

Subramania Athiray Panchapakesan**Curriculum Vitae**

CONTACT INFORMATION	Assistant Professor Department of Space Science Center for Space Plasma and Aeronomic Research University of Alabama Huntsville, AL.	<i>Phone:</i> +1-672-814-5739 <i>E-mail:</i> athray@gmail.com athiray.panchap@uah.edu athiray.panchap@nasa.gov
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) Research Scientist (The University of Alabama) NASA Postdoctoral Program (USRA) Postdoctoral Associate (University of Minnesota) Postdoctoral Fellow (Manipal University) Research Fellow (ISRO/IIA) Research Intern (IIA)	Aug.2023 - Present Dec.2021 - July 2023 Mar.2019 - Nov.2021 Nov.2016 - Feb.2019 Aug.2015 - Oct.2016 Jun.2009 - Jun.2015 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 <i>MaGIXS</i> data • Develop forward models using <i>SDO/AIA</i> and <i>Hinode/XRT</i> 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 <i>FOXSI</i> hard X-ray detectors using sealed radioactive sources and synchrotron facility • Support <i>FOXSI</i> team in optics calibration at Stray Light Test Facility (SLTF), NASA MSFC • Combined data from <i>SDO/AIA</i>, <i>Hinode/XRT</i> and <i>FOXSI-2</i>, 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 <i>x2abundance</i> • Validation of <i>x2abundance</i> 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 (~ 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](https://doi.org/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](https://doi.org/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](https://doi.org/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](https://doi.org/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., Tadeipalli, 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. Phys.*, 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., ... Wicczorek, 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, 12191E).  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.**, Unnikrishnan, U., Sreekumar, P., C1XS Team Grande, M., Cook, A., ... Wiecek, 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).