Biswajit Jana

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EDUCATION

University of Hertfordshire — Hatfield, United Kingdom
MSc Astrophysics with Advanced Research, Commendation — 2022–2024

- Dissertation: *Closed-Loop Feedback Control System for the Exoplanet High-Resolution RV Spectrograph (EXOhSPEC) Development*.
- Relevant modules: Star Formation and Evolution; Foundations of Cosmology; Physics of Astronomical Spectra; Early Universe and Galaxy Formation; High Energy Astrophysics; Galaxy Structure and Evolution; Statistics and Analysis; Research Techniques in Astrophysics; From Stars to Planets.

University of Engineering and Management — Jaipur, India
BTech Electronics and Communication Engineering, First Class with Distinction — 2017–2021

- Dissertation: *Dimming Controlled Visible Light Communication System using Raspberry Pi*.
- Thesis work published in *Optical and Quantum Electronics*, Springer.

PUBLICATIONS

- **Jana, B.**, et al. "Implementation of Dimming Controlled Visible Light Communication using Raspberry Pi." *Optical and Quantum Electronics*, 53, 725, 2021. DOI: 10.1007/s11082-021-03362-4.
- **Jana, B.**, et al. "GSM Controlled Location Specific Garbage Collecting Smart Bin." *9th Annual Information Technology, Electromechanical and Microelectronics Conference*, Jaipur, India, 2019. DOI: 10.1109/IEMECONX.2019.8877007.
- **Jana, B.**, et al. "Priority Encoder Using Reversible Logic Gates in QCA." *8th IEEE Annual Information Technology, Electronics and Mobile Communication Conference*, Vancouver, Canada, 2017, pp. 319–323. DOI: 10.1109/IEMCON.2017.8117242.

RESEARCH AND PROJECT EXPERIENCE

Closed-Loop Feedback Control System for EXOhSPEC — 2023–Present
MSc research project and continuing instrumentation development, University of Hertfordshire

- Developed a closed-loop stabilisation framework for EXOhSPEC, a high-resolution radial-velocity spectrograph testbed, integrating an IDS3010 interferometer, Meerstetter TEC, BME environmental sensors, MaxIm DL centroid tracking, and an **active-optics** tip–tilt unit through Python control workflows.
- Quantified optical-path-length (OPL) sensitivity from multi-sensor experiments: approximately 0.4 μm OPL per 1 hPa pressure change and approximately 6 μm OPL per 1°C temperature change.
- Achieved TEC stability of $\sigma_T = 2.47$ mK with 17.4 mK peak-to-peak variation during a 44.5 h run despite an approximately 3.2°C external temperature swing.
- Developed OPL–pixel-drift models from interferometric, environmental, and centroid telemetry; automated acquisition, diagnostics, and control through Python, Grafana, InfluxDB, serial communication, and web monitoring.
- Calibrated the active-optics unit using 36 centroid samples over 79.5 min: approximately 0.15 px per step; 8 automated corrections reduced mean residual error from 0.443 px to 0.153 px. Selected hybrid TEC–active-optics runs reduced dY RMS from 2.72 px to 0.69 px (74.5%).

Gaia DR3 H–R Diagram Laboratory — 2026–Present
Independent scientific software and browser-based stellar-population visualisation

- Built a browser-based Gaia DR3 laboratory that applies $\varpi > 2$ mas and $\varpi/\sigma_\varpi > 20$ quality cuts, computes distance and absolute Gaia G magnitude, and visualises the accepted sample in H–R and local 3D Cartesian projections.
- Implemented progressive right-ascension-sliced loading for 10,000, 50,000, and 100,000 catalogue rows, avoiding single-file browser payload failures while reporting parsed, accepted, and rejected rows, loading rate, and elapsed time.
- Added four stellar-region overlays (main sequence, giants, supergiants, and white dwarfs), Solar reference values, selectable colour mappings, zoom/export tools, and a local 3D Galactic projection using real catalogue data rather than synthetic points.
- Links: GitHub | Interactive Tool.

ExoIntel-Prime / ExoLight Transit Lab — 2026–Present
Independent browser-based exoplanet transit-photometry and science-communication project

- Developed a worker-based physical forward model for archival and locally processed transit light curves, using quadratic limb darkening, numerical stellar-disk integration, finite exposure-time integration, circular and approximate eccentric projected geometries, and optional starspot/exomoon hypothesis modes.
- Implemented diagnostics in physically meaningful units: transit depth in percent and ppm, $\sqrt{\delta}$ radius-ratio proxy, residual RMS, out-of-transit RMS, period, duration, inclination, eccentricity, and host-star parameters where available.

- Used HD 189733 b as a reproducible demonstration target with P = 2.21857567 d, quoted transit duration = 1.823 h, and catalogue transit depth = 24,000 ppm; retained a clear distinction between visual hypothesis modes and formal detection claims.
- Links: GitHub | Live Project | Blog

Detection of Pulsars by Image Stacking in Large FITS Datasets
Pulsar image-stacking and large astronomical image-processing project
- Processed 9,587 astronomical FITS images under memory and runtime constraints; applied the Binapprox algorithm for efficient median estimation rather than retaining the full image cube in memory.
- Built image-stacking and median-combination workflows to improve faint-source detectability, with emphasis on computational scaling, FITS handling, and signal extraction for pulsar-search-style datasets.

Dimming Controlled Visible Light Communication System using Raspberry Pi 2019–2021
BTech final-year project, University of Engineering and Management, India
- Implemented a Multi-Header Hybrid Pulse Position Modulation visible-light-communication system using Raspberry Pi and low-cost commodity hardware.
- Evaluated dimming levels of 0.25, 0.5, and 0.75; achieved communication distances of approximately 3 m at 0.25 and approximately 3.5 m at 0.5 and 0.75.
- Measured throughput behaviour across varying incidence angles; work was subsequently published in *Optical and Quantum Electronics*.

ADDITIONAL ASTRONOMY RESEARCH EXPERIENCE

Case Studies in Astrophysics University of Hertfordshire
MSc research-based coursework Sep–Dec 2022
- **Extra-solar planets:** analysed transit dips and radial-velocity variations using DACE, Python, and `lightkurve` to estimate planetary parameters and interpret exoplanet systems.
- **Brown dwarfs:** compared atmospheric-model arguments for VHS 1256 b, obtaining a cloudy-model interpretation with $T_{\rm eff} \sim 1100$ K, [M/H] $\sim +1.0$, $\log g \sim 5.5$, and $R \sim 1.37\ R_{\rm J}$; proposed follow-up with PICASO 3.0.
- **Hunting for Death Stars in Gaia:** investigated close stellar encounters and identified GJ 710 as a potential close-passage candidate through perihelion-distance and uncertainty analysis.

Bayfordbury Observatory Practical Experience University of Hertfordshire
Observational astronomy, calibration and public outreach 2022–2024
- Gained practical experience in CCD calibration, photometry, image acquisition, guiding, and spectroscopic data reduction using observatory telescopes and imaging systems.
- Participated in planetarium demonstrations and public telescope sessions, communicating observational techniques to students and visitors.

INTERNSHIPS, SUMMER AND WINTER PROGRAMMES

LUMI SPACE / SEPnet Summer Placement United Kingdom
Evaluating Microbolometer Camera Performance for Satellite Laser Ranging 5 Aug–4 Sep 2024
- Compared microbolometer, CMOS, CCD, and quad-detector approaches for satellite laser ranging and orbital-debris tracking using detector responsivity, beam-divergence, atmospheric-transmission, and link-budget calculations.
- Modelled refractive-index and detector-performance constraints and proposed improvement routes using high-TCR materials and optical-antenna coupling.

Summer Research Project University of Hertfordshire
Identifying Halo T Dwarf Candidates using VISTA, DES, and WISE Survey Data Jun–Jul 2023
- Worked under Professor David Pinfield to assess candidate Halo T dwarfs through cross-survey analysis of VISTA, DES, and WISE data.
- Contributed to candidate assessment, follow-up planning, and a CNTAC telescope-proposal submission for Magellan/FIRE spectroscopic follow-up in 2025A.

Carl Sagan Exoplanet Summer Workshop Caltech / NASA Exoplanet Science Institute
Atmospheric modelling and exoplanet analysis training 2023
- Gained hands-on exposure to exoplanet-atmosphere modelling, brown-dwarf atmosphere interpretation, and retrieval tools including PICASO and petitRADTRANS.

Radio Astronomy Summer School Gauribidanur Radio Observatory / Raman Research Institute / Naxxatra
Two-element radio interferometer and solar-transit observation Feb–May 2022
- Worked under Dr. Ramesh Balasubramanyam to demonstrate a two-element radio interferometer and observe solar transits, gaining practical exposure to radio instrumentation and interferometry.

IIT Kharagpur Winter Internship India
Electronics and robotics research-oriented projects 22 Dec 2019–23 Jan 2020
- Worked under Professor Sudip Misra on low-cost high-frequency detecting circuits using FPGA and on calibration and synchronisation of multiple drones for swarm configuration.

SELECTED SCIENTIFIC SOFTWARE AND OPEN-SOURCE PROJECTS

AstroBis 2026–Present
Browser-based astronomy data and visualisation platform
- Integrated six astronomy modules using NASA Exoplanet Archive, NASA/JPL, CelesTrak, and public stellar-catalogue data: Solar System Atlas, Exoplanet Explorer, ISS Mission Control, Small-Body Watch, 3D Stellar Atlas, and NASA APOD.
- Built a working archive subset of approximately 4,000 planetary systems; visualised eight planets and selected dwarf planets across compressed inner-Solar-System-to-Oort-cloud scales, close approaches through 2050, and three recorded interstellar visitors.
- Implemented SGP4-based ISS propagation, searchable catalogue filters, orbital and discovery analytics, and explicit separation of source data, derived quantities, and illustrative objects.
- Links: GitHub | Live Project.

CosmicLens Lab 2026–Present
Browser-native gravitational-lensing simulation and visualisation project
- Developed a thin-lens, geometric-optics laboratory implementing seven representative lens components or models: point mass, SIS, SIE-like softened elliptical, NFW radial helper, Sérsic-inspired profile, composite systems, and external shear.
- Produced seven reproducible example scenes spanning Einstein rings, double and quad imaging, baryon–halo composites, subhalo anomalies, time-delay surfaces, and cluster arcs; scene parameters can be exported as JSON.
- Established Python reference checks for point-mass image positions, SIS image multiplicity, deflection consistency, Fermat-potential behaviour, and browser–Python scene-export parity.
- Links: GitHub | Live Project

TALKS AND POSTER PRESENTATIONS

- *Testing Performance of Microbolometer Detector for Satellite Laser Ranging Application*. SEPnet Poster Presentation, London, UK, 20 November 2024.
- *High Resolution RV Spectrographs: ANDES and PID Loop Implementation in EXOhSPEC*. University of Hertfordshire, 7 March 2024. [Slides]
- *Optimising Path Length Stability in Laser Interferometers using Air Refractive Index*. University of Hertfordshire, 8 February 2024. [Slides]
- *Advancement in Precision: Laser Interferometer Control System*. University of Hertfordshire, 8 December 2023. [Slides]
- *State of the Art: Radial Velocity Spectrograph*. University of Hertfordshire, 9 November 2023. [Slides]

TECHNICAL SKILLS

Programming and analysis: Python, JavaScript, HTML, CSS, MATLAB, C/C++, PHP, SQL, Bash *(beginner–intermediate working proficiency*
Astronomy and data analysis: NumPy, SciPy, pandas, Matplotlib, Astropy, `lightkurve`, DACE, FITS workflows, Jupyter Notebook, Aperture Photometry Tool, RSpec.
Instrumentation and optics: laser optics, interferometry, IDS3010 displacement sensing, radial-velocity spectrograph stabilisation, environmental control, optical alignment, active-optics tip–tilt correction, PID control.
Telemetry and control systems: Grafana, InfluxDB, serial communication, RS-232/RS-485 communication, sensor fusion, real-time logging, feedback-control dashboards.
Hardware and embedded systems: Arduino, Raspberry Pi, NodeMCU ESP8266, PSoC 5LP, embedded boards, IoT systems, visible-light-communication prototypes.
Software and tools: MaxIm DL, MATLAB, Simulink, QCA Designer, PSpice, PSoC Creator, Git, LaTeX, Overleaf.
Scientific communication: technical reports, research posters, telescope-proposal preparation, scientific blogging, public research visualisation, outreach presentations.

REFERENCES

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