Ujjwal Panda

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Education

Masters of Science (*Hons.)* in **Chemistry** | *BITS Pilani, Rajasthan, India*
Bachelors of Engineering (*Hons.*) in **Electrical and Electronics Engineering** | *BITS Pilani, Rajasthan, India*

C.G.P.A: 7.58

Electives Taken: Atmospheric Chemistry (**A–**), Photochemistry and Laser Spectroscopy (**B–**), Antenna Theory and Design (**A–**), Digital Signal Processing (**B**), Solid State Chemistry (**A**), Medical Instrumentation (**B**)

[Grades for the courses are given in parentheses, in **bold**].

Career Objective

I wish to contribute to the research of chemical processes in the interstellar medium, planetary atmospheres, protoplanetary disks and other interstellar environments through both observational astronomy and laboratory simulations. I hope to help solve some of the fundamental questions pertaining to astrochemistry and astrobiology and learn and grow as a researcher while doing so.

Research Experience

WINTER INTERNSHIP: Gauribidanur Radio Observatory, Bangalore

Duration: Dec 2016 – Jan 2017

Status: Completed

Instructor-in-charge:

Dr. Avinash Deshpande (Professor, Department of Astronomy and Astrophysics, Raman Research Institute, Bangalore)

- Studied and operated the **Sky Watch Array Network (SWAN)**, a joint collaboration of 8 top universities engaged in scientific research across India to construct a radio telescope array spanning the Indian subcontinent.
- Acquired basic knowledge about Radio Astronomy, Interferometry and Aperture Synthesis, Antenna Theory, among other topics, in order to understand the operation of the SWAN tiles.

DESIGN PROJECT: NASA Radio Jove Telescope

Duration: Aug 2016 – Mar 2019

Status: Completed

Instructor-in-charge:

Dr. Sainath Bitragunta (Assistant Professor, Department of Electrical and Electronics Engineering, BITS Pilani)

- Headed a team that constructed the first functional radio telescope in BITS Pilani as part of the NASA Radio Jove Project and joined a network of researchers and students from 70 different countries working on detecting Jovian and solar radio emissions.
- The telescope is a dual dipole array with a narrow bandwidth of 100 KHz centered on 20.1 MHz, an optimum frequency for detection of the decametric radio emission from Jupiter.
- The project aims to help students in my college to observe and analyse these radio storms and contribute to the ongoing study behind the mechanism of these emissions and the information they yield about Jupiter's interior.

LABORATORY PROJECT: Remediation of Cr^{6+} from Lake Water using Biodegradable Adsorbents

Duration: May 2017 – July 2017

Status: Completed

Project-in-charge:

Dr. Noorbasha N. Meeravali (National Centre for Compositional Characterisation of Materials (NCCCM), Hyderabad)

- Did a quantitative analysis of the efficiency of a particular bio-adsorbent, sugar cane bagasse, in remediation of Cr (VI) ions, a known carcinogen, from lake water.
- Our project was the first step towards creating a practical, inexpensive and mass-scalable model using bio-adsorbents to remove Cr (VI), a

life-threatening carcinogenic contaminant, from water and make it safe to drink and use in areas most affected by it.
- Gained proficiency at using AAS (**A**tomic **A**bsorption **S**pectroscopy) and performing ultra-trace analysis.

SUMMER PROJECT: The Annihilation of Low-Energy Positrons on Molecular Targets

Duration: May 2018 – July 2018

Status: Completed

Instructors-in-charge:

1. Dr. Shamik Chakraborty (Assistant Professor, Department of Chemistry, BITS Pilani)
2. Dr. Debanjan Bose (Ramanujan Fellow, Department of Physics, IIT Kharagpur)

- Conducted a thorough survey of the scientific literature to construct a viable theory that could explain the abnormally high annihilation rates of low-energy positrons when they interact with complex molecules such as benzene and long-chain hydrocarbons.
- Completion of the project yielded an experimentally supported theory that could explain these elevated annihilation rates through interactions of the low-energy positrons with the vibrational states of the molecules involved. This interaction, called Vibrational Feshbach Resonance (VFR), yielded a quasi-stable bound positron-molecule complex.
- The project also involved analysing the limits of the theory presented and laying out avenues for further research in this area.

RESEARCH PROJECT: Understanding the Interaction of Cosmic Rays with Molecules in Planetary Atmospheres.

Duration: Jan 2019 – May 2019

Status: Completed

Instructors-in-charge:

1. Dr. Shamik Chakraborty (Assistant Professor, Department of Chemistry, BITS Pilani)
2. Dr. Debanjan Bose (Ramanujan Fellow, Department of Physics, IIT Kharagpur)

- I aimed to understand how cosmic rays interact with the upper atmospheres of Earth and other planets (such as Venus, Titan etc.). Specifically, I studied how energetic cosmic ray particles create a secondary electron flux, which might produce an appreciable amount of UV radiation in the upper atmosphere and can have consequences for the photochemistry of atmospheric molecules.
- I used Geant4 libraries to create an application that simulated the Earth's atmosphere, in order to help us study the secondary electrons produced by cosmic rays. I also explored other models that can simulate the chemistry of Earth's (upper) atmosphere and the effect of the UV re-radiation on the molecules.

SUMMER INTERNSHIP: Efficient Searches of Long Period Pulsars for the GHRSS Survey (Visiting Students' Research Programme (VSRP) at NCRA-TIFR, 2019)

Duration: May 2019 – July 2019

Status: Completed

Instructor-in-charge:

Prof. Jayanta Roy (National Center of Radio Astrophysics (NCRA), Tata Institute of Fundamental Research (TIFR))

- Slow pulsars, with periods greater than a second, are not easily detected by standard pulsar search methods, which use the Fast Fourier Transform (FFT) and work in the frequency domain. This is due to the presence of low-frequency red noise and the failure of red noise mitigation algorithms to recover pulsar signals.
- The Fast Folding Algorithm is a new time-domain pulsar search strategy that uses "folding" (cutting a de-dispersed time series into segments and adding them) to amplify the pulsar signal in a noisy time series.
- My project involved using RIPTIDE, an implementation of the FFA in Python, and PRESTO's FFT-based search methods to contrast the performances of the FFA and the FFT in searching for slow pulsars through the analysis of simulated datasets covering a wide period range.

BACHELORS' THESIS [ELECTRICAL AND ELECTRONICS ENGINEERING]: Building an FFA-based Python Pulsar Search Pipeline for the GHRSS Survey

Duration: Aug 2019 – Dec 2019

Status: Completed

Instructor-in-charge:

Prof. Jayanta Roy (National Center of Radio Astrophysics (NCRA), Tata Institute of Fundamental Research (TIFR))

- Recent research has shown that the predominant method of searching for pulsars, the FFT, has introduced a selection bias against pulsars with periods greater than a second. These slow pulsars could reveal new details about the pulsar emission mechanism.
- As several pulsar surveys augment their pipelines with an FFA module, the GMRT High Resolution Southern Sky (GHRSS) survey has also decided to do so.
- I worked on building an FFA-based search pipeline for the GHRSS survey. The FFA is a time domain pulsar search method that is complementary to the FFT. We are using the RIPTIDE implementation of the FFA, which has been written in Python and C by Vincent Morello from the University of Manchester.
- My work involved writing the entire pipeline from scratch in Python, using methods from RIPTIDE and PRESTO to create a completely automated pulsar search architecture. This pipeline is being used on both incoming as well as archival GHRSS survey data.

MASTERS' THESIS [CHEMISTRY]: A Study of Hydrogen-Bonding Interactions of Astrochemically Relevant Molecules

Duration: Jan 2020 – April 2020

Status: Completed

Instructor-in-charge:

Dr. Shamik Chakraborty (Assistant Professor, Department of Chemistry, BITS Pilani)

- I aimed to study the interactions of water complexes of astrochemically significant molecules, such as aminoacetonitrile (NH_2CH_2CN) and hydroxyacetonitrile ($HOCH_2CN$) (both amino acid precursors and known to be present in the ISM).
- I compared the interactions of these water complexes, with similar complexes formed with hydrogen sulphide, H_2S.
- Studied possible proton-relay mechanisms that could lead to isomerisation reactions of these molecules, while interacting with water and hydrogen sulphide clusters.
- Came up with and studied the feasibility of alternate mechanisms for the formation of amino-acids from these molecules, particularly in interstellar environments.

Projects

- Created **T**he **C**omprehensive **A**strochemists' **L**ist, a.k.a. **tcal**. This aims to be an updated and maintained list of astrochemists across the globe, including everyone, from undergraduates to professors. The list has currently more than **300** names and is published on the web **here**.

- Developing an updated version of a data processing pipeline for the **G**MRT **H**igh **R**esolution **S**outhern **S**ky (**GHRSS**) survey, focused on searching for **pulsars** and **radio transients**. The code for the same can be found **here**.

- Developing **ptypes**, a.k.a. **pulsar-types**, a pure Python package to read and write common data types associated with pulsar data, such as filterbank files, spectra, and time series. The code for the same can be found **here**.

Schools and Conferences

- Participated in the **Radio Astronomy School (RAS) (19th – 31st August 2019)** held at the **National Center for Radio Astrophysics (NCRA-TIFR), Pune**.
- Attended the **International Pulsar Timing Array (IPTA) meeting, 2019** held at the **National Center for Radio Astrophysics (NCRA-TIFR), Pune** from **10th – 24th June 2019**.

Scholarships and Grants

Professor I.J. Nagrath Student Project Fund (Sep 2016)

As a leader of my project team, I was able to secure funding from the Department of Electrical and Electronics Engineering, BITS Pilani for the NASA Radio Jove Project being built at BITS Pilani.

Positions of Responsibility

- **Member** of the **G**MRT **H**igh **R**esolution **S**outhern **S**ky (**GHRSS)** survey collaboration.

- **Member** of the **Sky Watch Array Network (SWAN)**, a collaborative effort by RRI, Bangalore and IIA, Bangalore (Aug 2016 – Present)
- **Founding Member** of *The Radio Astronomy Club*, BITS Pilani (Aug 2016 – Jul 2020)
- **Secretary** of the *Astronomy Club*, BITS Pilani (Aug 2017 – May 2018) and **Member** of the *Astronomy Club* (Aug 2015 – Jul 2020).

Other Skills

Coding:

- Python
- MATLAB
- C++ and C

Libraries and Packages:

- ANSYS HFSS
- GAUSSIAN09
- GEANT4