

Pavan Hebbar

Curriculum Vitae

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Research Interests

- Using X-rays and gamma rays to study compact objects, especially neutron stars and black holes
- Understanding the structure and evolution of gamma ray bursts from high-energy observations
- Electromagnetic follow-up of gravitational-wave detections

Education

2017 – Present **Masters in Physics, Specialization: Astrophysics,**
University of Alberta, Current GPA - **4.0/4.0**,
Supervisor: [Craig Heinke](#).

2013 – 2017 **B.Tech Aerospace Engineering,**
Indian Institute of Technology, Grade – **9.48/10**.

- Department Rank 1** among the class of 2017
- Awarded **AP** grade (for exceptional performance) in Spaceflight Mechanics
- Completed Honors, *Honors' Grade* – **10.0/10**
- Minor: Computer Science, Physics

Publications (Refereed)

- P. R. Hebbar, C. O. Heinke, G. R. Sivakoff, A. Shaw
'X-ray spectroscopy of the candidate AGN in Henize 2-10 and NGC 4178: Likely supernova remnants',
(Submitted to MNRAS)
- P. R. Hebbar, C. O. Heinke, D. Kandel, R. Romani
'On the vanishing X-ray variability in the eclipsing binary millisecond pulsar 47 Tuc W', (in preparation)
- P. Hebbar, C. O. Heinke
'X-ray spectroscopy reveals the nature of compact object in SNR 1E 0102.2-7219', (in preparation)

Publications (Non refereed)

- R. Mishra, S. Shahane, P. R. Hebbar, S. Jain, Manmohan
"Designing and Analysis Using ANSYS for 'Pratham' Student Satellite IIT Bombay", 65th
International Astronautical Congress 2014, Toronto, Canada
- R. Mishra, S. Shahane, P. R. Hebbar, S. Jain, Manmohan
"Structural Dynamics-Modeling and Simulation of IITB Student Satellite-Pratham",
National Seminar on Aerospace Structures 2014

Relevant Skills

Languages C/C++, Python, Shell Scripting, Matlab, HTML, \LaTeX

Software ANSYS, NASTRAN, OpenFOAM, SolidWorks CAD, AutoCAD

Packages Python packages: NumPy, SciPy, Matplotlib, GNUPlot and Astropy; WARP, Chandra Interactive Analysis of Observations (CIAO), XSPEC

Research Experience

- May 2016 – **47 Tuc W: X-ray Variable star**,
Present *Prof. Craig Heinke, Department of Physics, University of Alberta, (Paper under preparation).*
- Analysed the X-ray light curve of 47 Tuc W in order to check for transits observed in 2002 ACIS-I observations but not in HRC observations of 2004 - 2015
 - Performed the spectral analysis of data to understand the source of the X-ray emission and to look for any changes as compared to the previous observations
 - Aim to use the light curve and the spectral information to study the properties of the intrabinary shock and infer more details about the red-back system.
- June 2017 – **MOTIVE: Monitoring Of Transients Integrating Venus and Earth**,
August 2017 *Prof. Varun Bhalerao, Indian Institute of Technology Mumbai.*
- A proposal aimed at following up the gravitational wave detections in high energy, better localization of Gamma Ray Bursts (GRBs), study Venusian Gamma-ray Flashes (VGFs) and solar flares
 - Developed tools to localize GRBs using Earth-Venus-Mars triangulation and LIGO + Venus triangulation using the ephemeris data from astropy.
 - Generalized the code to triangulation from satellites (instead of planets), using the sgp4 algorithm to determine the position of satellites. This code could be used in future missions like LISA.
- May 2017 – **Automated GRB detection from AstroSAT CZTI data**,
July 2017 *Prof. Varun Bhalerao, Indian Institute of Technology Mumbai.*
- Designed an algorithm to automatically search for GRBs (short and long) in the data collected by Cadmium Zinc Telluride Imager on-board AstroSAT.
 - Algorithm was based on constructing light curves with different binning and checking for the coincidence of the peaks in multiple quadrants.
- December 2015 **B-mode spectrum and Inflation Models**,
National Initiative of Undergraduate Research - Astronomy,
N. Malsawmtluangi and Prof. P. K. Suresh, School of Physics, University of Hyderabad.
- Performed literature review on the anisotropies in the Cosmic Microwave Background Radiation.
 - Understood the theory of inflation and its effects on the anisotropies in CMBR.
 - Analyzed the validity of inflation models by comparing the covariance spectrum with Planck data.
- May 2015 – **Numerical Simulation of Collisionless Shocks**,
April 2016 *Prof. Bhooshan Paradkar, Centre for Excellence in Basic Sciences, University of Mumbai*
Prof. Kowsik Bodi, Aerospace Department, Indian Institute of Technology Bombay.
- Implemented Particle in Cell approach using WARP open source code to numerically simulate collisionless shocks in unmagnetized plasma and study the change in plasma parameters
 - Analyzed the results of the simulations to study the structure of the shocks
 - Studied the effects of initial velocities and composition of plasma on shock properties.
 - Parallelized the code using pyMPI to increase the speed of the simulation.
- Jan 2016 – **Solving Brio - Wu Shock Tube Problem**,
April 2016 *Prof. Avijit Chatterjee, Aerospace Department, Indian Institute of Technology Bombay.*
- Studied plasma flow dynamics and the different schemes used to implement it computationally
 - Implemented Godunov schemes to simulate the evolution of plasma in Brio - Wu Shock Tube
 - Compared the results with higher order schemes to analyze the errors
- December 2013 **Gamma Ray Detection Through Čerenkov Radiation**,
National Initiative for Undergraduate Science – Astronomy,
Dr. K K Yadav, Bhabha Atomic Research Center, Mumbai.
- Performed literature review on the detection of gamma rays through Čerenkov emission.
 - Designed programs to differentiate between Čerenkov emission shower due to cosmic and gamma rays
 - Analysed data collected from the TACTIC to study the properties of Crab Nebula and MRK 421

Technical Experience

2013 – **Mechanical Subsystem, Pratham – Student Satellite Team of IIT Bombay.**

- Present
- Performed Vibrational Analysis, Harmonic Analysis, Modal Analysis, Response Spectrum of the satellite
 - Performed steady-state and transient thermal analysis to determine the temperature distribution
 - Proposed SNAP model to switch the satellite on when it is launched with minimum power
 - Optimized satellite models used for analysis to minimize simulation time and maximize accuracy
 - Implemented ways to access the server remotely and perform parallel processing on ANSYS
 - Worked in the payload subsystem and suggested payloads for the next student satellite

Mentoring and Work Experience

September 2017 – **Teaching Assistant at University of Alberta.**

- 2017 – Present
- Held lab sessions and graded reports for the course PHYS 124 - Particles and Waves in Autumn 2017
 - Grading homework assignments for the courses ASTRO 122 - Astronomy of Stars and Galaxies and ASTRO 322 - Galactic and Extragalactic Astrophysics in Spring 2018.

March 2016 – **Institute Student Mentor.**

- Present
- Selected among a team of 81 mentors out of 368 participants to mentor first-year students
 - Involved in guiding twelve mentees allotted to me and solving their academic and social problems
 - Volunteered in the organization of welcome programs for freshmen
 - Attended a one day workshop organized by Tata Institute of Social Service (TISS) to learn different skills required for mentoring.

2015 – 16 & 2016 – **Department Academic Mentor.**

- Present
- Selected twice into a team of 25 mentors to help sophomores of aerospace department academically
 - Involved in guiding and solving academic problems of four mentees in 2015 – 16, one of whom secured the department rank one of their batch for that year.
 - Presently involved in inspiring and motivating three mentees under the Academic Rehabilitation Program to perform academically well.

July 2015 **Academic Committee Member – International Physics Olympiad 2015.**

- Selected as a student grader for the theory round of the Olympiad
- Involved in the critical discussion of theory questions
- Evaluated the answer scripts of students from 89 different countries

June 2015 **Resource Person and Student Facilitator.**

- Selected as a resource person for the Indian Astronomy Olympiad OCSC (Orientation-Cum-Selection Camp) for mentoring students, handling academic arrangements and aiding in evaluations
- Involved in the selection and training of Indian team which won 3 gold medals and 2 silver medals at International Olympiad for Astronomy and Astrophysics 2015.

2014 – 2016 **Teaching Assistants for IITB courses .**

PH 107: Quantum Physics and Application	Autumn 2014, Summer 2015, Autumn 2015
BB 101: Biology	Spring 2015
MA 214: Introduction to Numerical Analysis	Spring 2016

- Held tutorials where doubts of students were addressed and applications and problems related to the concepts learnt in lectures were discussed
- Evaluated the answer scripts of students in various exams

March 2015 – **Manager, Krittika – Astronomy Club of IIT Bombay.**

- March 2016
- Planned a budget of 225,000 rupees for club activities including lectures, documentary screenings, night-sky observations and workshops, field trips and competitions
 - Organized Institute Technical Summer Project 2015 which had a budget of 8 lakhs
 - Planned and organized the Inter IIT Messier Marathon 2014-15
 - Selected college level teams to participate in intercollegiate events
 - Awarded the Institute Technical Organization Color for exceptional performance

2014 – 2015 **Coordinator, Abhyudhay – Social Festival of IIT Bombay.**

- Worked under the Events Division and managed the logistics of various events including lectures, competitions, and Interactive sessions
- Planned and implemented urban farming in the hostels of the institute

Achievements

International Representations

- 2012 **Bronze Medal, International Olympiad on Astronomy and Astrophysics,**
Rio De Janeiro, Brazil.
- 2011 **Silver Medal, International Astronomy Olympiad,**
Almaty, Kazakhstan.
- 2013 **Prof. Harry Messel International Science School,**
University of Sydney, Australia.
One of the 5 students to represent India and awarded a medal
- 2012 **IGNOU UNESCO Science Olympiads for SAARC countries.**
Awarded medal for being among the top 40 participants

Other Achievements

- 2010 – 2012 **Olympiad Orientation Cum Selection Camps.**
- Astronomy Camps (2010, 2011 & 2012) among top 30 students in India
 - Awarded **Best Theory** Solution in 2012 and **Best Observer** in 2011 Astronomy Camps
 - Awarded Certificates of Merit in the National Standard Examinations in Physics(2013) and Junior Science (2011) for being in top 1% of the participants
- 2011 **Kishore Vaigyanik Protsahan Yojana Scholarship,**
Indian Institute of Science, Bangalore.
- Awarded by Government of India for students interested in research
 - Ranked 24 at national level
- 2009 **National Talent Search Examinations, NCERT, Delhi.**
- Awarded by Government of India for students interested in research
 - Ranked 2nd at national level and 1st at state level
- 2016 **Online Physics Brawl.**
Secured first position among 245 teams from all over the world in the online physics brawl conducted by FYKOS - students from Dept. of Maths and Physics at Charles University
- 2013 **Inter IIT Messier Marathon.**
Secured IIT Bombay the second position by putting on board 72 Messier objects including the entire Virgo cluster of galaxies

Relevant Courses Undertaken

Physics and Maths	Astrophysics, General Theory of Relativity, Quantum Mechanics I, Quantum mechanics and Applications, Electricity and Magnetism, Classical Mechanics, Condensed Matter Physics. Introduction to Nuclear and Particle Physics, Nonlinear Dynamics, Differential Equations, Linear Algebra, Calculus, Introduction to Numerical Analysis
Aerospace Engineering	Introduction to Plasma, Particle methods to simulate fluid flows, Vibrations, and Structural Dynamics, Aerospace Structures, Solid Mechanics, Continuum Mechanics, Compressible and Incompressible Fluid Mechanics, Thermodynamics and Propulsion, Engineering Design Optimisation
Computer Sciences	Computer Graphics, Image Processing, Data Structures and Analysis, Logic for Computer Programming, Introduction to Computer Science

Other Interests and Extra - curricular Activities

- Trekking**
- Attended Basic Mountaineering Camp in Summer 2014 and learned different techniques of rock climbing, river crossing, climbing in snowy and icy terrains, glissading etc.
 - Successfully ascended Mt. Balachanda (Altitude 15500ft) and several other peaks in the Western Ghats
- Basketball** Selected for NSO Basketball and proficient in all tricks and game play
- Others** Interested in cycling in my free time and would like to participate in adventure sports