Fall meeting*, San Francisco, CA, 13-17 December, 2010.
32. **Liu, Y.**, A. Wang, and J. J. Freeman (2009), Raman, MIR, and NIR spectroscopic study of calcium sulfates: gypsum, bassanite, and anhydrite. *40rd Lunar and Planetary Science Conference*, The Woodlands, Texas, 23-27 March, 2009.

OUTREACH ACTIVITIES

1. 3 hours' presentations and activities to help the elementary students with designing a space station on Mars for their semester project, January 2016
   - Session 1: 3rd to 5th grade GT program students at Memorial Elementary school, New Braunfels, TX (53 students)
   - Session 2: 3rd to 5th grade GT program students at Klein Road Elementary school, New Braunfels, TX (28 students)
2. LPI solar eclipse event at Levee Park, Houston, TX on August 21, 2017
3. LPI SkyFest event at LPI on September 16, 2017
4. Guest speaker on Mars exploration for "Space Center University" engineering design for a group of college students from Japan, September 13, 2017
5. Int'l Observe the Moon Night at Levee Park organized by LPI, Houston, TX on October 28, 2017
6. LPI SkyFest event at LPI on May 5, 2018

REFERENCES

Prof. Raymond E. Arvidson (Ph.D. Advisor)
James S. McDonnell Distinguished University Professor
Deputy Principal Investigator of Mar Exploration Rovers
Department of Earth & Planetary Sciences
Washington University in St. Louis
St. Louis, Missouri 63130
Email: arvidson@rsmail.wustl.edu
Phone: 314-935-5609

Dr. Louise M. Prockter
Director of Lunar and Planetary Institute
Houston, TX 77058
Email: prockter@lpi.usra.edu
Phone: 281-486-2130

Prof. Timothy D. Glotch
Associate Professor
Associate Editor of Journal of Geophysical Research-Planets
PI of the RIS ^{4}E node of NASA's SSERVI
Department of Geosciences
Stony Brook University
Stony Brook, New York 11794
Email: timothy.glotch@stonybrook.edu
Phone: 631-632-8217

Dr. Kurt D. Retherford
Staff Scientist & Planetary Section Manager, Southwest Research Institute
Adjoint Prof., University of Texas at San Antonio
PI Europa-UVS
Dep. PI JUICE-UVS
PI LRO-LAMP
San Antonio, TX 78238
Email: kretherford@swri.edu
Phone: 210-522-3809

Prof. Alian Wang
Research Professor
Department of Earth & Planetary Sciences
Washington University in St. Louis
St. Louis, Missouri 63130
Email: alianw@levee.wustl.edu
Phone: 314-935-5671