Curriculum Vitae

SHUBHONKAR PARAMANICK

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EDUCATION

Bachelor of Technology, Physical Sciences
Aug. 2013 – May 2017

Indian Institute of Space Science and Technology (IIST)
Thiruvananthapuram, Kerala, India

- Cumulative GPA : 8.91/10
- Final Year Average : 9.59/10
- Department Rank : 2
- Relevant Courses : Introduction to Astronomy and Astrophysics; Electromagnetic Theory and Relativity; Classical Mechanics; Quantum Mechanics; Statistical Mechanics; Atomic, Molecular and Nuclear Physics; Linear Algebra; Numerical Analysis; Differential Equations; Probability and Statistics; Pattern Recognition
- Relevant Electives : Radiation Process in Astrophysics; Cosmology and Astro Biology; Planetary Geosciences; Atmospheric Radiation and Climate

High School
June 2011 – May 2013

Montfort Senior Secondary School
Roorkee, Uttarakhand, India

- Major : Physics, Chemistry, Mathematics and Biology
- All India Senior School Certificate Examination, Central Board of Secondary Education (CBSE), Score : 96%
- Graduated in the top one percent of High School students in India with a State Rank of 8.
- Secured a State Rank of 34 out of over 25,000 students in the Joint Entrance Examination conducted by IIT (IIT-JEE–2013).

Secondary School
Apr. 2009 – June 2011

Holy Cross Secondary School
Haridwar, Uttarakhand, India

- Major : Physics, Chemistry, Mathematics and Biology
- All India Secondary School Examination, CBSE, Cumulative GPA : 10/10

TEST SCORES

GRE Physics Test *Oct. 2018*

- Scaled Score : 980/990

GRE General Test *Sep. 2019*

- Total Score : 318/340
- Quants : 167/170 Verbal : 151/170 AWA : 3.5

WORK EXPERIENCE

Scientist 'C' *Aug. 2017 to date*

U R Rao Satellite Centre[1], Bangalore, India
Indian Space Research Organization (ISRO)
Dept. of Space, Government of India

KEY PROJECTS

■ **Study of Habitable Planet Earth (SHAPE): Earth as an Extrasolar Planet**

- Leading the science team to simulate the photometry and spectroscopy of Earth from the lunar orbit.
- Characterized the Acousto-Optics Tunable Filter (AOTF) and the optics of the instrument with the calibration team.
- Disc-integrated reflected light observations of earth will provide the benchmark measurements that will help us in comparing habitable exoplanets to our home planet earth. Observations will be carried out using a broadband NIR Spectro-polarimeter onboard Chandrayaan-3.
- Development towards Direct Imaging of Exoplanets: Direct imaging of exoplanetary systems with SHAPE will yield the true population statistics as opposed to the indirect detection techniques which renders a biased statistics towards heavier and larger exoplanets. It will also be possible to unveil the habitable zone planets and their properties.

■ **Aditya - L1 — First Indian mission to study the Sun**

- Computed the spectral and total irradiances and the variations in it for different state of the Sun (active and quiet) by utilizing the spectral synthesis models of the broad spectral bands.
- Designed and developed the test setup for the test and calibration of the Solar Ultraviolet Imaging Telescope (SUIT) payload planned for Aditya-L1 mission.
- SUIT will image the spatially resolved solar photosphere and chromosphere in the near-ultraviolet (200-400 nm) and measure the variations in the solar irradiance at the first Lagrangian point.

[1] Formerly known as ISRO Satellite Centre.

RESEARCH EXPERIENCES

PROJECTS AND THESES

■ Research Project *July 2020 – Oct. 2020*

Indian Space Research Organisation (ISRO), Bangalore

- Title : **'Analytical Derivation and Numerical Calculation of the Rossiter–McLaughlin (RM) Effect for Transiting Exoplanetary Systems: Perturbative Expansion and Comparison with Simulated and Actual Data'**
- Developed a theoretical framework to determine the asymmetric distortion in the line profiles of the stellar spectrum resulting in an apparent anomaly in the the radial velocity curves because of the stellar spin during the planetary transit (RM effect).
- Estimated the stellar spin angular velocity and its direction angle with respect to the planetary orbit for transiting HD 209458 system.
- Derived the exact analytic formulae for the radial velocity (RV) curves considering an idealistic case of uniform stellar intensity model.
- Obtained the approximate (but accurate) analytic expressions for the anomaly in the RV curves of exoplanetary systems taking into account the stellar limb-darkening effect both during the transit and the ingress/egress phases.
- Examined the sensitivity of the radial velocity anomaly to the parameters of the planetary system and the numerical accuracy of the analytic expressions (using Monte Carlo with importance sampling and with Metropolis–Hastings algorithm) by applying the analytic templates to the HD 209458 system.
- Evaluated the uncertainties of the fitted parameters and their correlations by creating mock samples for the RV profiles for the transiting system, HD 209458.
- Demonstrated the efficiency and robustness of the estimated spin parameters by combining the analytic expressions with the high-resolution spectroscopic data HD 209458.
- Study is useful in inferring about the origin and the evolution of angular momentum in extra-solar planetary systems.

■ Research Project *Sep. 2020 to date*

Advisor: Dr. Arvind Singh Rajpurohit
Physical Research Laboratory (PRL), Ahmedabad

- Title : **'Geometry of the Reflected Light Curves of Exoplanets'**
- Investigated the nature of the photometric light curves produced by exoplanetary systems by connecting the orbital and physical parameters of exoplanets to their signatures on the transit and photometric light variations.
- Modeled the reflected light from different positions on an exoplanet transiting its uniform far-off host star using plane parallel rays.
- Analyzed the reflected planetary intensity distribution as a function of phase for close-in exoplanets taking into account the finite angular size of the host star for which the plane parallel ray model of incident stellar radiation breaks down.

- Constructed a three-zone template, viz.: fully illuminated by starlight, penumbral, and unilluminated zones to determine the reflected light distribution, as opposed to the illuminated and unilluminated zones present in the plane parallel ray model.
- Demonstrated that the difference between modeling the exoplanet using the plane parallel ray approximation and appropriately accounting for the finite angular size of the host star is insignificant and is unobservable with current high-resolution spectroscopy.

■ Research Project *May 2020 – July 2020*

Indian Space Research Organisation (ISRO), Bangalore

- Title : **'Characterization of Extrasolar Planets using the Radial Velocity'**
- Theoretically modeled the radial velocity variations of the stars, HAT-P-7 and Pegasi 51, as a function of the known variable (stellar mass) and the unknown variables (inclination angle, planetary mass, and the rotation period).
- Constructed the codes that work with both circular and eccentric orbits in order to fit the actual data (taking into account the data uncertainties) obtained from different spectroscopic observations and understand the systems.
- Derived the closed-form expressions for the general and weighted non-linear and linear least squares regression to the RV profiles.
- Worked out the relationship between the curvature/Hessian matrix and the error of the fit as a function of the independent variable.
- Derived and numerically optimized the parameters non-linearly using Gauss-Newton iteration and Levenberg-Marquardt algorithm.
- Estimated the parameters of the Gaussian probability density function by maximizing the likelihood function and computed the effect of variables' uncertainties on the uncertainty of the likelihood function so that under the assumed statistical model, the RV data is most probable.
- Obtained the degeneracies associated with the model by generating a 4-D map of the likelihood function and analyzing the different planar views of the volumetric data over a large parameter space.
- Generatively modeled the data using Markov Chain Monte Carlo (MCMC) by performing the probabilistic inferences and sampling the posterior distribution around the optimum values in order to determine the associated uncertainties on the sampling estimate and to understand multi-modalities in the data.

■ Research Project *March 2020 – May 2020*

- Title : **'Characterization of Exoplanetary Systems using Transit Timing Variations'**
- Analyzed the transit timing variations exhibited by the exoplanet Kepler-410A(b).
- Computed the quadratic limb darkening coefficients using the systematic de-trended flux data for all the available quarters from the NASA Exoplanet Archive.
- Determined the transit parameters of the exoplanet by using a Markov Chain Monte Carlo simulation-based model.

■ Junior Thesis and Student Intern *May 2016 – July 2016*

Advisor: Dr. Neeraj Gupta

Inter–University Centre for Astronomy and Astrophysics (IUCAA), Pune

- Title : **'Kinematic Modeling of Galaxies through HI 21 cm Line Observations'**
- Work done as a part of the Vacation Students' Programme (VSP 2016).
- Analyzed the data from a single–dish (GBT, West Virginia) and an array of antennae (WSRT, ASTRON).
- Derived the exact expressions for the HI mass of a warped edge-on galaxy (NGC 4013) and its column density for optically thin and thick medium.
- Computed the HI mass of the galaxy and its column density from the integrated line flux using the single dish and interferometer data. The antennae field patterns were modeled for a uniform linear array of N elements. Kinematic modeling and analysis of NGC 4013 were done utilizing zeroth, first and second moment maps after WSRT data processing and calibration.
- Generated the HI rotation curve of NGC 4013 using the 'Solid Body' and the 'Brandt Rotation Curve Model'. Estimated the observed onset radii for the warps in the edge-on system.

■ Undergraduate Major Course Project *Oct. 2016*

Dept. of Earth and Space Sciences, IIST, Trivandrum

- Title : **'Determination of the Cosmological Density Parameters based on Type Ia Supernova Redshift'**
- Work done as a part of the 'Cosmology and Astrobiology' course project.
- Obtained the data from the Supernova Cosmology Project (SCP) and the High-Z Supernova Search for 583 different Type Ia supernovae.
- Constricted the systematic uncertainties related to the data using a Bayesian hierarchical model.
- Determined the Cosmological Density Parameters (Ω_Λ and Ω_m) by minimizing the χ^2/maximizing the Log–like function.

■ Senior Thesis *Dec. 2016 – May 2017*

Advisor: Dr. V.J. Rajesh

Dept. of Earth and Space Sciences, IIST, Trivandrum

- Title : **'Spectral and chemical characterization of Copiapite and Rozenite: Implications for hydration processes on Mars'**
- Analyzed the CRISM and HiRISE datasets of different Martian regions.
- Carried out the VNIR, TIR, FTIR spectroscopy, Laser Raman and X–ray diffraction analyses. Interpreted and quantitatively matched the absorption spectra, emission bands and the vibration modes in the lattice with the reference database using different matching algorithms.
- Outlined the astrobiological significance of secondary sulfates' detection on Mars.

PAYLOAD PROPOSAL

- **Proposed a Laser Raman Spectrometer for Mars surface studies** for the Mars Orbiter Mission (MOM-2) of ISRO.

INTERNSHIPS AND WORKSHOPS ATTENDED

■ **Student Intern** *Dec. 2015 – Jan. 2016*

Supervisor: Dr. Apoorva Nagar

Dept. of Physics, IIST, Trivandrum

- Title : **'Analysis of Driven, Duffing Oscillator and the study of Chaotic Dynamics'**
- Investigated the dependence of amplitude and phase lag of a driven oscillator on its driving frequency.
- Analyzed the periodic change of the chaotic attractor of the duffing oscillator for an undamped, weakly forced and periodically forced systems.
- Simulated the damped driven harmonic oscillator and confirmed the chaotic behavior using a Poincaré section.

■ **Student Intern** *June 2015 – July 2015*

Advisor: Dr. Sanjay Kumar Mishra

Instruments Research and Development Establishment, Defence Research and Development Organization, Dehradun

- Title : **'Measurement and interpretation of Point Spread Function (PSF) due to Diffraction by a Circular Aperture'**
- Studied the diffraction by a circular aperture in the Fresnel and Fraunhofer regions. Determined the locations of maxima and minima of the Airy pattern numerically by solving the Bessel function of the first kind of order one.
- Computed the radius of the Airy disk and verified the linear dependence of half-angle beam spread on the $f_{\#}$ by capturing the PSF images with a CCD camera.

■ **Workshops**

- **'Multi-wavelength observations using Astrosat'** organized by IUCAA, Pune (December 2017)
- '**Radio Astronomy School – 2019'** held at the National Centre for Radio Astrophysics (NCRA-TIFR), Pune (August 2019)

ARTICLES SUBMITTED TO REFEREED JOURNALS

- **Paramanick, Shubhonkar**; V.J., Rajesh; Praveen, M. N.; K. S., Sajin Kumar; Bhattacharya, Satadru (2019). Occurrence of Copiapite and Rozenite in the southern Indian shield: Implications for future Mars missions. *Chemical Geology. pp. 1–66.* URL https://www.journals.elsevier.com. Under-review, Submission No.: CHEMGE12138R1 (Senior Thesis).

OTHER REFEREED CONTRIBUTIONS [ADS]

- **Paramanick, Shubhonkar***; V.J., Rajesh; Praveen, M. N.; K. S., Sajin Kumar; Bhattacharya, Satadru (2018). Spectral and chemical analyses of probable Martian chemical analogue minerals, copiapite and rozenite: Implications for hydration processes on mars. *42nd Committee on Space Research Scientific Assembly, Pasadena, CA. B4.1-0023-18, pp. 441–442.* URL http://adsabs.harvard.edu/abs/2018cosp...42E2580P. International Conference. Refereed Paper, Oral and Poster Presentation (Senior Thesis).
- **Paramanick, Shubhonkar***; V.J., Rajesh; Praveen, M. N.; K. S., Sajin Kumar (2018). Spectral Characterization of Copiapite and Rozenite and its implications. *49th Lunar and Planetary Science Conference, LPI, Texas. LPI Contrib. No. 2083, Volume: 49, #2299.* URL https://www.hou.usra.edu/meetings/lpsc2018/pdf/2299.pdf. International Conference. Refereed Paper and Poster Presentation (Senior Thesis).

NON-REFEREED CONTRIBUTIONS

- **Paramanick, Shubhonkar*** (2019). Design and Development of Registration and Collinearity Test Bench for Test and Evaluation of SUIT. *Technical Report, ISRO (Restricted & Confidential) pp. 1–62.* Indian Space Research Organisation (Work Experience).
- **Paramanick, Shubhonkar*** and Narayanan, Anand (2016). Determination of the Cosmological Constant based on Type Ia Supernovae Redshift. *Research Report. pp. 1–59.* Indian Institute of Space Science and Technology (Undergraduate Work).
- **Paramanick, Shubhonkar*** and Gupta, Neeraj (2016). Kinematic modeling of galaxies through HI 21 cm line observations. *Research Report. pp. 1–174.* Inter-University Centre for Astronomy and Astrophysics (Junior Thesis).
- **Paramanick, Shubhonkar*** and Lekshmi, Resmi (2016). Polarization states of time-varying E-field. *Research Report. pp. 1–28.* Indian Institute of Space Science and Technology (Undergraduate Work).
- **Paramanick, Shubhonkar*** (2016). Evidence of Water on Moon — Results from Chandrayaan-1. *Study Report. pp. 1–47.* Indian Institute of Space Science and Technology (Undergraduate Work).
- **Paramanick, Shubhonkar** and Nagar, Apoorva (2016). Analysis of Driven, Duffing Oscillator and the study of Chaotic Dynamics. *Research Report. pp. 1–24* (Undergraduate Work).
- **Paramanick, Shubhonkar*** and Mishra, Sanjay (2015). Measurement and Interpretation of Point Spread Function due to Diffraction by a Circular Aperture. *Technical Report. pp. 1–76.* Defence Research and Development Organisation (Sophomore Thesis).

PRESENTATIONS AT INTERNATIONAL CONFERENCES

- 42nd Committee on Space Research Scientific Assembly, Pasadena, CA, USA. August 2018.

*Presenting Author

- 49th Lunar and Planetary Science Conference, Lunar and Planetary Institute, TX, USA. March 2018.

SKILLS

TECHNICAL SKILLS

- **Programming Languages :** C, C++, Python, MATLAB, Fortran, IDL, JavaScript.
- **Markup Languages :** LaTeX, HTML5, CSS, Sass.
- **Operating Systems :** Linux, Windows, Mac OS (X).
- **Applications/Astronomy Packages :** Astropy, Git, Astronomical Image Processing System (AIPS), Common Astronomy Software Applications (CASA), CIAO, HEASoft, SAOImage DS9, MayaVi, IRAF, SimuLink, Mupad, Matplotlib, Mathematica, Gnuplot, Microsoft Office Suite.

LANGUAGES

- English and Hindi (Full professional proficiency, Conversationally fluent).

SCHOLARSHIPS, AWARDS AND HONORS

- Department Rank (B.Tech. in Physical Sciences) : 2.
- Awarded *IIST Academic Scholarship* based on the academic performance in the undergraduate program, 2013-2017 — funded by the Department of Space (DOS), Government of India.
- Awarded *DOS Book Grant Assistantship* for the bachelor's program, 2013-2017.
- Awarded *Summer Research Fellowship* by the Jawaharlal Nehru Centre For Advanced Scientific Research (JNCASR), Bangalore, in 2016.
- Awarded *Vacation Students' Programme Fellowship* by the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, in 2016.
- Received the *INSPIRE Scholarship* for Higher Education (SHE) from the Department of Science and Technology (DST), Government of India for the year 2013.
- Qualified Joint Entrance Screening Test (JEST) in 2017 (for admission to the graduate schools in India).

PROFESSIONAL AFFILIATIONS

- Member of the Astronomical Society of India.
- Member of The Planetary Society.

UNIVERSITY SERVICE AND OUTREACH ACTIVITIES

- Co–organizer, World Space Week Celebration – 2018 at URSC, Bangalore.
- Team member, 'Nirmaan' outreach program, IIST (2015-2017).

- Organizer, IIST Physics Club and IIST Astronomy Club during the academic year 2015-2016.
- Coordinator (Science Lecture Organizing Team), Conscientia – 2014, the Annual Astronomy and Technology Festival of IIST.
- Coordinator, Dhanak – 2013, the Annual Cultural Festival of IIST.

REFERENCES

DR. SAMIR MANDAL, Associate Professor & Head, ESS Department

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