Rik Bhattacharyya

Curriculum Vitae

Graduate Student
Texas A&M University, USA
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DOB: 10.22.1995

Education

2019–Present **Graduate Research Scholar**
Mitchell Institute for Fundamental Physics and Astronomy, Texas A&M University.
College Station | USA
Advisor: Prof. Dave Toback

2016-2019 **Masters (Integrated MSc-PhD) in Physics**
National Institute of Science Education and Research (NISER).
Homi Bhabha National Institute (HBNI), Bhubaneswar | India
Dissertation: *"Study of Si-32 background for CDMS II and neutron detector for dark matter search experiments."*
Advisor: Prof. Bedangadas Mohanty

2013–2016 **Bachelor in Physics**
Ramakrishna Mission Residential College (Autonomous), Narendrapur.
University of Calcutta, Kolkata | India

2011–2013 **Higher Secondary Examination**
Chandrakona Road Saradamoyee Higher Secondary School.
Chandrakona Road | India

2005–2011 **Secondary Examination**
Chandrakona Road Saradamoyee Higher Secondary School.
Chandrakona Road | India

Research Experiences

May, 2020 - Present **Detector Control and Readout Card (DCRC) Testing and Calibration**
Texas A&M University, College Station | USA
Advisor: Prof. Dave Toback.

- The Detector Control and Readout Card (DCRC) is an ultra-low-noise electronics board that controls and collects data from SuperCDMS detectors. It also provides bias voltages to our detectors and performs various trigger operations to record the events to the DAQ. I have done some DCRC calibration, testing and helped in the internal documentation.

Sep - Nov, 2020 **Chandrasekhar mass limit for magnetized-rotating white dwarfs**
Stellar Astrophysics course | Texas A&M University, College Station | USA
Advisor: Prof. Robert Kennicutt.

- Relativistic polytropic relation suggests that a white dwarf more than Chandrasekhar limit (1.4 $M_\odot$) can not be supported by degeneracy pressure anymore. But, recently some type Ia supernovae suggest super-Chandrasekhar white dwarfs (2.1-2.8 $M_\odot$) as its progenitor. The original derivation leads to Chandrasekhar mass limit does not count the effect of stellar rotation and magnetic field. Both rotation and magnetic field destroy the spherical symmetry, so we need to consider Tolman-Oppenheimer-Volkoff (TOV) equation. In General Relativistic Magneto-Hydrodynamics (GRMHD) framework, a magnetized-rotating white dwarf could be as massive as 3.1 $M_\odot$, which can explain the such supernovae.

Jan, 2018 – Jul, 2019 **Study of Si-32 background for CDMS II and neutron detector for dark matter search experiments**
Masters' Thesis | NISER, Bhubaneswar | India
SuperCDMS Collaboration | Supervisor: Prof. Bedangadas Mohanty.

- The Super Cryogenic Dark Matter Search (SuperCDMS) is one of the leading direct low-mass dark matter search experiments. The CDMS experiment looks for elastic scattering of dark matter with the detector by measuring charge and phonon signals. To detect this rare and weak signal, a rigorous understanding of backgrounds is essential. Si-32 isotope exists in the Si detectors right from the time of its fabrication. It shows beta decay, which will be the dominant source of background in the future based experiment that employs silicon detectors. The first part of this thesis describes the analysis procedures to estimate Si-32 background activity.

- Neutron is another important background in dark matter search experiments. We used a liquid organic scintillator detector at NISER for neutron studies. To characterize the detector, we used various gamma sources and Am-Be. For the unfolded neutron spectrum in neutron recoil energy scale, we used the GEANT4 simulation toolkit, and this study is described in the second part of the thesis.

May - Jun, 2017 **Exploration of modified Poisson's equation and its possible physical application**
Indian Institute of Science (IISc), Bangalore | India
Advisor: Prof. Banibrata Mukhopadhyay.

- For a spherically symmetric, non-magnetized white dwarf, the Lane-Emden equation predicts the famous Chandrasekhar Mass limit (1.4 $M_{\odot}$). Many recent observations from Type Ia Supernovae implies the super-Chandrasekhar limit. We tried to explore the solutions of the Lane-Emden equation under a small external perturbation. Restricting ourselves in the classical regime, we obtained sub and super-Chandrasekhar mass limits.

Dec, 2016 **Characterization and testing of Multi-Wire Proportional Chamber**
Variable Energy Cyclotron Centre (VECC), Kolkata | India
Advisor: Dr. Tilak Kumar Ghosh.

- In this project, I was introduced first time to various types of detectors and the interaction of charged particles with matters. We characterized a Multi-Wire Proportional Chamber (MWPC) with two-position sensing plates like a cross-grid (basically, a Breskin detector). With this detector, one can measure a particle's trajectory more accurately (2D position in space, and time). We also optimized the noise up to $\sim$ 50 mV for anode while $<$ 100 mV for X, Y plates. And we found that asymmetric bias voltage across the MWPC leads to better response under very-low pressure ($\sim$ 3.2 torr).

Publications

2021

1. **Bhattacharyya, R.** (on behalf of SuperCDMS Collaboration), Si-32 and P-32 background estimate in CDMS II Silicon detectors, Proceedings, XXIII DAE High Energy Physics Symposium, Vol 261 (2018) [DOI].

2020

1. I. Alkhatib et al. (SuperCDMS Collaboration), Constraints on Lightly Ionizing Particles from CDMSlite [arXiv: 2011.09183].
2. I. Alkhatib et al. (SuperCDMS Collaboration), Light Dark Matter Search with a High-Resolution Athermal Phonon Detector Operated Above Ground [arXiv: 2007.14289].
3. D. W. Amaral et al. (SuperCDMS Collaboration), Constraints on low-mass, relic dark matter candidates from a surface-operated SuperCDMS single-charge sensitive detector [Phys. Rev. D 102, 091101(R)].
4. T. Aralis et al. (SuperCDMS Collaboration), Constraints on dark photons and axion-like particles from SuperCDMS Soudan [Phys. Rev. D 101, 052008].

2018

1. Kashyap, V.K.S., Chandra, S., **Bhattacharyya, R.**, Mohanty, B., Pattnaik, B, Neutron detection using liquid scintillator and study of polyethene and borated polyethene for neutron shielding, Proceedings, DAE Intl. Symp. on Nucl. Phys., Vol 63 [DOI].

Talks/Presentations

2018-2019 Background Working Group Meeting (internal talk)
SuperCDMS Collaboration

Talk Si-32 and P-32 background estimate in CDMS II Silicon detectors
Dec, 2018 XXIII DAE-BRNS High Energy Physics Symposium
Department of Atomic Energy (DAE) | Board of Research in Nuclear Sciences (BRNS)
IIT Madras | Chennai | India

Poster, Dec, 2018 Neutron detection using liquid scintillator and study of polyethene and borated polyethene for neutron shielding in DAE International Symposium on Nuclear Physics | DAE-BRNS
Bhabha Atomic Research Centre (BARC) | Mumbai | India

Conferences / Workshops Attended

Aug, 2020 [Online] The Almost Invisibles: Exploring the Weakly Coupled Universe
48th SLAC Summer Institute (SSI 2020), Stanford Linear Accelerator Center (SLAC) | CA | USA

Jul, 2020 [Online] SuperCDMS Collaboration Meeting

Jun, 2020 [Online] II Joint ICTP-Trieste/ICTP-SAIFR School on Particle Physics
S$\tilde{a}$o Paulo | Brazil

Apr, 2020 [Online] APS April Meeting
American Physical Society | Washington DC | USA

Jan, 2020 SuperCDMS Collaboration Meeting
Texas A&M University (TAMU) | TX | USA

Jan, 2019 XII SERB School on Experimental High Energy Physics
Tata Institute of Fundamental Research (TIFR) | Mumbai | India

Jun, 2018 Symposium on Heavy-Ion Physics at FAIR, RHIC and LHC Facilities
National Institute of Science Education and Research (NISER) | Bhubaneswar | India

Dec, 2017 GIAN course on Dark Matter : the Astroparticle Perspective
Jawaharlal Nehru University (JNU) | New Delhi | India

Computation Skills

Languages Python | C++ | FORTRAN 95

Software Packages ROOT (C++ based) | PyROOT (C++ and Python integrated) | Jupyter | GEANT4 (Simulation toolkit) | LaTeX | Origin | MS Office | MATLAB | MATHEMATICA

OS macOS | Linux | Windows

Teaching Experiences

Spring, 2021 PHYS 202: College Physics Lab: Electromagnetism, Light and Contemporary Physics, TAMU.

Fall, 2020 Phys 201: College Physics Lab: Mechanics, Heat, and Sound, TAMU.

Summer, 2020 PHYS 206 (DP): Don't Panic - Mechanics, TAMU.

Spring, 2020 PHYS 206 (UP): Newtonian Mechanics for Engineers and Scientists, TAMU.

Fall, 2019 PHYS 206 (UP): Newtonian Mechanics for Engineers and Scientists, TAMU.

Achievements

2017 UGC-CSIR National Eligibility Test (NET) qualified.

2016 All India Rank 24 in Joint Entrance Screening Test (JEST).

2016 Top 1% out of $\sim$ 11,000 in National Graduate Physics Examination (NGPE).

2013-16 Recipient of INSPIRE scholarships, funded by DST, Govt. of India, during Bachelors.

Other Activities

2017 Organizer in Dark Matter Day event for local school students and public in NISER.

2014 Stood first in the inter-departmental science wall-magazine competition - Scientilla.

Languages

Bengali (Native) | English | Hindi

Additional Links

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Researchgate: https://www.researchgate.net/profile/Rik_Bhattacharyya

LinkedIn: https://www.linkedin.com/in/rik-bhattacharyya/