Subramania Athiray Panchapakesan **Curriculum Vitae**

CONTACT INFORMATION

Assistant Professor
Department of Space Science
Center for Space Plasma and Aeronomic Research
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EDUCATION

Ph.D in Physics - University of Calicut June 2015
Indian Space Research Organization (ISRO) Satellite Centre, Bangalore
Indian Institute of Astrophysics (IIA), Bangalore

Thesis Title : Study of lunar surface chemistry using Swept Charge Devices
Thesis Advisers : Dr. P. Sreekumar ; Prof. B. R. S. Babu

PERSONAL DETAILS

Date of Birth - 30 March 1983
Nationality - Indian

PROFESSIONAL APPOINTMENTS

Assistant Professor (The University of Alabama)	**Aug.2023 - Present**
Research Scientist (The University of Alabama)	**Dec.2021 - July 2023**
NASA Postdoctoral Program (USRA)	**Mar.2019 - Nov.2021**
Postdoctoral Associate (University of Minnesota)	**Nov.2016 - Feb.2019**
Postdoctoral Fellow (Manipal University)	**Aug.2015 - Oct.2016**
Research Fellow (ISRO/IIA)	**Jun.2009 - Jun.2015**
Research Intern (IIA)	**Jun.2007 - Dec.2009**

KEY MISSIONS AND RESEARCH EXPERIENCE

Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)
NASA Solar Sounding rocket mission **Launch : 2021**

- X-ray calibration lead : responsible for end-to-end calibration, data analysis, generation of calibration products
- Analyze flight data for science studies, generate flight instrument response function, and develop inversion method(s) to unfold *MaGIXS* data
- Develop forward models using *SDO*/AIA and *Hinode*/XRT data to calculate and verify radiometric predictions

Focusing Optics X-ray Solar Imager (*FOXSI*-3)
NASA Solar Sounding rocket mission **Launch : 2018**

- Detector team lead : Calibration of *FOXSI* hard X-ray detectors using sealed radioactive sources and synchrotron facility
- Support *FOXSI* team in optics calibration at Stray Light Test Facility (SLTF), NASA MSFC
- Combined data from *SDO*/AIA, *Hinode*/XRT and *FOXSI*-2, and produced a well constrained differential emission measure (DEM) of solar microflares

Chandrayaan-2 Large Area Soft x-ray Spectrometer(CLASS)
Indian Moon mission Chandrayaan-2 **Launch : 2019**

- Characterization and ground calibration of X-ray detectors; Collimator design, data rate and operations

ASTROSAT - Scanning Sky Monitor (SSM)
Indian multi-wavelength Astronomy mission **Launch : 2015**

- X-ray transmission studies of filters - using synchrotron beam

Chandrayaan-1 X-ray Spectrometer (C1XS)
Indian Moon mission Chandrayaan-1 **Launch : 2008**

- Development of X-ray Fluorescence (XRF) inversion algorithm *x2abundance*
- Validation of *x2abundance* using laboratory XRF experiments
- X-ray spectral analysis of C1XS data & determination of lunar abundances

Current Missions & Roles

Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)-2
NASA Solar Sounding rocket mission **Expected Launch : 2024**

- Role : Deputy Instrument Scientist
- Status : Funded
- PI : Dr. Amy Winebarger, NASA MSFC

CubeSat Imaging X-ray Solar Spectrometer (CubIXSS)
NASA Cube Satellite Mission **Expected Launch : 2025**

- Role : Project Scientist
- Status : Funded
- PI : Dr. Amir Caspi, South West Research Institute

Upcoming Missions& Roles

The third flight of the Marshall Grazing Incidence X-ray Spectrometer
NASA Solar Sounding rocket mission **Expected Launch : 2026**

- Role : Principal Investigator
- Status : To be submitted

Research Interests Expertise

Scientific Expertise: Solar flare heating, High-temperature solar coronal diagnostics, Lunar surface chemistry, X-ray fluorescence (XRF) spectroscopic analysis

Instrumentation: X-ray instrument testing and calibration, X-ray imaging and spectroscopy, Imaging spectrographs, Calculation and verification of radiometric calibration of detectors and instruments, X-ray detector testing (Si/CdTe Strip detectors, X-ray CCDs, Swept Charge Devices)

Data analysis and modeling techniques: XRF inversion for elemental abundances, Charge transport model for X-ray CCDs, Methods for photon counting in X-ray images, Inversion of spatial-spectral information from Imaging Spectrographs

Awards & Fellowships

- National Merit Scholarship, University Grants Commission 2003 - 2005
- DST Research Fellowship 2008 - 2009
- ISRO - IIA Research Fellowship 2009 - 2015
- LPI Career Development Award :
  Lunar & Planetary Institute, NASA, USRA 2014
- K. D. Abhyankar Best Thesis Presentation Award :
  Astronomical Society of India 2016
- NASA Postdoctoral Program : USRA 2019 - 2021

STUDENTS & COMMUNITY SERVICE

- Have been an active mentor to train undergraduate students for solar physics research under the *Research Experiences for Undergraduates program at UAH* (since 2019)
- Currently mentoring a foreign exchange program Masters' student from France to work on inversion of spectroheliogram data ($\sim$ 7 months)
- Have been a co-convener/chair for a solar physics session in the American Geophysical Union Fall meeting (since 2000)
- Have been serving in the NASA panel (ROSES) as a referee to review research proposals (since 2019)
- Have been a referee for the journal *National Academy Science Letters* (since 2016)
- Have been a referee for the journals *Frontiers in Space and Astronomy* under solar physics and instrumentation section (since 2018)
- Have been a volunteer judge to evaluate student presentations and grade them for the Outstanding Students' Poster Award (OSPA) in the American Geophysical Union Fall meeting
- Have been a volunteer judge for "The Innovative System Project for the Increased Recruitment of Emerging STEM Students" (InSPIRESS), which is a STEM outreach program based at The University of Alabama in Huntsville, introducing high school students to create space-based mission.
- Volunteered as a judge to evaluate projects of middle/high school students and interact with them for the "North Alabama Regional Science and Engineering Fair" (NARSEF).

EXPERIMENTAL EXPERIENCE

Experiments using advanced facilities

- XRF on lunar analogs :*Conducted XRF experiments on lunar analog samples using synchrotron X-ray beam at Indus II facility, RRCAT, Indore, India*
- X-ray detector characterization : *Performed first FOXSI X-ray detector (Si/CdTe strip sensors) characterization using the Advanced Light Source, Berkeley*
- X-ray Optics testing : *Performed calibration of grazing incidence X-ray mirrors using the SLTF and X-ray and Cryogenics Facility (XRCF) at NASA MSFC*

TEACHING EXPERIENCE

- Graduate course : **Research Methodologies** 2015
  Lectures on data reduction and statistics, assignments and grading
  Organized by : Manipal Centre for Natural Sciences, Manipal University
- Graduate course : **Astronomical Instrumentation (X-rays)** 2011-2013
  Share responsibility for lectures, laboratory, exam, assignments and grades
  Organized by : Indian Institute of Science, (Joint Astronomy Program)
- Undergrad certificate course : **Space and Rocket Dynamics** 2011-2014
  Lectures on planetary system formation, evolution and measurements
  Organized by : ISRO, IIA and St. Joseph's College, Bangalore

HARDWARE & SOFTWARE SKILLS

Simulation Tools : GEANT4, Zemax
Computer Programming : IDL, C, Python
Data Analysis Packages : XSPEC, OSPEX (Solar soft - SSWIDL), Gnuplot, R
Operating systems : GNU/Linux, Windows, MacOS

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Research Publications

Journal Articles

1. Mondal, B., Klimchuk, J. A., Vadawale, S. V., Sarkar, A., Del Zanna, G., **Athiray**, **P. S.**, … Bhardwaj, A. (2023). Role of Small-scale Impulsive Events in Heating the X-Ray Bright Points of the Quiet Sun. *ApJ*, *945*(1), 37. doi:10.3847/1538-4357/acb8bb. arXiv: 2301.02519 [astro-ph.SR]

2. Savage, S. L., Winebarger, A. R., Kobayashi, K., **Athiray**, **P. S.**, Beabout, D., Golub, L., … Wright, E. (2023). The First Flight of the Marshall Grazing Incidence X-Ray Spectrometer (MaGIXS). *ApJ*, *945*(2), 105. doi:10.3847/1538-4357/acbb58. arXiv: 2212.00665 [astro-ph.SR]

3. Buitrago-Casas, J. C., Glesener, L., Christe, S., Krucker, S., Vievering, J., **Athiray**, **P. S.**, … Bale, S. D. (2022). The faintest solar coronal hard X-rays observed with FOXSI. *A & A*, *665*, A103. doi:10.1051/0004-6361/202243272. arXiv: 2205.04291 [astro-ph.SR]

4. Champey, P. R., Winebarger, A. R., Kobayashi, K., **Athiray**, **P. S.**, Hertz, E., Savage, S., … Wright, E. (2022). The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS). *Journal of Astronomical Instrumentation*, *11*(2), 2250010. doi:10.1142/S2251171722500106

5. **Athiray**, **P. S.**, Winebarger, A. R., Champey, P., Kobayashi, K., Savage, S., Beabout, B., … Wright, E. (2021a). Calibration of the Marshall Grazing Incidence X-Ray Spectrometer Experiment. II. Flight Instrument Calibration. *ApJ*, *922*(1), 65.

6. **Athiray**, **P. S.**, Winebarger, A. R., Champey, P., Kobayashi, K., Savage, S., Beabout, B., … Wright, E. (2021b). Calibration of the Marshall Grazing Incidence X-Ray Spectrometer Experiment. II. Flight Instrument Calibration. *ApJ*, *922*(1), 65.

7. Pillai, N. S., Narendranath, S., Vadodariya, K., Tadepalli, S. P., Radhakrishna, V., Tyagi, A., … Vadawale, S. (2021). Chandrayaan-2 Large Area Soft X-ray Spectrometer (CLASS): Calibration, In-flight performance and first results. *Icarus*, *363*, 114436.

8. Vigil, G. D., Winebarger, A., Rachmeler, L., Donders, N., **Athiray**, **P. S.**, Kobayashi, K., & Kankelborg, C. (2021). Design for a portable calibration system for the Full-sun UV Rocket SpecTrometer instrument. *Journal of Astronomical Telescopes, Instruments, and Systems*, *7*, 035009.

9. Vievering, J. T., Glesener, L., **Athiray**, **P. S.**, Buitrago-Casas, J. C., Musset, S., Ryan, D. F., … Krucker, S. (2021). FOXSI-2 Solar Microflares. II. Hard X-ray Imaging Spectroscopy and Flare Energetics. *ApJ*, *913*(1), 15.

10. **Athiray**, **P. S.**, Winebarger, A. R., Champey, P., Kobayashi, K., Vigil, G. D., Haight, H., … Kegley, J. (2020). Calibration of the MaGIXS Experiment. I. Calibration of the X-Ray Source at the X-Ray and Cryogenic Facility. *ApJ*, *905*(1), 66.

11. Buitrago-Casas, J. C., Christe, S., Glesener, L., Krucker, S., Ramsey, B., Bongiorno, S., … Bale, S. (2020). Use of a ray-tracing simulation to characterize ghost rays in the FOXSI rocket experiment. *Journal of Instrumentation*, *15*(11), P11032.

12 **Athiray**, **P. S.**, Vievering, J., Glesener, L., Ishikawa, S.-n., Narukage, N., Buitrago-Casas, J. C., … Ryan, D. (2020). FOXSI-2 Solar Microflares. I. Multi-instrument Differential Emission Measure Analysis and Thermal Energies. *ApJ*, *891*(1), 78.

13 **Athiray**, **P. S.**, Winebarger, A. R., Barnes, W. T., Bradshaw, S. J., Savage, S., Warren, H. P., … Glesener, L. (2019). Solar Active Region Heating Diagnostics from High-temperature Emission Using the MaGIXS. *ApJ*, *884*(1), 24.

14 Furukawa, K., Buitrago-Casas, J. C., Vievering, J., Hagino, K., Glesener, L., **Athiray**, **P. S.**, … Takahashi, T. (2019). Development of 60 μm pitch CdTe double-sided strip detectors for the FOXSI-3 sounding rocket experiment. *Nuclear Instruments and Methods in Physics Research A*, *924*, 321–326.

15 Panini, S. S., Sreekumar, P., Marshall, H. L., Narendranath, S., Nayak, M., & **Athiray**, **P. S.** (2018). Multilayer mirror-based soft x-ray polarimeter for astronomical observations. *Journal of Astronomical Telescopes, Instruments, and Systems*, *4*, 011002.

16 **Athiray**, **P. S.**, Sreekumar, P., Narendranath, S., & Gow, J. P. D. (2015). Simulating charge transport to understand the spectral response of Swept Charge Devices. *A & A*, *583*, A97.

17 **Athiray**, **P. S.**, Narendranath, S., Sreekumar, P., & Grande, M. (2014). C1XS results-First measurement of enhanced sodium on the lunar surface. *Planet. & Sp. Sci.*, *104*, 279–287.

18 Narendranath, S., **Athiray**, **P. S.**, Sreekumar, P., Radhakrishna, V., Tyagi, A., Kellett, B. J., & Class Team. (2014). Mapping lunar surface chemistry: New prospects with the Chandrayaan-2 Large Area Soft X-ray Spectrometer (CLASS). *Advances in Space Research*, *54*(10), 1993–1999.

19 Narendranath, S., Sreekumar, P., Alha, L., Sankarasubramanian, K., Huovelin, J., & **Athiray**, **P. S.** (2014). Elemental Abundances in the Solar Corona as Measured by the X-ray Solar Monitor Onboard Chandrayaan-1. *Sol. Phy.*, *289*(5), 1585–1595.

20 **Athiray**, **P. S.**, Sudhakar, M., Tiwari, M. K., Narendranath, S., Lodha, G. S., Deb, S. K., … Dash, S. K. (2013). Experimental validation of XRF inversion code for Chandrayaan-1. *Planet. & Sp. Sci.*, *89*, 183–187.

21 **Athiray**, **P. S.**, Narendranath, S., Sreekumar, P., Dash, S. K., & Babu, B. R. S. (2013). Validation of methodology to derive elemental abundances from X-ray observations on Chandrayaan-1. *Planet. & Sp. Sci.*, *75*, 188–194.

22 Weider, S. Z., Kellett, B. J., Swinyard, B. M., Crawford, I. A., Joy, K. H., Grande, M., … Wieczorek, M. (2012). The Chandrayaan-1 X-ray Spectrometer: First results. *Planet. & Sp. Sci.*, *60*(1), 217–228.

23 Narendranath, S., **Athiray**, **P. S.**, Sreekumar, P., Kellett, B. J., Alha, L., Howe, C. J., … C1XS Team. (2011). Lunar X-ray fluorescence observations by the Chandrayaan-1 X-ray Spectrometer (C1XS): Results from the nearside southern highlands. *Icarus*, *214*(1), 53–66.

Conference Proceedings

1 Duncan, J., **Athiray**, **P. S.**, Musset, S., Vievering, J., Nagasawa, S., Buitrago Casas, J. C., … Krucker, S. (2022). Modeling effects of charge sharing on the response of the FOXSI sounding rockets. In A. D. Holland & J. Beletic (Eds.), *X-ray, optical, and infrared detectors for astronomy x* (Vol. 12191, 121911E). doi:10.1117/12.2629443

2 Buitrago-Casas, J. C., Vievering, J., Musset, S., Glesener, L., **Athiray**, **P. S.**, Baumgartner, W., … Zhang, Y. (2021). FOXSI-4: the high resolution focusing X-ray rocket payload to observe a solar flare. In *Society of photo-optical instrumentation engineers (spie) conference series* (Vol. 11821, p. 118210L).

3 Buitrago-Casas, J., Glesener, L., Christe, S., Krucker, S., Vievering, J., **Athiray**, **P. S.**, … Duncan, J. (2021). Assessing quiet Sun hard X-rays using observations from the FOXSI Sounding Rockets. In *American astronomical society meeting abstracts* (Vol. 53, p. 106.04).

4 **Athiray**, **P. S.**, Winebarger, A. R., Champey, P. R., Kobayashi, K., Savage, S. L., Vigil, G. D., … Golub, L. (2020). The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) solar sounding rocket campaign - Calibration and performance. In *Agu fall meeting abstracts* (Vol. 2020, SH048–0008).

5 Buitrago-Casas, J. C., Glesener, L., Christe, S., Krucker, S., Vievering, J. T., **Athiray**, **P. S.**, … Duncan, J. M. (2020). Limits on the X-ray emission of the quiet Sun from the FOXSI sounding rockets. In *Agu fall meeting abstracts* (Vol. 2020, SH043–0002).

6 Glesener, L., Buitrago-Casas, J. C., Musset, S., Vievering, J. T., **Athiray**, **P. S.**, Baumgartner, W., … Winebarger, A. R. (2020). The FOXSI-4 Sounding Rocket: High Resolution Focused X-ray Observations of the Sun. In *Agu fall meeting abstracts* (Vol. 2020, SH048–0011).

7 Vievering, J. T., Glesener, L., **Athiray**, **P. S.**, Buitrago-Casas, J. C., Musset, S., Ryan, D., … Krucker, S. (2020). New Methods for Solar Hard X-ray Imaging Analysis with the FOXSI Sounding Rocket Experiment. In *Agu fall meeting abstracts* (Vol. 2020, SH048–0010).

8 Basu Sarbadhikari, A., Srivastava, Y., Bhatt, M., Arora, G., Narendranath, S., **Athiray**, **P. S.**, … Bhardwaj, A. (2020). Significance of the Presence of Deep Crustal Na-Rich Rocks of the Moon. In *51st annual lunar and planetary science conference* (p. 1893).

9 Buitrago-Casas, J. C., Glesener, L., Courtade, S., Vievering, J. T., **Athiray**, **P. S.**, Musset, S., … Ramsey, B. (2019). Hardware upgrades and science outcomes from the latest flights of the FOXSI rocket. In *Agu fall meeting abstracts* (Vol. 2019, SH31C–3316).

10 Champey, P., Winebarger, A. R., **Athiray**, **P. S.**, Kobayashi, K., Savage, S., Kolodziejczak, J. K., … Ramsey, B. (2019). X-ray evaluation of the Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) nickel-replicated mirrors. In *Optics for euv, x-ray, and gamma-ray astronomy ix* (Vol. 11119, p. 1111917).

11 Musset, S., Buitrago-Casas, J. C., Glesener, L., Bongiorno, S., Courtade, S., **Athiray**, **P. S.**, … Krucker, S. (2019). Ghost-ray reduction and early results from the third FOXSI sounding rocket flight. In *Uv, x-ray, and gamma-ray space instrumentation for astronomy xxi* (Vol. 11118, p. 1111812).

12 **Athiray**, **P. S.**, Glesener, L., Vievering, J., Ishikawa, S.-N., Inglis, A., Narukage, N., … Krucker, S. (2019). FOXSI-2 Solar Microflares : Multi-Instrument Differential Emission Measure Analysis. In *American astronomical society meeting abstracts #234* (Vol. 234, p. 225.02).

13 **Athiray**, **P. S.**, Glesener, L., Vievering, J. T., Ishikawa, S. N., Inglis, A. R., Narukage, N., … Krucker, S. (2018). Constrained Differential Emission Measure of Microflare Heating Observed with FOXSI-2, Hinode/XRT and SDO/AIA. In *Agu fall meeting abstracts* (Vol. 2018, SH23A–06).

14 Buitrago-Casas, J. C., Glesener, L., Vievering, J. T., Musset, S., **Athiray**, **P. S.**, Davis, L., … Krucker, S. (2018). The third flight of the FOXSI rocket: Performance and results. In *Agu fall meeting abstracts* (Vol. 2018, SH21B–3287).

15 Ishikawa, S. N., Narukage, N., Takahashi, T., Furukawa, K., Watanabe, S., Mitsuishi, I., … Krucker, S. (2018). Soft X-ray imaging spectroscopy of the Sun using a high-speed CMOS sensor with the FOXSI-3 sounding rocket. In *Agu fall meeting abstracts* (Vol. 2018, SH33E–3688).

16 Vievering, J. T., Glesener, L., Courtade, S., Buitrago-Casas, J. C., **Athiray**, **P. S.**, Musset, S., … Ramsey, B. (2018). FOXSI-3: Mission Overview and Observations from the Third Sounding Rocket Flight of the Focusing Optics X-Ray Solar Imager. In *Agu fall meeting abstracts* (Vol. 2018, SH23A–01).

17 **Athiray**, **P. S.**, Buitrago-Casas, J. C., Bergstedt, K., Vievering, J., Musset, S., Ishikawa, S.-n., … Monson, S. (2017). Calibration of the hard x-ray detectors for the FOXSI solar sounding rocket. In *Society of photo-optical instrumentation engineers (spie) conference series* (Vol. 10397, 103970A).

18 Buitrago-Casas, J. C., Elsner, R., Glesener, L., Christe, S., Ramsey, B., Courtade, S., … Krucker, S. (2017). Methods for reducing singly reflected rays on the Wolter-I focusing mirrors of the FOXSI rocket experiment. In *Society of photo-optical instrumentation engineers (spie) conference series* (Vol. 10399, 103990J).

19 Panini, S., Narendranath, S., Sreekumar, P., **Athiray**, **P. S.**, & Nayak, M. (2016). Soft X-Ray Imager Using Multilayer Mirror Optics for Martian Exospheric Studies. In *3rd international workshop on instrumentation for planetary mission* (Vol. 1980, p. 4054).

20 **Athiray**, **P. S.**, Narendranath, S., Sreekumar, P., & C1XS Team. (2016). New Views of Southern Nearside Lunar Highland Composition from the Chandrayaan-1 X-ray Spectrometer (C1XS). In *New views of the moon 2* (Vol. 1911, p. 6062).

21 Grande, M., **Athiray**, **P. S.**, Narendranath, S., Sreekumar, P., & Carter, J. (2015). 3. C1XS results - First measurement of enhanced Sodium on the Lunar surface. In *Egu general assembly conference abstracts* (p. 2324).

22 Narendranath, S., **Athiray**, **P. S.**, Parameswaran, S., & Grande, M. (2015). Surface chemistry of the Moon: New views from Chandrayaan-1 X-ray Spectrometer and future potentials. In *Egu general assembly conference abstracts* (p. 524).

23 **Athiray**, **P. S.**, Kusuma, K. N., Narendranath, S., & Sreekumar, P. (2014). Direct Evidence of Enhanced Sodium Content on the Moon Around Tycho Region: C1XS Observations. In *45th annual lunar and planetary science conference* (p. 1857).

24 Narendranath, S., Tadeppalli, S. P., **Athiray**, **P. S.**, Misra, A., & Sreekumar, P. (2014). Observations of the Geotail While in Lunar Orbit by the Chandrayaan-1 X-Ray Spectrometer (C1XS). In *45th annual lunar and planetary science conference* (p. 2199).

25 **Athiray**, **P. S.**, Narendranath, S., & Sreekumar, P. (2013). Lunar X-Ray Fluorescence (XRF) observations with C1XS during weak solar flares. In *Astronomical society of india conference series* (Vol. 9, p. 108).

26 **Athiray**, **P. S.**, Narendranath, S., Sreekumar, P., Gow, J., Radhakrishna, V., & Babu, B. R. S. (2012). Modeling charge transport in swept charge devices for x-ray spectroscopy. In A. D. Holland & J. W. Beletic (Eds.), *High energy, optical, and infrared detectors for astronomy v* (Vol. 8453, p. 84532L).

27 Radhakrishna, V., Narendranath, S., Tyagi, A., Bug, M., Unnikrishnan, U., Kulkarni, R., … Sreekumar, P. (2011). The Chandrayaan-2 Large Area Soft X-Ray Spectrometer (CLASS). In *42nd annual lunar and planetary science conference* (p. 1708).

28 Unnikrishnan, U., Sudhakar, M., Tyagi, A., Bug, M., Radhakrishna, V., & **Athiray**, **P. S.** (2011). Charged particle detection using swept charge devices. In *Astronomical society of india conference series* (Vol. 3, p. 163).

29 Narendranath, K. C. S., **Athiray**, **P. S.**, Unnikrishann, U., Sreekumar, P., C1XS Team Grande, M., Cook, A., … Wieczorek, M. (2010). Analysis of Lunar X-Ray Data: Line Flux to Elemental Abundance from the C1XS Experiment on Chandrayaan-1. In H. Lacoste (Ed.), *Workshop x-ray fluorescence spectroscopy in planetary remote sensing* (Vol. 687, p. 6).

30 Narendranath, S., Sreekumar, P., Kellett, B. J., Joy, K. H., Howe, C. J., Crawford, I. A., … C1XS Team. (2010). Lunar Chemistry from Chandrayaan-1, C1XS Results from Southern Nearside Highlands of the Moon. In *41st annual lunar and planetary science conference* (p. 1882).

31 Goswami, A., **Athiray**, **P. S.**, & Karinkuzhi, D. (2010). Elemental abundances in CEMP stars: r- and s-process elements. In *Recent advances in spectroscopy theoretical, astrophysical and experimental perspectives* (Vol. 17, pp. 211–216).