

# AKASH KUMAR TARAI

Postdoctoral Research Fellow  
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## **EDUCAITON AND TRAINING**

Postdoctoral Research Fellow

Dec 2024 – Present

Department of Physical Sciences, Indian Institute of Science Education and Research (IISER) Berhampur, Odisha, India  
Mentor: Dr. Vyas Akondi

Ph.D. in Physics

2024

Advanced Centre of Research in High Energy Materials (ACRHEM), School of Physics  
University of Hyderabad, Hyderabad, India

*Ph.D. Thesis: Development of a novel LIBS – based technique for elemental analysis and harnessing machine learning for real-time applications using LIBS and Raman spectroscopy*  
Mentor: Prof. G. Manoj Kumar

M.Sc. in Physics

2017

Pondicherry University, Puducherry, India  
*Specialization: Laser fundamentals and applications*  
*Summer Internship: Wave propagation in optical fibers*  
Mentor: Late Prof. K Porsezian

B.Sc. in Physics

2015

Ravenshaw University, Cuttack, Odisha, India

## **RESEARCH EXPERIENCE**

- Wavefront sensing in Adaptive Optics using deep learning.
- Development of Simplified LIBS-based intensity-ratio approach for concentration estimation (SLICE): a new technique for elemental analysis using LIBS.
- Modeling the temporal dynamics of Laser Produced Plasma (LPP).
- Machine Learning coupled with LIBS for classification of human tooth, plastics, drugs, high energy materials, etc.
- Development of Python and MATLAB programs for comprehensive LIBS data analysis, encompassing advanced chemometrics, statistics, and machine learning techniques.
- Development of a compact, portable Raman spectroscopic setup equipped with advanced machine learning for the rapid, real-time detection of high-energy materials (HEMs).
- Machine learning coupled with Raman spectroscopy for detection of HEMs in mixtures.
- Investigation of various materials using LIBS and Raman spectroscopy, such as metals, alloys, liquids (sewage water, seawater, nanoparticles), human teeth, plastics, drugs, explosives, soils, thin films, and several other organic specimens.
- Interfacing CCD spectrometers using LabView and Python for spectroscopic applications.

## **TEHCNICAL SKILLS AND INSTRUMENTATION EXPERIENCE**

- Nd:YAG nanosecond laser, 1064/532 nm, ~7 ns (Spitlight 1200, M/s Innolas)
- Nd:YAG nanosecond laser, 1064/532 nm, ~10 ns (TITAN-5, M/s Amplitude Laser Technologies)
- Excimer nanosecond laser, 193 nm, ~7 ns (ExciStar 200 emon, M/s Coherent)
- Nd:YVO4 picosecond laser, ~30 ps (PL-2250 series, M/s Ekspla)
- Ti:Sapphire femtosecond laser, ~50 fs (Libra, M/s Coherent Co.)
- 8900 Triple Quadrupole ICP-MS (M/s Aligent)
- Raman system (LabRAM HR Evolution, M/s Horiba)
- Raman system (i raman plus, M/s BWteK)

- Raman laser, 785 nm (M/s Ocean Optics)
- High-resolution ICCD spectrograph (Kymera 328i, M/s Andor)
- Echelle type ICCD spectrograph (ME 5000 with iStar DH 334T and iStar DH 734, M/s Andor)
- CCD Spectrometers (M/s Avantes – AvaSpec uIs2048L-usb2 and M/s – Ocean Optics – HR 2, Maya 3000, QEPro, USB 4000 and NIR Quest)
- Motion Controller (ESP 300 and ESP 301, M/s Newport)
- Delay Generator (DG 535 and DG 645, M/s Stanford Research System)
- Digital Oscilloscope (TDS 2014B and TDS 2024B, M/s Tektronix)
- Hardware integration: LabView, Python, MATLAB, and Arduino

## **ANALYTICAL SKILLS**

- Analytical models: Statistical, Chemometrics, Machine learning, and deep learning
- Data analysis: Expertise in Python and MATLAB. Intermediate in Iolite, Fortran, C, R, Mathematica, and Arduino
- Data visualization: Origin, Tableau, and Microsoft Excel
- Internet of Things (IoT): MATLAB Simulink
- Modeling and simulation: Python and MATLAB
- Graphical user interface (GUI): Python and MATLAB
- Others: Microsoft Office (PowerPoint, Word, Excel), GitHub, LATEX

## **PUBLICATIONS**

1. **Tarai, A. K.**, Rashkovskiy, S. A., & Gundawar, M. K. (2024). Simplified LIBS-based intensity-ratio approach for concentration estimation (SLICE): an approach for elemental analysis using laser induced breakdown spectroscopy. *Optics Express*, 32(4), 6540-6554.
2. **Tarai, A. K.**, Junjuri, R., Dhobley, A., & Gundawar, M. K. (2023). Classification of human tooth using laser-induced breakdown spectroscopy combined with machine learning. *Journal of Optics*, 1-11.
3. **Tarai, A. K.**, & Gundawar, M. K. (2023). Raman spectroscopy combined with machine learning for the quantification of explosives in mixtures. *Journal of Optics*, 1-9.
4. **Tarai, A. K.**, Junjuri, R., Rashkovskiy, S. A., & Gundawar, M. K. (2022). Time- Dependent Intensity Ratio-Based Approach for Estimating the Temperature of Laser Produced Plasma. *Applied Spectroscopy*, 76(11), 1300-1306.
5. **Tarai, A. K.**, Junjuri, R., & Gundawar, M. K. (2021). Advances in applications of LIBS in India: A Review. *Asian Journal of Physics*, 30(6), 871-888.
6. John, L. M., **Tarai, A. K.**, Gundawar, M. K., & KK, A. (2024). Self-absorption of emission lines in picosecond-laser-produced gold plasmas. *Physics of Plasmas*, 31(4).
7. Junjuri, R., **Tarai, A. K.**, & Gundawar, M. K. (2024). Identification of the optical isomers using laser induced breakdown spectroscopy combined with machine learning. *Journal of Optics*, 1-11.
8. Gupta, V., Rai, A. K., Kumar, T., **Tarai, A. K.**, Kumar Gundawar, M., & Rai, A. K. (2024). Calibration-free approaches for quantitative analysis of a brass sample. *Zeitschrift für Naturforschung A*, (0).
9. John, B., Joseph, G., Aryadevi, G., **Tarai, A. K.**, Gundawar, G. M. K., Navya, S., & Ginson, P. J. (2024). Tweaking Bis Thiourea Cadmium Chloride single crystals for Optoelectronic applications by L-Valine. *Journal of Materials Science: Materials in Electronics*, 35(135).
10. Gupta, V., Rai, A. K., Kumar, T., **Tarai, A.**, Gundawar, G. M. K., & Rai, A. K. (2023). Compositional analysis of copper and iron-based alloys using LIBS coupled with chemometric method. *Analytical Sciences*, 1-13.
11. Gupta, V., Rai, A. K., Kumar, R., **Tarai, A. K.**, Gundawar, M. K., & Rai, A. K. (2023). Compositional quantification of binary ternary and quaternary metallic alloy-based coins using laser-induced breakdown spectroscopy. *Journal of Optics*, 52(3), 1245-1257.
12. Gazali, Z., Gupta, V., Kumar, T., Kumar, R., **Tarai, A. K.**, Rai, P. K., ... & Rai, A. K. (2023). Effect of mineral elements on the formation of gallbladder stones using spectroscopic techniques. *Analytical and Bioanalytical Chemistry*, 1-11.
13. Dubey, D., Kumar, R., Gupta, V., **Tarai, A. K.**, Gundawar, M. K., & Rai, A. K. (2022). Investigation of Hazardous Materials in Firecrackers using LIBS Coupled with a Chemometric Method and FTIR Spectroscopy. *Defence Science Journal*, 72(4), 618.

14. Mishra, P., Kumar, R., **Tarai, A. K.**, Kumar, M., & Rai, A. K. (2022). Characterization of toxic substances present in smoking tobacco using different spectroscopic techniques. *Journal of Laser Applications*, 34(2).

### **CONFERENCE PROCEEDINGS**

1. **Tarai, A. K.**, & Gundawar, M. K. (2022). Possibility of Plastic Discrimination using Picosecond Laser Induced Breakdown Spectroscopy. In 2022 Workshop on Recent Advances in Photonics (WRAP) (pp. 1-2). IEEE.
2. Junjuri, R., **Tarai, A. K.**, Dhobley, A., & Gundawar, M. K. (2019). Identification of the calcified tissues using laser induced breakdown spectroscopy. In 2019 Workshop on Recent Advances in Photonics (WRAP) (pp. 1-3). IEEE.

### **CONFERENCE CONTRIBUTIONS**

1. *Thesis presentation* entitled "Development of a novel LIBS based Technique for Elemental Analysis and Harnessing Machine Learning for Real time Applications using LIBS and Raman Spectroscopy" at "National Photonics Symposium (NPS2025)" organized by Cochin University of Science and Technology (CUSAT), Kerala, India during 27 – 28<sup>th</sup> Feb 2025.
2. *Poster presentation* entitled "Laser induced breakdown spectroscopy combined with machine learning: An efficient tool for plastic waste sorting" at "Frontiers in Physics (FIP 2023)" organized by University of Hyderabad, Hyderabad, India during 3 – 4<sup>th</sup> Mar 2023.
3. *Poster presentation* entitled "Effect of feature selection and extraction in identification of post-consumer plastics using picosecond laser induced breakdown spectroscopy" at "XII Laser Induced Breakdown Spectroscopy (LIBS 2022)" held at Bari, Italy during 5 – 9<sup>th</sup> Sep 2022.
4. *Poster presentation* entitled "Quantitative estimation of ammonium nitrate in mixtures using portable Raman spectroscopy" at "13<sup>th</sup> International High Energy Materials Conference & Exhibits (HEMCE 2022)" organized by Terminal Ballistics Research Laboratory (TBRL), Chandigarh, India during 26 – 28<sup>th</sup> May 2022.
5. *Poster presentation* entitled "Possibility of Plastic Discrimination using Picosecond Laser Induced Breakdown Spectroscopy" at "5<sup>th</sup> IEEE Workshop on Recent Advances in Photonics (WRAP 2022)" held at Mumbai, India (Virtual) during 4 – 6<sup>th</sup> Mar 2022.
6. *Contributed Oral Presentation* entitled "Estimation of radiation decay constant of laser produced brass plasma from its emission intensities" at 47<sup>th</sup> IEEE International Conference on Plasma Science (ICOPS 2020) held at Singapore (Virtual) during 6 – 10<sup>th</sup> Dec 2020.
7. *Poster presentation* entitled "Standoff detection of explosives using laser induced breakdown spectroscopy" at "12<sup>th</sup> International High Energy Materials Conference & Exhibits (HEMCE 2019)" organized by Indian Institute of Technology Madras (IIT – Madras), Chennai, India during 16 – 18<sup>th</sup> Dec 2019.

### **WORKSHOPS & TRAINING PROGRAM ATTENDED**

1. "Convergence of Multifunctional Materials, Photonics, Bioscience and Artificial Intelligence (MPBA 2025)" organized by Indian Institute of Science Education and Research (IISER) Berhampur, India during 20 – 21<sup>st</sup> Mar 2025.
2. "Machine learning workshop 2022" organized by University of Hyderabad, India during 26 – 28<sup>th</sup> Oct 2022.
3. "National Workshop on Explosive Detection (NWED 2020)" organized by High Energy Materials Research Laboratory (HEMRL), Pune, India during 1 – 2<sup>nd</sup> Mar 2020.
4. "Workshop on advances in optics and photonics 2019" organized by University of Hyderabad, India during 18 – 23<sup>rd</sup> Mar 2019.
5. "Workshop on photonics for detonics 2019" organized by Terminal Ballistics Research Laboratory (TBRL), Chandigarh, India during 1 – 2<sup>nd</sup> Mar 2019.
6. "Winter school on photonics" organized by SPIE student chapter, IISER Kolkata, India during 26 – 29<sup>th</sup> Dec 2013.

## **AWARDS & GRANTS**

1. Best Thesis Award at National Photonics Symposium (NPS2025) organized by Cochin University of Science and Technology (CUSAT), India during 27 – 28<sup>th</sup> Feb 2025.
2. *Australian National University – Future Research Talent (ANU-FRT) Award.*
3. *Science and Engineering Research Board – International Travel Scheme (SERB – ITS)* sanctioned to attend “12th Euro-Mediterranean Symposium on Laser-induced Breakdown Spectroscopy (EMS LIBS 2023)” held at Porto, Portugal during 4 – 7th Sep 2023.
4. *Best Poster Award* received for presenting work entitled “Laser induced breakdown spectroscopy combined with machine learning: An efficient tool for plastic waste sorting”, at Frontiers in Physics (FIP 2023), organized by University of Hyderabad, Hyderabad, India during 3 – 4th Mar 2023.
5. *Institute of Eminence – University of Hyderabad – International Travel Grant (IoE – UoH – ITG)* received to attend “XII Laser Induced Breakdown Spectroscopy (LIBS 2022)” held at Bari, Italy during 5 – 9th Sep 2022.

## **TEACHING EXPERIENCE**

1. Worked as a Teaching Assistant for MBA Data Visualization course at the University of Hyderabad from Jan – Apr 2023.
2. Worked as a Teaching Assistant for M.Sc. Laser Physics Lab at the University of Hyderabad from Jul – Dec 2021.
3. Worked as a Teaching Assistant for Integrated M.Sc. Waves and Oscillations Lab at the University of Hyderabad from Jan – Apr 2019.
4. Worked as a Teaching Assistant for Integrated M.Sc. Optics Lab at the University of Hyderabad from July – Dec 2018.

## **PERSONAL INFORMATION**

- Nationality: Indian
- Marital Status: Unmarried
- Gender: Male
- Language Known: English, Hindi and Odia

## **REFERENCE**

### *Reference 1*

Prof. G. Manoj Kumar (Ph.D. Supervisor)

ACRHEM, School of Physics, University of Hyderabad, Hyderabad, Telangana, India 500046

E-mail: [manoj@uohyd.ac.in](mailto:manoj@uohyd.ac.in), [my.hunn.manoj@gmail.com](mailto:my.hunn.manoj@gmail.com)

### *Reference 2*

Prof. Narahara Chari Dingari

Department of Data Science, Worcester Polytechnic Institute, 100 Institute Rd., Worcester, MA, 01609, USA

E-mail: [dnchari@gmail.com](mailto:dnchari@gmail.com), [ndingari@wpi.edu](mailto:ndingari@wpi.edu)

### *Reference 3*

Prof. Sergey A. Rashkovskiy

Ishlinsky Institute for Problems in Mechanics, Russian Academy of Sciences, Vernadskogo Ave., 101/1 Moscow, 119526, Russia

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