Saurabh

Curriculum Vitae

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"Everything happens for a reason and that reason is always good!"

Objective

To create interest among the youngsters in the field of Science, especially in the field of Physics and Astronomy and to develop creative and enquiring learning mind committed to lifelong learning and get acquainted with the fun along learning.

Education

2017–2020 **B.Sc Honours (Physics)**,
Department of Physics, Dyal Singh College, University of Delhi, India.

2017 **Intermediate**,
Manav Rachna International School,Charmwood Village, Faridabad, India (82%).

2015 **Matriculation**,
Manav Rachna International School, Charmwood Village, Faridabad, India (CGPA 8.4).

Scholastic and Curricular Achievements

2017-present Member of the College Physics Society - Cosmos

2017 Founded **Stellar Universe** - A student organisation for every astronomy and physics enthusiast to work and learn collectively while providing a platform to grow in the field by doing activities such as research/learning projects, seminars, webinars, lectures , interactive sessions, etc. and organising interactive sessions every weekend.

2015-2017 Member of the Student council as Vice-House Captain (2015-16) and House-Captain (2016-17))

2015 AIR - 100 in National Astronomy Olympiad organised by Orange Organisation

2014-2017 Won several awards and top positions while representing the school in inter(intra)-school competitions (Dance Drama (1st), Mono-acting(3rd), Debate, Volleyball, Basketball,Cricket etc.)

Coursework

Core Courses Mechanics, Mathematical Physics (I, II, III), Electromagentism, Waves and Optics, Thermodynamics, Digital Systems and Applications, Analog Systems and Applications, Modern Physics, Solid State Physics*, Quantum Mechanics and Applications*, Electromagnetic Theory**, Statistical Mechanics**

Lab Courses Mathematical Physics Labs (I,II,III) and Advanced Mathematical Physics Lab* - Numerical Methods and their applications in Physics using C++ and Scilab, Solving Schrodinger Equations for various various potentials and systems using Scilab and C++, Digital and Analog Electronics, Thermodynamics.

Awards

1 1st Prize for Presentation/Seminar Presentation, 2020 at Dyal Singh College, University of Delhi, Topic: Shadows cast by compact and ultracompact objects

2 1st Prize, Astronomy Quiz during SKA-Outreach at Vigyan Samagam, New Delhi.

Technical Skills

Programming Python (Scipy, Numpy, Matplotlib, Astropy, Gravipy, EinsteinPy), C++, Scilab, Fortran, Bash

Software Mathematica, CASA (Common Astronomy Software Application), LaTeX

Libraries

`EinsteinPY` (Contributor), ShadowPY (Under Development)

Research Interests

General Relativity, Relativistic Ray Tracing, Radio Astronomy and Synthesis Imaging, Gravitational waves

Research Internships

(1) Summer Research Internship Program - 2019

Mentor Prof. Pankaj Joshi

Topic Shadows of Black Holes and Naked Singularities

Institution International Centre for Cosmology (ICC), CHARUSAT University, Gujarat

Duration 1 Month

(2) Summer Internship - 2019

Mentor Dr. Himanshu Kumar

Topic Twin Paradox Studies and Simulations in General Relativity

Institution Dyal Singh College, University of Delhi

Duration 15 Days

Projects Undertaken

Completed

(1) Twin Paradox around Black Hole (Resinner-Nordstrom Spacetime)

(2) Timelike and Null Geodesics in spherically symmetric static and stationary Spacetimes.(Naked Singularities, Black Holes, Wormholes)[Reading Project].

(3) Data Analysis (Timing) of VELA PULSAR (data taken from Ooty Radio Telescope.)

(4) Measuring angular diameter of the sun using hand-made Solar Projector.

(5) Measuring angular diameter of the Moon using modified version of Cross-Staff (Observations taken during Lunar eclipse, 31st Jan,2018 and compared results to normal day.)

Ongoing

(1) Imaging and Simulations of Shadows cast by Compact objects such Black Holes.

(a) **Imaging Non-Kerr Black Holes with Event Horizon Telescope**:
Supervisor : Dr.Sourabh Nampalliwar (University of Tübingen)
Recent observations from the EHT of the center of the M87 galaxy has opened a whole new era for testing general relativity using black hole images. Normally, the astrophysical black holes are thought to be described by the Kerr metric from General relativity, but theories beyond general relativity predict black holes that deviate from the Kerr solution. To test the Kerr hypothesis and hence GR, we are developing a framework that can perform theory-independent tests of general relativity by analyzing black hole images. The process includes modeling the black hole neighborhood, building and comparing black hole images, and using Bayesian analysis on the EHT data to estimate the deviation parameters that characterize deviations from the Kerr solution.

(b) **Observational features of Black Hole vs Naked Singularity pierced by a Cosmic String** :
Supervisor : Prof. Pankaj Joshi (ICC and Charusat University)
Co-Supervisor : Dr. Dipanjan Dey (ICC and Charusat University)
We study the timelike and lightlike geodesics in the Schwarzschild and Janis-Newman-Winicour (JNW) naked singularity spacetimes pierced by an infinity thin cosmic string. We derive an orbit equation to understand how massive particles move in these spacetimes and find the change in the perihelion shift of a particle due to the deficit angle. We do the simulations taking into effect when a cosmic string is pierced through the spacetimes. The size of the shadow cast by these spacetimes will be change and that depends on the deficit angle parameter β, and we compare our results with that of standard spherically symmetric and static, Schwarzschild and JNW spacetimes for the condition $\beta = 0$.

(2) Radio Interferometry and Synthesis Imaging with SWAN
(SKY WATCH ARRAY NETWORK)[Raman Research Institute]:
While cm and mm wave studies of radio sources have been possible at angular resolutions of even sub-arc-second level, meter-wave studies have not yet been possible at any comparable resolution. There is a need thus for such a very long baseline array, particularly in India, complementing the capabilities of the GMRT at the low radio frequencies. The proposed Indian-SWAN will extend our capabilities for studies at these frequencies in both sensitivity and angular resolution, by significant factors. The proposed competitive coordinated network (with nominally 1000 sq. m array area at each location and operation spanning a decade in frequency; 50-500 MHz) will be developed. In the beginning phase, a moderate setup will be attempted for realizing and demonstrating the essential features

(3) Programming Beamformer system on *Rasperberry Pi* for the SWAN system.

(4) Making a Horn antenna for radio astronomical observations.

Conferences & Workshops

(1) Sixth Southern Regional Meeting, Research in Astronomy: Opportunities and Challenges, Sponsored by IUCAA, 2020

(2) 23rd Capra Meeting on Radiation Reaction in General Relativity, University of Texas at Austin

(3) Black Hole Perturbation Toolkit (BHPToolkit) Spring 2020 Workshop

(4) Cosmology Summer School 2020 (University of Michigan)

(5) International Workshop on Astrophysics and Cosmology organised by International Centre for Cosmology (ICC),Charusat University, Gujarat, India

(6) 30th Indian Association for General Relativity and Gravitation Meet (IAGRG) at BITS Pilani Hyderabad Campus.

(7) Co-hosted and Participated in Astronomy Boot Camp organised by Nehru Planetarium (2019)

(8) Astronomy Code Camp organised by Nehru Planetarium (2018)

(9) Research Assistant at One-Day RAD Workshop (ODRAW) at St. Stephens College, Delhi University organised by RAD@HOME

(10) RAD@HOME Discovery Camp (2018)

(11) International Capsule Workshop organised by Indian Astro-Biology Research Center

Participations

(1) Organised Astro Retreat 2020, an online/virtual meet for talks and poster presentations in collaboration with SciRox (Science Club, Guru Nanak Dev University, Amritsar).

(2) Organising a free certificate course on 'Special and General Theory of Relativity' in Collaboration with Scienceteen Edt. Pvt. Ltd., Ramanujan Research Institute and Nehru Planetarium.

(3) Volunteer at LIGO-India booth (One week) at Vigyan Samagam, Delhi

(4) SWAN Imaging Challenge (Creating a 100 Sq.degree Image of any part of sky with observations from SWAN).

(5) Attended lecture by Prof. Kip Thorne at ICTS, Bangalore

(6) Co-organised and attended Lecture by Dr. Bharat Ratra at Nehru Planetarium, New Delhi.

(7) Regular participation in lectures organised in the Colleges and Universities.

Talks and Poster presentation

(1) Lightning Talk - 'Theory-Independent tests of General Relativity by analysing Black hole images' during Sixth Southern Regional Meeting, Research in Astronomy: Opportunities and Challenges, Sponsored by IUCAA

(2) Poster Presentation - 'The ageing problem of twins in Reissner–Nordström spacetime' during International Workshop on Astrophysics and Cosmology, ICC, Gujarat, India

(3) Talk - 'Shadows cast by compact and ultracompact objects' during *P*resentation/Seminar Presentation, Dyal Singh College, University of Delhi

(4) Talk - 'Timing of *V*ela Pulsar using Python (Data taken from Ooty Radio Telescope)' as Student-Coordinator during SKA-Outreach Week, Vigyam Samagam, New Delhi

Publications

(1) **Saurabh** & Himanshu Kumar, 'The ageing problem of twins in Reissner–Nordström spacetime', *Mod. Phy. Lett. A*, 2019, 10.1142/S021773232050008X

(2) Shubham Kala, **Saurabh**, Hemwati Nandan,'Deflection of light and Shadow cast by a Dual Charged Stringy Black Hole',2020 (Under Review)

(3) Shreyas Bapat, (34 authors), **Saurabh**, (15 authors), 'EinsteinPy: A Community Python Package for General Relativity', 2020 [arXiv:2005.11288]