

SOLVING MANY-ELECTRON SYSTEMS USING SCF METHOD

Project Report Submitted to
Department of Physics
Christ College (Autonomous), Irinjalakuda



In partial fulfillment of the requirements
for the award of the degree of
MASTER OF SCIENCE IN PHYSICS

by

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Under the Supervision of
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July 25, 2023

Certificate

This is to certify that the report entitled "**Solving Many-Electron Systems Using SCF Method**", was carried out by **JULIET BIJU (CCAVMPH008)** at Central University of Kerala, for the award of the degree of **Masters of Science in Physics**, is a record of the original research work carried out by her under my supervision and guidance. The report has reached the standards of fulfilling the requirements of the regulations related to the award of the degree.

The results contained in this report have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma to the best of my knowledge.

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This is to certify that the work incorporated in the project report entitled "**Solving Many-Electron Systems Using SCF Method**", which is being submitted by **JULIET BIJU (CCAVMPH008)** at the Department of Physics, Christ College (Autonomous), Irinjalakuda, University of Calicut, is based on the investigation carried out by her under the guidance of Prof. Vincent Mathew, Professor, Department of Physics, Central University of Kerala, Periyar, Kasaragod.

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Abstract

This project discusses the "Self-Consistent Method (SCF)" to solve the many-electron systems. Thereby we could obtain information about the electronic properties and structural behaviour of materials. All the numerical methods that is discussed in this project is solved using "Python" programming language. Initially we dealt with "Particle in a Box" problem using "Method of Finite Differences" and then switched to many-electron systems such as helium and silicon atoms. The radial probability distribution of helium and silicon atom is briefly analysed using SCF method . But this method have certain limitations due to lack of high accuracy to deal with complex molecules. So we required advanced technologies to overcome these difficulties.

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**INVESTIGATION OF RESISTANCE CHANGE WITH BENDING
DEFORMATION IN TRANSPARENT CONDUCTING OXIDE
THIN FILMS ON FLEXIBLE SHEETS**

*Project report submitted in partial fulfillment of the
requirements for the degree of*

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**CHRIST COLLEGE (AUTONOMOUS),
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IRINJALAKUDA**

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This is to certify that this project report entitled **“Investigation of Resistance Change with Bending Deformation in Transparent Conducting Oxide Thin Films on Flexible Sheets”** is a bonafide record of the work carried out by Ms. Kesline Wilson, Department of Physics, Christ College (Autonomous), Irinjalakuda in partial fulfillment for the award of the Degree of Master of Science in Physics under the guidance of DR. S N Potty (Scientist E), at Centre for Materials for Electronics Technology (C-MET), Thrissur during the academic period 2021-2023.

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21.07.2023

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I wish to express my gratitude and respect to my parents, teachers, family members and all my friends for their help and encouragement throughout my career. I thank Almighty for blessing me to make this endeavour a successful one.

ABSTRACT

Flexible transparent electronics is the new emerging field of interest where thin films with optical transparency and electrical conductivity play major role. Transparent conducting oxide (TCO) thin films such as indium doped tin oxide, tin oxide doped with fluorine, zinc oxide doped with (In, Al), etc. are currently using for such purposes. Proper evaluation of TCO films coated on flexible sheets need to be analysed before going for commercialisation. The consistency in the electrical resistance is one of the important properties that must be optimised. In this work, developed a simple method for the estimation of resistance variation of such films coated on flexible sheets. The doped zinc oxide films coated on two substrates, on easily available over head project (OHP) sheet and on the standard polyethylene terephthalate (PET) sheet were used for the study. The variations of electrical resistance, on bending the flexible sheets in tensile and compressive modes for several cycles, were systematically investigated. The resistance variation measurements were done with a Keithley make electrometer. The results were explained on the basis of the structural and morphological features. The morphological analysis by recording the scanning electron microscope images confirmed the formation of cracks in coated sheets on bending deformation. The results revealed that the film coated on PET sheet had better electrical properties. Finally, to establish simple practical applications, these highly conducting films on OHP and PET sheets were used as invisible electrical contacts for lighting LED. This study confirmed that the variation of resistance in each mode of bending is not affecting much on the intensity of light from the LED.

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**NEAR FIELD DISTRIBUTION STUDIES OF SRR AND
BCSRR**

Submitted

By

NIRANJANA C V

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**Post Graduate and Research Department of Physics
Christ College, Irinjalakuda**

CALICUT UNIVERSITY

JULY 2023

**In partial Fulfillment of
the requirements for the Degree**

MASTER OF SCIENCE IN PHYSICS

CERTIFICATE

This is to certify that the thesis entitled "NEAR FIELD DISTRIBUTION STUDIES OF SRR AND BCSRR" is a bona fide record of the research work carried out by Ms. NIRANJANA C V(CCAVMPH010) under my supervision in the Department of Physics, Christ College Autonomous Irinjalakuda, in partial fulfillment of the requirement for the award of degree of Master of Science in Physics under University of Calicut during the academic year 2021-2023.

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ABSTRACT

The project entitled "NEAR FIELD DISTRIBUTION STUDIES OF SRR AND BCSRR" presents the resonance and field distribution studies of Split ring resonator and Broadside coupled split ring resonator using HFSS simulation software.

Metamaterials are artificially constructed structures which have negative permittivity and permeability values showing exotic properties. Split ring resonators and Broadside coupled Split ring resonators are a type of metamaterial which have negative permeability value. Their resonance frequency changes due to variation in structural parameters and by introducing dielectrics to their near field. This sensor property of SRR and BCSRR is analysed using HFSS software.

This dissertation is divided into four chapters. The first chapter is the introduction to the concept of metamaterials. The second chapter includes the theory of Split ring resonator and Broadside coupled Split ring resonator and describe simulation techniques used for study. The third chapter contain the experimental details, results and analysis including graph and simulated figures and the fourth chapter contain the conclusion.

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LIGHT CURVE ANALYSIS OF MIRA TYPE VARIABLE STARS

A project report submitted by

PAULMON T JAISON

for the award of the degree of

Master of science

in Physics



Supervising Guide

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This is to certify that the project report entitled “LIGHT CURVE ANALYSIS OF MIRA TYPE VARIABLE STARS” submitted to the Department of Physics by PAULMON T JAISON is the bona-fide work done by him under my guidance at Postgraduate and Research Department of Physics, Christ College (Autonomous), Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Master of Science in Physics under the University of Calicut.

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ABSTRACT

The project discusses about the different types of variable stars, their classification and with an emphasis on the Mira type variable stars and the eclipsing binaries. The light curve analysis of 8 different Mira type variable stars is done. The star data is collected from ASAS . The period of each star has been found out using 'Period04' software. The modeling of Eclipsing binary stars is done using the Starlight Pro software. The star data is collected from ASAS. The star parameters such as inclination, mass ratio, temperature and pole radius are found using the software.

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CROSS PERMUTATION ENTROPY ANALYSIS OF EEG FOR DETECTION OF SLEEP DISORDERS

MASTER OF SCIENCE IN PHYSICS

Submitted By

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Date: 24/07/2023

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This is to clarify that the work incorporated in the project report entitled “**CROSS PERMUTATION ENTROPY ANALYSIS OF EEG FOR DETECTION OF SLEEP DISORDERS**” which is being submitted by **RAINA PAUL (CCAVMPH012)** at the Department of physics, Christ college (Autonomous), Irinjalakuda, in partial fulfilment of the requirements for the award of Degree of Master of Science in physics under the university of Calicut, based on investigation carried out under the guidance and supervision of Dr. Bindu M Krishna, Chief Research Officer, Centre for Research and Innovation in Multidisciplinary Science.

Dr. Sudheer Sebastian k

Professor

Head of department of physics

Christ College, Irinjalakuda

DECLARATION

I affirm that the project report entitled '**CROSS PERMUTATION ENTROPY ANALYSIS OF EEG FOR DETECTION OF SLEEP DISORDERS**', being submitted in partial fulfilment for the award of degree of Master of Science in Physics, is the original work carried out by me under the supervision of Dr. Bindu M Krishna, Chief Research Officer, Centre for Research and Innovation in Multidisciplinary Science. This work has not been submitted elsewhere for the award of any degree.

Place: Irinjalakuda
Date: 24/07/2023

RAINA PAUL
REG NO: CCAVMPH012

ACKNOWLEDGEMENTS

The successful completion of any task is complete and meaningless without giving any due credit to the people who made it possible without which the project would not have been successful and would have existed in theory.

First and foremost, I owe my gratitude to Dr. Bindu M Krishna, Chief Research Officer (CRIMS), for her valuable guidance, encouragement and constant support throughout the project work.

I would also like to thank Dr. Sudheer Sebastian, Head of the Department of Physics, for the valuable advices and guidance in the execution of the project work. I also express my gratitude to Dr. Rev. Fr. Jolly Andrews CMI, Principal, Christ College, Irinjalakuda, for his continuous support.

I extend my heartily gratitude to the interns Ms. Najma k and Ms. Sreelakshmi S of CRIMS who helped us unconditionally, Librarian and other library staff of Christ College, Irinjalakuda for their whole-hearted cooperation.

I am intended to the faculty members in the Department of Physics, Christ College, Irinjalakuda, for their support. I would also like to thank my classmates, non-teaching staff of the Department of Physics, Christ College, Irinjalakuda, for their support and cooperation during the project work.

Above all, I thank God Almighty for always being with me and showering his blessings upon me.

RAINA PAUL

Abstract

Sleep can be regarded as reduced awareness and responsiveness. It is a naturally initiated biological process. Sleep is controlled by brain. Sleep helps brain to gain energy after working for a day. Sleeplessness cause lack of energy and cause sleep disorders. Brain activities can be studied by using electroencephalogram [EEG]. Analysis of EEG patterns during sleep helps to understand quality and architecture of sleep, identify sleep disorders, and study the different stages of sleep. Nonlinear approaches provide clear understanding of dynamic nature and irregularity of EEG signals. Cross permutation entropy is a nonlinear approach used to analyze the synchronization of EEG signals in different brain region. This helps to study the coordination of brain regions during sleep. In this project it is aimed to evaluate the efficiency of cross permutation entropy in diagnosing different sleep disorders. An effective sleep disorder diagnosis can provide early detection of sleep disorders and can provide effective treatments.

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SIMULATION STUDIES ON N719 DYE SENSITIZED SOLAR CELLS

Project report submitted to the
DEPARTMENT OF PHYSICS
CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

In partial fulfilment of the requirement for the award of the degree of

MASTER OF SCIENCE IN PHYSICS

Submitted By
RIYA.P.DAVIS

REG NO. CCAVMPH013

Under The Supervision Of

Dr. SUDHEER SEBASTIAN K



DEPARTMENT OF PHYSICS
CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA
JULY 2023

CERTIFICATE

This is to certify that the project work entitled “**SIMULATION STUDIES ON N719 DYE SENSITIZED SOLAR CELLS**” is a bone fide work done by **Ms. RIYA.P.DAVIS (REG No. CCAVMPH013)**, Department of physics, Christ college (Autonomous) Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Master of Science in physics under the university of Calicut.

Dr. SUDHEER SEBASTIAN K.

Professor

Department of Physics

Christ College (Autonomous)

Irinjalakuda

Place: Irinjalakuda

Date:

DECLARATION

I RIYA. P. DAVIS, hereby declare that the work presented in this report entitled “**SIMULATION STUDIES ON N719 DYE SENSITIZED SOLAR CELLS**” is based on the original work done by me under the guidance of Dr. Sudheer Sebastian K, Professor, Department of physics, Christ College (Autonomous), Irinjalakuda and has not been included in any other thesis submitted previously for the award of any other degree.

Place: Irinjalakuda

Date:

RIYA.P.DAVIS

REG NO: CCAVMPH013

ACKNOWLEDGEMENTS

I take this opportunity to express my deep sense of gratitude and extend my thanks to all the people who have inspired and motivated me during my course and project.

Firstly, I would like to acknowledge the motivation and guidance given by my project advisor and Head of the Dept. **Dr. SUDHEER SEBASTIAN K**, Dept. of physics, Christ College (Autonomous) Irinjalakuda, throughout my project.

I heartily thank **Dr. Shaju K Y**, Dept. of Physics, Christ College Irinjalakuda, for providing me with the necessary support to carry out my project work.

My special thanks to **Ms. DENET DAVIS**, Research scholar, Dept. of Physics, Christ College Irinjalakuda, for her valuable and sincere help at every stage right from the starting till the completion of my project.

I am thankful to all my classmates, teaching and non-teaching staff of the Dept. of Physics. I am indebted to my family for their constant source of inspiration.

I thank God, Almighty, who always with me, and I am always in need of his blessings all my life time.

RIYA.P.DAVIS

ABSTRACT

Dye sensitized solar cells is a type of thin film solar cell which have been of great interest due to their low cost and ease of production. In this work, we have investigated the performance of N719 dye sensitized solar cell using SCAPS 1-D simulation software. The structure of this solar cell is composed of FTO/PFN:Br/N719/PEDOT:PSS/Au, where FTO acts as anode, PFN:Br acts as the electron transport layer, N719 acts as the photoactive layer, PEDOT:PSS acts as the hole transport layer and Au acts as the counter electrode. The influence of thickness, defect density, doping density, electron affinity, and carrier mobility of N719, on the device output parameters is analyzed. A study on effect of different metal electrodes on device performance is carried out. The working point conditions such as temperature, series and shunt resistance were studied. Our simulation studies gave an optimized efficiency of 5.53%.

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ELECTROCHEMICAL PERFORMANCE OF
 $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{Ni}_x\text{O}_{3-\delta}$
ELECTROCATALYSTS IN NONAQUEOUS
LITHIUM AIR BATTERY

Project report submitted by
Sandra K S
Reg No: CCAVMPH014

In partial fulfilment of the requirements for the award of
MASTER OF SCIENCE IN PHYSICS



Department of physics
Christ college (Autonomous), Irinjalakuda
Calicut University, July 2023

Supervising Guide
Dr. Damian Kowalski
Assistant Professor



UNIVERSITY
OF WARSAW

CERTIFICATE

This is to certify that the project report entitled '**ELECTROCHEMICAL PERFORMANCE OF $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{Ni}_x\text{O}_{3-\delta}$ ELECTROCATALYSTS IN NONAQUEOUS LITHIUM AIR BATTERY**' submitted by Sandra K S (Reg No: CCAVMPH014) in partial fulfilment of the requirement for the award of Master of Science in Physics, based on investigation carried out under the guidance and supervision of Dr. Damian Kowalski, Assistant professor, University of Warsaw.

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Assistant Professor

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DECLARATION

I affirm that the project report entitled '**ELECTROCHEMICAL PERFORMANCE OF $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{Ni}_x\text{O}_{3-\delta}$ ELECTROCATALYSTS IN NONAQUEOUS LITHIUM AIR BATTERY**' being submitted in partial fulfilment for the award of degree of master of science in physics, is the original work carried out by me under the supervision of Dr. Damian Kowalski, Assistant Professor, University of Warsaw. This work has not been submitted elsewhere for the award of any degree.

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The successful completion of any task is incomplete and meaningless without giving any due credit to the people who made it possible without which the project would not have been successful and would have existed in theory.

First and foremost, I owe my gratitude to Dr. Damian Kowalski, Assistant professor, University of Warsaw, for his valuable guidance. A great thank you to National Science Centre for fulfilling the financial part of my research.

I would also like to thank Dr. Sudheer Sebastian, Head of the department of physics and Dr. Ajith R, Assistant professor, Christ college, Irinjalakkuda, for their valuable advices and guidance in the execution of the project work. I also express my gratitude to Dr. Rev Fr. Jolly Andrews CMI, Principal, Christ College, Irinjalakkuda, for his continuous support.

I am intended to the faculty members in the department of physics, Christ college, Irinjalakkuda, for their support. I would also like to thank my classmates, non-teaching staff of the department of physics, Christ College, Irinjalakkuda for their support and cooperation during the project work.

Ms SANDRA K S

ABSTRACT

Non aqueous Lithium-air batteries have gained significant research interest in the last decade because of their excessive theoretical energy density and low cost. In this project, $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{Ni}_x\text{O}_{3-\delta}$ ($x = 0.1, 0.3, 0.5$) and $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-\delta}$ were synthesised and used as a cathode in rechargeable Li-air batteries. The material characterisations, Xray diffraction spectroscopy, Raman spectroscopy, and Transmission electron microscopy showed that $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{1-x}\text{Ni}_x\text{O}_{3-\delta}$ ($x = 0.1, 0.3, 0.5$) gives almost identical structure of $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-\delta}$.

The electrochemical performance of the battery is analysed through cycling. In initial research stage the electrolyte used is 1M LiTFSi/TEDGME, the performance analysed with drying the salt and without drying the salt. The results show there is a significant improvement in the capacity by heating the salt. Further the electrolyte is switched to 0.25 LiTFSi + 0.75 LiNO₃, the presence of LiNO₃ remarkably improved the battery performance. In Li-air battery, cathodes having $\text{La}_{0.7}\text{Sr}_{0.3}\text{Mn}_{0.5}\text{Ni}_{0.5}\text{O}_{3-\delta}$ catalyst provided improved electrochemical performance in terms of specific capacity.

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PROPAGATION CHARACTERISTICS OF A TUNABLE FERROELECTRIC BASED MICROSTRIP LINE WAVEGUIDE

A PROJECT REPORT
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
MASTER OF SCIENCE IN PHYSICS

Submitted by
SREEDEVI T P
REG NO : CCAVMPH015

Under the supervision of
Dr. AJITH R



Department of Physics
Christ College, Irinjalakuda
CALICUT UNIVERSITY
JULY 2023

CERTIFICATE

This is to certify that the project entitled **PROPAGATION CHARACTERISTICS OF A TUNABLE FERRO-ELECTRIC BASED MICROSTRIP LINE WAVEGUIDE** is the bonafide work done by Ms. SREEDEVI T P (Reg no : CCAVMPH015) in partial fulfillment of the requirements for the award of the degree of Master of Science in Physics of Calicut University, under my guidance and supervision.

Irinjalakuda

Date:18/07/2023

Dr. Ajith R

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Assistant Professor

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DECLARATION

I, SREEDEVI T P, hereby declare that the project entitled **PROPAGATION CHARACTERISTICS OF A TUN-
ABLE FERROELECTRIC BASED MICROSTRIP LINE WAVEGUIDE** submitted to the Department of Physics,
Christ College Irinjalakuda, is a record of the original work done by me under the guidance of Dr. Ajith R, Depart-
ment of Physics, Christ College, Irinjalakuda. This work has not been submitted elsewhere for the award of any
degree.

Irinjalakuda

Date:18/07/2023

SREEDEVI T P

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First and foremost, I owe my gratitude to my project supervisor, Dr. Ajith R. His exceptional guidance, unwavering support, and boundless patience have been instrumental throughout this journey. His profound expertise and dedicated commitment have consistently propelled this project forward, shaping its direction and outcomes.

I would also like to thank Prof. Dr. Sudheer Sebastian K, Head of the Department of Physics, for his valuable advices and guidance. I also express my gratitude to Dr. Rev. Fr. Jolly Andrews CMI, Principal, for his consistent support.

I am deeply indebted to the faculty members and non-teaching staff of the Department of Physics, for their unwavering support and valuable contributions throughout this endeavour. I would like to thank Ms. Stiji Jose T, Faculty Member, Department of Physics, for her continuous support.

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I would like to acknowledge my heartfelt gratitude to all my family members for their constant support and love. Their presence has been a source of strength and motivation throughout this journey.

I extend my sincere regards and appreciation to all those who have supported me in any capacity during the course of this project.

SREEDEVI T P

ABSTRACT

Transferring information efficiently from one place to another is a need of the time. Among all methods adopted, transmission of the information encoded in microwave frequency range is one of the most dominant methods. Conventional microwave waveguides typically have fixed geometries and material properties and lack the ability to alter the transmission characteristics in response to external stimuli. Tunability often requires manual adjustments or external components, which can be cumbersome and time-consuming. One of the potential solution to this problem is the use of ferroelectric materials in the waveguides. Dielectric properties of the ferroelectric materials can be modified with the aid of an external electric field. This project aims at studying the microwave propagation characteristics of a microstrip line supported by a ferroelectric layer theoretically. The transmission characteristics are derived from the basic Maxwell's equations using spectral domain method and with the help of computational techniques dispersion characteristics are studied. The findings from this study may hold promise to the future of tunable microwave applications.

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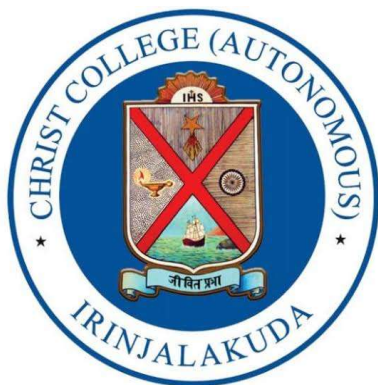
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“DETECTION OF EXTRASOLAR PLANETS THROUGH THE RADIAL VELOCITY METHOD”

Project Report

*In partial fulfilment of the requirement for the award of the
degree of*

MASTER OF SCIENCE



Submitted by

ANJU KRISHNA K K CCASSPH003

Under the supervision of

Dr. ANAND NARAYANAN

DEPARTMENT OF EARTH AND SPACE SCIENCES

IIST TRIVANDRUM

JULY 2023

CERTIFICATE

This is to certify that the project report entitled “**DETECTION OF EXOPLANETS – RADIAL VELOCITY METHOD**” is bonafide record of project done by **Anju Krishna K K (CCAVMPH003)** under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE IN PHYSICS** and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Thiruvananthapuram

July 2023

Dr. Anand Narayanan

(Project guide)

DECLARATION

I, ANJU KRISHNA K K, hereby confirm that the research work presented in this thesis titled "Detection and Characterization of Exoplanets using Radial Velocity Technique" is an authentic representation of my project work. I conducted this research under the guidance of Dr. ANAND NARAYANAN, an Associate Professor in the Department of Earth and Space Sciences at the Indian Institute of Space Science and Technology, Valiyamala, Thiruvananthapuram, Kerala. This work fulfils the requirements for the attainment of a Master of Science degree in Physics.

Place:

ANJU KRISHNA K K

Date:

ABSTRACT

The radial velocity technique is a commonly employed approach for the detection and analysis of exoplanets. The objective of this project is to develop an algorithm that can identify Keplerian patterns within radial velocity data and determine specific planetary parameters based on the fitted data. Through the utilisation of this algorithm, five exoplanets have been successfully confirmed and characterised. A comprehensive investigation into the radial velocity technique has been conducted and summarised. The project concludes by comparing the effectiveness of the radial velocity technique to other widely utilised methods for detecting and characterising exoplanets.

ACKNOWLEDGEMENTS

I would like to sincerely express my gratitude to my project advisor, Dr. ANAND NARAYANAN, an Associate Professor in the Department of Earth and Space Sciences at IIST, for his invaluable guidance throughout the project. His timely assistance and patience have played a crucial role in enabling me to complete this endeavour. I would also like to extend my thanks to Dr. SUDHEER SEBASTIAN K (professor of physics department, Christ College (Autonomous) irinjalakuda) for his continuous encouragement, which served as a great source of inspiration for me to pursue my project at IIST.

I am deeply grateful to my teachers who have consistently motivated and supported me in this journey. Additionally, I would like to express my heartfelt appreciation to my family and friends for their unwavering support and encouragement throughout the project.

Finally, I would like to acknowledge and thank all those who have directly or indirectly contributed to the successful completion of my project. Their assistance has been instrumental in shaping this research endeavour.

CERTIFICATE

This is to certify that the project report titled “DETECTION OF EXTRASOLAR PLANETS THROUGH THE RADIAL VELOCITY METHOD” is bonafide record of project done by Anju Krishna K K (CCAVMPH003) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of MASTER OF SCIENCE IN PHYSICS. This work reproduces the steps involved in estimating the properties of planets orbiting other stars as detected through their radial velocity signal.

Irinjalakuda
July 2023

(Internal Advisor)
Dr.Sudheer Sebastian K
Professor ,Department of physics
Christ College (Autonomous) Irinjalakuda

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NONLINEAR ANALYSIS OF ELECTROENCEPHALOGRAPH FOR SLEEP DISORDER CHARACTERIZATION

Project report submitted by,

ADEENA KRISHNAN U R

Reg No: CCAVMPH001

In partial fulfilment of the requirements for the award of

MASTER OF SCIENCE IN PHYSICS



Department of physics

Christ College (Autonomous), Irinjalakuda

Calicut university, July 2023

Supervising Guide

DR. BINDU M KRISHNA

Chief research officer of CRIMS

Center for research and innovation in multidisciplinary science (CRIMS)



CERTIFICATE

This is certify that the project entitled **“NONLINEAR ANALYSIS OF ELECTROENCEPHALOGRAM FOR SLEEP DISORDER CHACTERIZATION”**

Submitted by ADEENA KRISHNAN U R (Reg NO: CCAVMPH001) in partial fulfillment of the requirement for the award of master of science in physics. Based on investigation carried out under the guidance and supervision of Dr. BINDU M KRISHNA, chief research officer, center for research and innovation in multidisciplinary science.

Dr. BINDU M KRISHNA

Chief research officer

Center for research and

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Kochi-682301

CERTIFICATE

This is to certify that the project entitled "**NONLINEAR ANALYSIS OF ELETROENCEPHALOGRAM FOR SLEEP DISORDER CHARACTERIZATION**" submitted by ADEENA KRISHNAN UR (Reg NO:CCAVMPH001) in partial fulfilment of the requirement for the award of master of science in physics. Based on investigation carried out under the guidance and supervision of Dr. BINDU M KRISHNA, chief research officer, center for research and innovation in multidisciplinary science.

Dr. SUDHEER SUBASTIAN K

Professor

Head of the Department

Department of Physics

Christ College (Autonomous), Irinjalakuda

DECLARATION

I affirm that the project report **“NONLINEAR ANALYSIS OF ELECTROENCEPHALOGRAM FOR SLEEP DISORDER CHARACTERIZATION”** being submitted in partial fulfilment for the award of master of science in physics is the original work carried out by me under the supervision of Dr. BINDU M KRISHNA, chief research officer center for research and innovation in multidisciplinary science. This work has not been submitted else where for the award of any degree.

ADEENA KRISHNAN U R
(Reg NO: CCAVMPH001)

Irinjalakuda

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The successful completion of any task is complete and meaningless without giving any due credit to the people who made it possible without which the project would have not been successful and would have existed in theory.

First and foremost, I owe my gratitude to Dr. BINDU M KRISHNA, chief research officer (CRIMS) for her valuable guidance encouragement and constant support throughout the project work. I would also like to thank NAJMA K and SREELAKSHMI S for their valuable advices and guidance in the execution of the project.

I am intended to the faculty in the department of physics, christ college irinjnalakuda for their support. I would also like to thank my classmates non-teaching staff of the department of physics, christ college irinjnalakuda for their support and cooperation during the project

Above all I thank God almighty for always being with me and showering his blessings upon me.

ADEENA KRISHNAN U R

ABSTRACT

Sleep is a complex process where renewal of body and mind take place. Sleep can be analysed using the minute changes that arises in the EEG signal during different stages of sleep. Characterizing the EEG signal at different stages of sleep and scoring them is the most common clinical method of diagnosing and treating various type of sleep disorders. However nonlinear methods are more effective in analysing the EEG signal. In this study we used permutation entropy as a tool for analysing EEG signal for study the sleep disorder characterization at selected channels on different sleep disorder subjects and it compared with the normal subject.

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EFFECT OF COPPER AND SILVER DOPING ON ZINC OXIDE THIN FILMS

Project report submitted by

ANITA JOY

Reg. No: CCAVMPH002

for the award of the degree of

MASTER OF SCIENCE IN PHYSICS

under

University of Calicut

Supervising Guide

Dr. EDWIN JOSE

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JULY 2023

DECLARATION

I affirm that the project report entitled 'Effect of Copper and Silver doping on Zinc Oxide thin films', being submitted in partial fulfillment for the award of degree of Master of Science in Physics, is the original work carried out by me under the supervision of Dr. Edwin Jose, Assistant Professor, Department of Physics, Christ College, Irinjalakuda. This work has not been submitted elsewhere for the award of any degree.

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I am extremely thankful to my friends and family for their wholehearted cooperation and prayers for the successful completion of my work.

Above all, I thank God Almighty for always being with me and showering his blessings upon me.

ANITA JOY

ABSTRACT

The zinc oxide, copper doped zinc oxide and silver doped zinc oxide thin film under various doping concentration (1%, 2%, 3%) were deposited on glass substrate by spray pyrolysis deposition technique. The characterization of thin films is important to understand their properties and applications. The structural, morphological, compositional, optical and electrical properties of the deposited films were characterised using X- Ray diffraction (XRD), Scanning electron microscope (SEM), Electron dispersive X-Ray spectroscopy (EDS), UV-Visible spectroscopy and Hall effect measurements. The XRD analysis confirmed formation of ZnO phase in deposited films. Morphological analysis using SEM confirmed uniform formation of film over the substrate surface. Elemental composition analysis using EDS confirmed presence of Cu and Ag in doped samples. Using UV-Vis spectroscopy, optical transmittance and band gap of the films were found out. It is observed that, Cu doping increases optical transmittance where as Ag doping decreases it. Electrical measurements showed the increase of conductivity with doping. To find the best sample, Figure of merit (FOM) - the product between conductivity and average transmittance, was calculated.

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**“ THE FORMATION OF WARM IONIZED
INTERSTELLAR MEDIUM AND ITS CONNECTION
WITH STAR FORMATION IN GALAXIES ”**

Project Report

In partial fulfillment of the requirement for the award of the degree of

MASTER OF SCIENCE



Submitted by

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Under the supervision of

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This is to certify that the project report entitled “**THE FORMATION OF WARM IONIZED INTERSTELLAR MEDIUM AND ITS CONNECTION WITH STAR FORMATION IN GALAXIES** ” is bonafide record of project done by **ANNAM KHEMA THOMAS (CCAVMPH004)** under my guidance and supervision in partial fulfillment of the requirement for the award of the degree of **MASTER OF SCIENCE IN PHYSICS**.

Irinjalakuda
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DECLARATION

I ANNAM KSHEMA THOMAS (CCAVMPH004) hereby declare that the project work entitled “ **THE FORMATION OF WARM IONIZED INTERSTELLAR MEDIUM AND ITS CONNECTION WITH STAR FORMATION IN GALAXIES** ” is a record of independent and bonafide project carried out by myself under the supervision and guidance of Dr. ANAND NARAYANAN, Professor, Department of Earth and Space sciences, IIST Thiruvananthapuram.

The information and data given in the report is authentic to the best of my knowledge.

Irinjalakuda
July 2023

ANNAM KSHEMA THOMAS
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I am indebted to all the faculty members of the department for their interest and cooperation throughout the project. I am also grateful to the librarian and other library staff of our college for their wholehearted cooperation. Furthermore, I would like to express my heartfelt thanks to my friends and family for their unwavering support in successfully completing this report.

Lastly, I would like to extend my sincere thanks and gratitude to all those who have provided me with sound advice and capable guidance throughout this journey.

Abstract

This project titled "*The Formation of Warm Ionized Interstellar Medium And its Connection with Star Formation in Galaxies*" is an investigation study to identify the spectral classes of stars that contribute to the formation of warm ionized medium zones, what we can call the Strömgren spheres in galaxies. The primary objective is to understand the roles of these stars in the process of the formation of WIM. To achieve this, the project begins by generating spectral energy distribution curves for different stellar spectral classes. This is done by applying Planck's radiation law, considering the corresponding temperatures of the stars. The frequency and luminosity distributions are then analyzed based on these curves.

Next, in this project we calculate the photon flux capable of ionizing neutral hydrogen that is radiated by stars of each spectral class. This is done by integrating the corresponding Planck curves and determining the area under the curve for energies greater than 13.6 eV, using the equivalent frequencies. Using the obtained photon flux and the conditions of equilibrium between photoionization and recombination, the project estimates the radius of the Strömgren sphere produced by each stellar type. The Strömgren sphere represents the region around a star where the ionization and recombination processes are balanced.

By studying the distribution and properties of the warm ionized medium in galaxies, it becomes possible to trace the presence of star formation zones and gain insights into the underlying processes responsible for their formation. Studying the WIM is crucial for understanding the complex interplay of ionizing radiation, feedback mechanisms, star and galaxy formation. It offers valuable perception into the evolution of interstellar matter and the birth of stars.

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Effect of Zr/Ti ratio on the energy storage properties of Pb (Zr,Sn,Ti)O₃ compositions

*A Dissertation submitted in partial fulfilment of the requirements for the degree
of*

Master of Science

In

PHYSICS

By

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DECLARATION

I, **CAROLIN SANTHOSH**, Register No:**CCAVMPH005**, hereby declare that the project work entitled “**Effect of Zr/Ti ratio on the energy storage properties of Pb (Zr,Sn,Ti)O₃ compositions**” submitted to the Department of Physics, **Christ College (Autonomous) Irinjalakuda**, is a bonafide record of the project work done by me at Centre for Materials for Electronics Technology (C-MET), Thrissur, under the guidance of **Dr. Karthik T**, for the partial fulfilment of **Master Degree of Science in Physics** during the academic year 2021-2023. I further declare that the results obtained in this project report have not been submitted to any other University or Institution for the award of any degree or in any other title of recognition.

Place: Irinjalakuda

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21/7/ 2023



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This is to certify that the dissertation entitled “**Effect of Zr/Ti ratio on the energy storage properties of Pb (Zr,Sn,Ti)O₃ compositions**” is a bonafide record of the project work carried out by **CAROLIN SANTHOSH (CCAVMPH005)** of Department of Physics, Christ College (Autonomous), Irinjalakuda, under the guidance of Dr. Karthik T, Scientist-D, Centre for Materials for Electronics and Technology C-MET, Thrissur. This work is carried out in partial fulfilment for the award of the Degree of Master of Science in Physics under University of Calicut during the academic period 2021- 2023.

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I express my deep and sincere thanks to our Head of the Department, **Dr. Shaju K Y**, our tutor, **Dr. Sudheer Sebastian** and my internal guide, **Dr. Xavier Joseph** and all other lectures at Christ College (Autonomous), Irinjalakuda for their valuable support and encouragement throughout this project.

I wish to express my gratitude and respect to my parents, teachers, family members and all my friends for their help and encouragement throughout my career. I thank Almighty for blessing me to make this endeavour a successful one.

CAROLIN SANTHOSH

ABSTRACT

In the ternary system $\text{PbZrO}_3\text{-PbSnO}_3\text{-PbTiO}_3$, compositions that lie in the antiferroelectric tetragonal region are potential candidates for energy storage application. Structural, dielectric and piezoelectric properties of the compositions are carried out. The composition having Zr/Ti ratio of 50/7 is found to have the highest recoverable energy and energy storage efficiency. Through systematic XRD and Raman spectra, it is found that in compositions having $[\text{Ti}^{4+}] = 0.09$, antiferroelectric tetragonal and ferroelectric rhombohedral coexist, limiting their energy storage potential.

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LIST OF ABBREVIATIONS

PZST	Lead Zirconium Tin Titanate
MPB	Morphotropic Phase Boundary
AFE	Antiferroelectric
FE	Ferroelectric
RFE	Relaxor Ferroelectric
PNR	Polar Nano Regions
AFE _T	Tetragonal Antiferroelectric
FE _R	Rhombohedral Ferroelectric
XRD	X-Ray Diffractometer

ABUNDANCE ANALYSIS OF A MILDLY METAL POOR r_s -ENRICHED BARIUM STAR

MSc project report submitted in partial fulfillment of the
requirements for the degree of
Master of Science in Physics

by

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DECLARATION

I, GOURINANDANA V, hereby declare that the project report titled '**Abundance analysis of a mildly metal poor rs-enriched barium star**' is a record of original research work carried out by me towards the award of the degree of Master of Science in Physics. I have completed this study under the supervision of Dr. Drisya Karinkuzhi, Assistant professor , University of calicut and internal guide Dr Edwin Jose, Assistant professor, Department of physics, Christ collage (Autonomous) Irinjalakuda . I also declare that this report has not been submitted for the award of any degree, diploma, associateship, fellowship or other title. We hereby confirm the originality of the work and that there is no plagiarism in any part of the report.

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ABSTRACT

HD106191 is a barium enriched star selected from the Barium star catalogue of Lu (1990). The metallicity value $[Fe/H]$ of -0.37 , confirms the mild metal poor nature of this object. In general, the abundance pattern in stars are helpful for understanding their origin. Here we try to derive the complete abundance pattern in HD106191 using the high – resolution spectra acquired using the HERMES spectrograph connected to 1.2 m MERCATOR telescope in La Palma canary island. We use TURBOSPECTRUM radiative transfer code for the synthesis of theoretical spectrum using MARCS model atmospheres. We derived the abundances of all possible elements and found that this star show enhancement of both s-process and r-process elements thus classified as an rs-enriched star. The rs nature at mild metallicity of HD106191 makes it very important for understanding the nucleosynthetic origin of different elements at moderate metallicities.

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CHARACTERISING THE EXTENDED FERMI LAT EMISSION WITH RESPECT TO SWIFT XRT X-RAY AFTERGLOW EMISSIONS

A Project Report Submitted
in Partial Fulfilment of the Requirements
for the Degree of

MASTER OF SCIENCE

in
PHYSICS

by

HIBA T K
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to

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July 2023

DECLARATION

I, **Hiba T K** (Roll No: **CCAVMPH007**), hereby declare that, this report entitled “**CHARACTERISING THE EXTENDED FERMI LAT EMISSION WITH RESPECT TO SWIFT XRT X-RAY AFTERGLOW EMISSIONS**” submitted to Christ College (Autonomous) Irinjalakuda towards the partial requirement of **Master of Science in Physics**, is an original work carried out by me under the supervision of **Dr. Shabnam Iyyani** and has not formed the basis for the award of any degree or diploma, in this or any other institution or university. I have sincerely tried to uphold academic ethics and honesty. Whenever a piece of external information or statement or result is used then, that has been duly acknowledged and cited.

Irinjalakuda - 680 125

Hiba T K

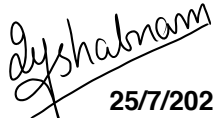
July 2023

CERTIFICATE

This is to certify that the work contained in this project report entitled “**CHARACTERISING THE EXTENDED FERMI LAT EMISSION WITH RESPECT TO SWIFT XRT X-RAY AFTERGLOW EMISSIONS**” submitted by **Hiba T K (Roll No: CCAVMPH007)** to Christ College (Autonomous) Irinjalakuda towards the partial requirement of **Master of Science in Physics** has been carried out by her under my supervision and that it has not been submitted elsewhere for the award of any degree.

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July 2023


25/7/2023

Dr. Shabnam Iyyani

Project Supervisor



Certificate

This is to certify that the work contained in this project report entitled "**CHARACTERISING THE EXTENDED FERMI LAT EMISSION WITH RESPECT TO SWIFT XRT X-RAY AFTERGLOW EMISSIONS**" submitted by **Hiba T K** (Roll No. **CCAVMPH007**) to Christ College (Autonomous) Irinjalakuda, is based on the investigation carried out by her under the guidance of Dr. Shabnam Iyyani, Assistant Professor, IISER Thiruvananthapuram.

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Irinjalakuda - 680 125

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July 2023

ABSTRACT

The Gamma ray bursts (GRBs) are the brightest events detected in the Universe. Using various satellites in the multi energy band, the GRBs have been widely studied for its dynamic emission processes and complex nature of light curves. We have used the data from two observatories, namely Fermi Gamma ray Space Telescope and Neil Gehrels Swift Observatory to investigate about the relation of extended Fermi LAT to the Swift XRT afterglow and to focus on their characterisation. In order to compare the characteristics of the Fermi extended LAT with the Swift XRT, the light curves are plotted and spectral analysis is carried out with a simple power law. The time-resolved analysis of GRB 130427A, one of the brightest burst detected by the Fermi satellite, provided valuable insight into the emission mechanism of gamma ray bursts. It helped in understanding the transition from prompt emission to afterglow emission. A distinct shift in the power law index α is observed for different energy bands. Before the point of shift, there is a gradual increase in the power law indices, followed by a gradual decrease, which suggests the transition from prompt emission to afterglow emission. Since the power law indices varies for XRT and extended LAT, we conclude that both of these emissions at different energy ranges might be from different segments of a synchrotron spectrum.

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