# SELF BALANCING PLATFORM

Project Report Submitted To

DEPARTMENT OF PHYSICS CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA

In Partial Fulfilment of The Requirement for The Award of The Degree Of

## BACHELOR OF SCIENCE IN PHYSICS

Submitted By


**ABHAY HARIDAS - CCAVSPH001**

**ANAGHA P S - CCAVSPH003**

**ATHIRA VINAYAN – CCAVSPH006**

**NABEEL MUSTHAQUE T – CCAVSPH010**

**ANISH V U -CCAVSPH019**


Under The Supervision Of


**ASST.PROF. STIJI JOSE**

**FACULTY DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**APRIL 2024**

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

## CALICUT UNIVERSITY

## DEPARTMENT OF PHYSICS

## CERTIFICATE

This Is to Certify That the Project Report Entitled "Self-Balancing Platform" Is A Bonafide Record of Project Done by **ABHAY HARIDAS**, Reg.No. CCAVSPH001, Under My Guidance and Supervision in Partial Fulfilment of The Requirement for The Award of The Degree of BACHELOR OF PHYSICS And It Has Not Previously Formed the Basis for Any Degree, Diploma and Associateship or Fellowship.

Dr. Sudheer Sebastian K
Head Of the Department

Asst.Prof. Stiji Jose
Project Guide

# DECLARATION

I ABHAY HARIDAS (CCAVSPH001) hereby declare that the project entitled “SELF BALANCING PLATFORM” is a group project done under the supervision and guidance of Miss Stiji Jose Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024 CCAVSPH001

Submitted for the Examination Held On:

INTERNAL EXAMINER EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully.

I'm grateful to our principal, Rev.Dr. Jolly Andrews CMI for providing us various facilities.

I also express my gratitude to Prof. Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation.

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Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024

# Contents

# CHAPTER 1

## INTRODUCTION

**Control theory** is a field of applied mathematics that deals with the control of dynamical system in engineered processes and machines. The objective is to develop a model or algorithm governing the application of system inputs to drive the system to a desired state, while minimizing any delay, overshoot, or steady-state error and ensuring a level of control stability; often with the aim to achieve a degree of optimality.

## 1.1 AUTOMATIC CONTROL THEORY

The science dealing with methods for the determination of laws for controlling systems that can be realized by automatic devices. The controller used in the project is a proportional-integral-derivative controller, also referred to as a PID controller. A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. It uses a control loop feedback mechanism to control process variables and are the most accurate and stable controller. The proportional part compensates for disturbances but does not eliminate their effect. The integral part on the other hand does reduce the effect of the disturbances but may cause issues with regards to system stability. Moreover, the derivative part of the controller does improve stability margins but at the expense of increased measurement errors.

# NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER

Project report submitted by

**ANNA VARGHESE (REG No.: CCAVSPH021)**

**EV VISHNUPRIYA (REG No.: CCAVSPH026)**

**ALINA NA (REG No.:CCAVSPH036)**

**HEMANTH SURESH (REG No.: CCAVSPH028)**

**AMALDEV CA (REG No.: CCAVSPH002)**

for the award of the degree of

**BACHELOR OF SCIENCE IN PHYSICS**


Supervising Guide

**Dr. Sudheer Sebastian K.**

Professor, Department of Physics

Christ College (Autonomous), Irinjalakuda

**CALICUT UNIVERSITY**

**2024**

# CERTIFICATE

This is to certify that the project work entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER"** is a bona fide work done by **Ms. ANNA VARGHESE, Ms. EV VISHNUPRIYA, Ms. ALINA NA, Mr. HEMANTH SURESH & Mr. AMALDEV CA** Department of Physics, Christ College (Autonomous) Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Bachelor of Science in Physics under the University of Calicut.

**Dr. SUDHEER SEBASTIAN K.**
Professor
Head of Department of Physics
Christ College (Autonomous)
Irinjalakuda

Place: Irinjalakuda
Date: 17/04/2024

# DECLARATION

We hereby declare that the work presented in this report entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHINE OXIDE AS HOLE TRANSPORT LAYER"** is based on the original work done by me under the guidance of Dr. Sudheer Sebastian K., Professor, Head of 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: 17/04/2024

# ACKNOWLEDGEMENTS

We take this opportunity to express our deep sense of gratitude and extend our thanks to all the people who have inspired and motivated us during our course and project.

Firstly, We would like to acknowledge the motivation and guidance given by our project adviser, **Dr. SUDHEER SEBASTIAN K.**, Professor, Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda, throughout our project.

Our special word of thanks to **Ms. Denet Rose 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.

We are thankful to all our classmates, teaching and non-teaching staff of the Dept. of Physics. We are indebted to our family for their constant source of inspiration.

We thank God, Almighty, Who is always with us, and we are always in need of his blessings all our life time.

# ABSTRACT

Numerical simulation study of $MAPbI_3/FA_{0.5}MA_{0.5}Pb_{0.5}Sn_{0.5}I_3$ based bilayer inverted perovskite solar cell is done in this work. The enhancement of device performance also depends on the electron transport layer and hole transport layer. As an effective hole transport layer, PEDOT:PSS is widely utilized due to its favourable electrical conductivity, transparency, and film-forming characteristics. Its efficient hole transportation capability significantly contributes to the overall improvement of organic electronic devices. However, it is important to note that PEDOT:PSS does have some drawbacks, such as its acidic nature and hygroscopicity, which can result in the degradation of solar cells. Graphene oxide is a good replacement for PEDOT:PSS due to its extraordinary electrical properties. In this work we introduce graphene oxide as hole transport layer instead of PEDOT:PSS and extensive simulation study is carried out.

Keywords: bilayer inverted perovskite solar cell, hole transport layer, graphene oxide, simulation study

# CONTENTS

# CHAPTER 1: INTRODUCTION

The light from the Sun is a non-vanishing renewable source of energy which is free from environmental pollution and noise. It can easily compensate the energy drawn from the non -renewable source of energy such as fossil fuel and petroleum deposits inside the earth[1]. Everyday sun sends out tremendous amount of energy in the form of heat and radiations called solar energy. Solar energy is a limitless source of energy which is available at no cost [2] [3]. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly harvested into solar energy with the use of small and tiny photovoltaic (PV) solar cells [4] [5]. The Sun is assumed as a big spherical gaseous cloud made up of hydrogen and helium atoms. This big spherical gaseous cloud is mainly composed of several hydrogen nuclei combining to form helium energy with the emission of energy from the fusion of the hydrogen nuclei in inner core of the Sun via nuclear fusion [6].

During this process of fusion, four hydrogen atoms combine to form one helium atom with a loss of mass which is radiated as thermal energy [2] [5] - [6]. This radiant energy produced by fusion reactions is free from any pollutant, gases, or other reaction by-product. This is why it is the major driving force of all the clean energy technology, in view of the climatic disturbance caused by the emission of carbon from the fossil fuels deposits. One of the biggest advantages of solar energy is that it is free reachable to common people and available in abundant supply compared to that of the price of various fossil fuels and oils in the past decade [2] - [8].

Solar power generation has been developed as one of the most demanding renewable sources of electricity. It has several advantages compared to other forms of energy like fossils fuels

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**APRIL 2024**

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## CALICUT UNIVERSITY

## DEPARTMENT OF PHYSICS

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Dr. Sudheer Sebastian K
Head Of the Department

Asst.Prof. Stiji Jose
Project Guide

# DECLARATION

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Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024 CCAVSPH001

Submitted for the Examination Held On:

INTERNAL EXAMINER EXTERNAL EXAMINER

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Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024

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# CHAPTER 1

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# "OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"

PROJECT REPORT

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

**BACHELOR OF SCIENCE**

*Submitted by*


**ANGEL MARIYA SHAJU**

**ADITHYA VV**

**ASHLIN ASOK**


*Under the supervision of*


**DR NITHYA K S**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**17 / 04 / 2024**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**CALICUT UNIVERSITY**


# CERTIFICATE

This is to certify that the project report entitled **"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a bona fide record of project done by **ANGEL MARIYA SHAJU**, Reg No. CCAVSPH004, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**Dr Nithya KS**

**Assistant Professor**
**Department of Physics**

# DECLARATION

I, **ANGEL MARIYA SHAJU**, hereby declare that the project work entitled

**"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a record of independent and bona fide project work carried out by me under the supervision and guidance of Dr Nithya KS, Assistant Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge.

Place: Irinjalakuda ANGEL MARIYA SHAJU

Date: 17 / 04 / 2024 CCAVSPH004

Submitted for the examination held on_____

INTERNAL EXAMINER EXTERNAL EXAMINER

## ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully. I am grateful to our principal, Rev.Fr. Dr Jolly Andrews CMI for providing us various facilities. I also express my gratitude to Prof. Dr Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Nithya KS, Asst. Professor, whose guidance and support throughout the period

helped me to complete this work successfully. I am also thankful to all the faculties of the department for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda ANGEL MARIYA SHAJU

Date:17 / 04 / 2024

# ABSTRACT

This study presents an optimization approach for CIGS (Copper Indium Gallium Selenide) solar cells with a Cadmium Sulphide (CdS) buffer layer, employing advanced techniques from OGHMA NANO. The optimization process focuses on enhancing the efficiency and performance of the CIGS solar cells through precise control of material properties and device architectures. OGHMA NANO techniques, including computational modelling, material synthesis, and device fabrication, are integrated to systematically investigate and improve various aspects of the CIGS solar cell structure. Through iterative experimentation and simulation, optimal parameters such as layer thickness and material parameters are identified to maximize the device efficiency. In the CIGS solar cell, the material parameters are band gap, electron affinity, electron mobility and hole mobility. The effect of these parameters on the CIGS solar cell is evaluated by

changing their values. The buffer layer present in the CIGS solar cell can be made up of different materials such as CdS, $SnO_2$, $TiO_2$, PCBM, C60.Thus we can determine the most efficient material which can be used as the buffer layer. The results demonstrate significant enhancements in the power conversion efficiency and stability of the CIGS solar cells, highlighting the potential of OGHMA NANO techniques for advancing photovoltaic technologies. This work contributes to the ongoing efforts in achieving cost-effective and sustainable energy solutions through the development of high-performance thin-film solar

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# CHAPTER 1

## 1.1 INTRODUCTION

In modern era the attention towards the renewable source of energy is increasing over the years because the growing trends of energy is increasing day by day. In photovoltaic applications second generation solar radiation collector are efficient and reliable, they are less costly and the fabrication process is simple because their absorbing medium is very narrow which is also known as thin-film solar cell (TFSC). Manufacturing cost of TFSC is less as matched to conventional photovoltaic devices. Thin film solar cells, based on CIGS and perovskites, continue to enhance their market share as promising energy conversion devices for indoor and outdoor applications. Copper Indium Gallium Selenide (CIGS) has been known for its high absorption coefficient, tuneable band gap and flexibility. Nevertheless, the use of toxic, regulated elements (Cd) and reliance on rare
elements creates a huge barrier in the efforts to enhance the commercial market of CIGS. Normally, the structure of CIGS solar cell starts with soda lime glass substrate and Mo back contact on the bottom, following CIGS as the interlayer, on the top are ZnO/Al:ZnO and n-type CdS as window layer and it is usually fabricated by co-evaporation process and precursor reaction process. Buffer layer is an intermediate layer film between the absorber and window layers with two main objectives, to provide structural stability to the device and to fix the electrostatic conditions inside the absorber layer. Cadmium sulphide (CdS) is a prominent candidate to be used as a buffer layer. The benefit of CIGS is that bandgap can be adjusted from 1 to 1.7 eV. Thickness of the absorber layer of thin film CIGS solar cell is varying from 1.5 to 2.5 μm thick. The Thick absorber layer
needs more materials for their fabrication which increase the solar cell cost because of the use of indium and gallium. Indium and gallium materials are limited and the researchers want to limit the thickness of absorber layer. Hence, the use of lesser amount of material leads to limited overall cost of fabrication process of CIGS TFSC.

# "Analysis of Quantum Entanglement and Bell States: Computational Simulations on Quantum Computers"

Project Report submitted to

**CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA**

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

**BACHELOR OF PHYSICS**

Submitted by

**ANOUSHKA M S**

**(CCAVSPH005)**

Under the supervision of

**Dr. ANJU PAULSON**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA UNIVERSITY OF CALICUT**

**MARCH 2024**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**CALICUT UNIVERSITY**


**DEPARTMENT OF PHYSICS CERTIFICATE**

This is to certify that the project report entitled **"ANALYSIS OF QUANTUM ENTANGLEMENT AND BELL STATES: COMPUTATIONAL SIMULATIONS ON QUANTUM COMPUTERS"** is a bona fide record of project done by **ANOUSHKA M S**, Reg.No. **CCAVSPH005**, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**Dr. ANJU PAULSON**

Project guide &

Assistant Professor

Department Of Physics

Christ College (Autonomous)

Irinjalakkuda

**MARCH 2024**

## DECLARATION

I, **ANOUSHKA M S,** hereby declare that the project work presented in this report entitled "**Analysis of Quantum Entanglement and Bell States: Computational Simulations on Quantum Computers**" is a record of independent and bona fide project work carried out by me under the supervision and guidance of Dr. Anju Paulson, Assistant Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

**Place: Irinjalakuda** **ANOUSHKA M S**

**Date: 16 / 04 / 2024** **REG No: CCAVSPH005**

Submitted for the examination held on_____

INTERNAL EXAMINER EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

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.

I am grateful to our principal, Rev.Dr. JOLLY ANDREWS CMI for providing us with various facilities.

I also express my gratitude to Dr. SUDHEER SEBASTIAN K., Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda , for his encouragement and support for the preparation.

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I thank God Almighty, who is always with me, and I am always in need of his

blessings all my lifetime.

**ANOUSHKA M S**

**REG No: CCAVSPH005**

# ABSTRACT

Quantum entanglement, a fundamental aspect of quantum mechanics, continues to intrigue physicists for its profound implications and potential applications in quantum information processing. In this study, I present a comprehensive investigation of quantum entanglement through computational simulations on quantum computers. My project encompasses the development of computational tools for analyzing entangled states, validation of theoretical predictions through simulated experiments, and rigorous verification of entanglement using statistical methods. I begin by constructing circuit diagrams representing maximally entangled Bell states, followed by executing their simulations on real quantum hardware to obtain measurement outcomes. Histograms of measurement frequencies are then plotted to analyze the statistical distribution of outcomes, while the Chi-Squared Test is employed to assess the presence and degree of entanglement. My findings not only confirm the existence of entanglement in the studied systems but also shed light on the behavior of entangled states under measurement. Through this interdisciplinary approach, I contribute to the advancement of quantum computing research and offer insights into the future potential of quantum entanglement in various fields.

Keywords: Quantum entanglement, Bell states, Computational simulations, Quantum computing, Statistical analysis.

# ANALYSIS OF QUANTUM ENTANGLEMENT AND BELL STATES: COMPUTATIONAL SIMULATIONS ON QUANTUM COMPUTERS

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**CHAPTER 7: APPLICATIONS AND FUTURE TRENDS**

- 7.1. Applications in Quantum Information Processing
- 7.2. Potential Future Developments

**REFERENCES**

# CHAPTER 1: INTRODUCTION TO QUANTUM ENTANGLEMENT

# 1.1. Introduction:

Quantum entanglement stands as one of the most intriguing phenomena in the realm of quantum mechanics, defying classical intuition and underpinning the foundations of modern physics.

Einstein famously called entanglement "spooky action at a distance," since the particles seemed to be communicating faster than the speed of light.

"The best possible knowledge of a whole does not necessarily include the best possible knowledge of all its parts." Schrödinger, one of the founders of quantum mechanics, highlighted the non-separability of entangled quantum systems, where the state of the whole cannot be fully understood by examining its individual parts.

Feynman, a Nobel laureate in physics said: “It is safe to say that nobody understands quantum mechanics.” and expresses the inherent complexity and mysteriousness of quantum mechanics, including phenomena like entanglement, which challenge our classical intuitions.

By harnessing the unique properties of entanglement, researchers aim to revolutionize various fields such as : Quantum Computing, Quantum Cryptography, Quantum Communication, Quantum Metrology etc., paving the way for advancements that could redefine the technological landscape in the coming years.

This project endeavors to provide a comprehensive exploration of quantum entanglement, spanning theoretical principles, experimental methodologies, and computational simulations. Through a multidisciplinary approach, the aim is to elucidate the intricacies of entanglement phenomena, validate theoretical predictions through empirical analysis, and contribute to the ongoing discourse surrounding the potential applications and implications of entangled states in modern physics and technology.

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Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024 CCAVSPH001

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# CHAPTER 1

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# YOUNGS MODULUS MEASUREMENT USING LASER

Project report submitted to

## CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

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

## BACHELOR OF PHYSICS

Submitted by


**CHRIS SABU**

**CHERIE JOBY ACHANDY**

**PARVATHY GIREESH**

**ABHISHEK M KUMAR**

**AQUEENA ROSE SHAJU**

**CCAVSPH022**

DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

UNIVERSITY OF CALICUT

MARCH 2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CALICUT UNIVERSITY

# DEPARTMENT OF PHYSICS CERTIFICATE

This is to certify that the project report entitled "**YOUNGS MODULUS MEASUREMENT USING LASER** " is a bonafide record of project done by **AQUEENA ROSE SHAJU**, **CCAVSPH022** , under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Head Of The Department

Dr. Sudheer Sebastian K

PROJECT GUIDE

Dr. XAVIER JOSEPH

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Place: Irinjalakuda

Date:

AQUEENA ROSE SHAJU

CCAVSPH022

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

Iam grateful to our principal, Rev. Fr. Dr. Jolly Andrews CMI for providing us with various facilities. I also express my gratitude to Dr Sudheer Sebastian K , Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Xavier Joseph, Associate Professor, whose guidance and support throughout the period helped me to complete this work successfully. I am also thankful to all the faculties of the department and lab assistants for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda AQUEENA ROSE SHAJU

Date:

# TABLE OF CONTENT

# CHAPTER 1

## STRESS

When the deforming force is applied to an object, the object deforms. In order to bring the object back to its original shape and size, there will be an opposing force generated inside the object. This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress. Thus, Stress is defined as "The restoring force per unit area of the material". It is a tensor quantity. Denoted by Greek letter σ. Measured using Pascal or N/m2. Mathematically expressed as

$$\sigma = \frac{F}{A}$$

Where,

F is the restoring force measured in Newton or N.

A is the area of cross-section measured in m2. σ

is the stress measured using N/m2 or Pa

## STRAIN

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The following equation gives the relation for deformation in terms of the length of a solid:

$$\varepsilon = \frac{\delta L}{L}$$

where ε is the strain due to the stress applied, δl

is the change in length and

L is the original length of the material.

The strain is a dimensionless quantity as it just defines the relative change in shape.

# “VERIFYING EXPANSION OF UNIVERSE USING HUBBLE’S DIAGRAM”

Project Report submitted to

## DEPARTMENT OF PHYSICS CHRIST COLLEGE

## (AUTONOMOUS) IRINJALAKUDA

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

**BACHELOR OF SCIENCE IN PHYSICS**

Submitted by

**AUSTIN FRANSIC**

**JERIN C JOHNSON**

**SHELTON STANLEY**

**SNEHA STEPHAN**

**SIVANANDANA A S**

Under the supervision of

**Dr. EDWIN JOSE**

**ASSISTANT PROFESSOR**

# DEPARTMENT OF PHYSICS

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

# APRIL 2024

# DECLARATION

I **SIVANANDANA A S,** hereby declare that the project work entitled **"Expansion of Universe using Hubble's Diagram"** is recorded of independent and bona fide project work carried out by Me under the supervision and guidance of Mr. Edwin Jose, Asst. Professor, Department of Physics, Christ College Autonomous Irinjalakuda.

The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar tile of any other university or institute

Place: IRINJALAKUDA SIVANANDANA A S

Date: 17-04-2024 CCAVSPH039

Submitted for the examination held on:

Internal Examiner: External Examiner:

# CHRIST COLLEGE (AUTONOMOUS)

# IRINJALAKUDA

# UNIVERSITY OF CALICUT


## CERTIFICATE

This is to certify that the project report entitled "**EXPANSION OF UNIVERSE USING HUBBLES' DIAGRAM**" is a bona fide record of project done by SIVANANDANA A S , Reg. No. CCAVSPH039, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Dr. Edwin Jose

Project Guide

# ACKNOWLEDGEMENT

I would like to take the opportunity to express my preferred thanks and gratitude to all people who have helped me with sound advice and able guidance

Above all, I express my eternal gratitude to lord almighty under whose divine guidance; I have been able to complete this work successfully.

I would like to express my sincere obligation to Rev. DR. Jolly Andrews CMI, our principal for providing various facilities.

I am thankful to Prof. Sudheer Sebastian K, Head of the Department for providing proper help and encouragement in the preparation of this report.

I express my sincere gratitude to Dr. Edwin Jose, Asst. Professor, whose guidance and support throughout the period helped me to complete this work successfully.

I would like to express my preferred gratitude to all faculties of the Department for their interest and cooperation in this regard

I ex tend my heartly gratitude to the Librarian and the Library staffs of my college for their whole hearted cooperation.

I express my sincere thanks to my friends and family for their support in completing this report successfully.

Place: IRINJALAKUDA SIVANANDANA A S

Date:17-04-2024

# VERIFYING EXPANSION OF UNIVERSE USING HUBBLE'S LAW

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# CHAPTER – 4

# CHAPTER 1
# INTRODUCTION

## *1.1 - EXPANSION OF UNIVERSE*

The universe, an enigmatic expanse of space-time and matter, has a history as intricate and compelling as any epic saga. At the heart of this cosmic narrative lies the phenomenon of universe expansion—a concept that has transformed our understanding of existence itself. From the primordial singularity to the accelerating cosmos of today, the history of universe expansion unveils a mesmerizing tale of cosmic evolution, punctuated by pivotal moments of discovery and revelation.

The General Theory of Relativity, formulated by Albert Einstein in 1915, fundamentally altered our understanding of gravity and the nature of spacetime. In this theory, spacetime is not just a backdrop for the events of the universe but an active participant in them. It's a four-dimensional continuum where the three dimensions of space

# Unraveling Asteroid Trajectories: Insights from Many Body Systems

A Project report submitted to

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA**

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

**BACHELOR OF SCIENCE IN PHYSICS**


Submitted by

**MALAVIKA A P - CCAVSPH038**

**MILAN PRASAD - CCAVSPH009**

**ANET RANS SUNNY - CCAVSPH018**

**SALEEL SAHU - CCAVSPH035**

**JOSEPH JOY K - CCAVSPH030**

Under the supervision of

**Dr. Ajith R**




Department of Physics

Christ College (Autonomous), Irinjalakuda

CALICUT UNIVERSITY


**APRIL 2024**

**CERTIFICATE**

This is to certify that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is the bonafide work done by MALAVIKA A P (CCAVSPH038), MILAN PRASAD (CCAVSPH009), ANET RANS SUNNY (CCAVSPH018), SALEEL SAHU (CCAVSPH035), JOSEPH JOY K (CCAVSPH030) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE IN PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Place: Irinjalakuda
Date:17/04/2024

**D. Ajith R**
Project Guide
Department of Physics
Christ College(Autonomous),
Irinjalakuda.

## DECLARATION

**MALAVIKA A P(CCAVSPH038), MILAN PRASAD(CCAVSPH009), ANET RANS SUNNY(CCAVSPH018), SALEEL SAHU(CCAVSPH035), JOSEPH JOY K(CCAVSPH030)** hereby declare that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is a record of independent and bonafide project work carried out by us under the supervision and guidance of Dr. Ajith R, Department of Physics, Christ College Irinjalakuda.

The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

MALAVIKA A P(CCAVSPH038)
MILAN PRASAD(CCAVSPH009)
ANET RANS SUNNY(CCAVSPH018)
SALEEL SAHU(CCAVSPH035)
JOSEPH JOY K(CCAVSPH030)

Place: Irinjalakuda
Date:17/04/2024

## ACKNOWLEDGEMENT

We express our sincere gratitude to our project guide Dr. AJITH R who helped us in this endeavour, his constant guidance and willingness to share his vast knowledge made us understand this project and its manifestations in great depths and helped us to complete the assigned tasks on time. Without his help, co-operation, guidance and encouragement the project could not have been what it evolved to be.

We are thankful to Dr. SUDHEER SEBASTIAN, Head of Department, for providing proper help and encouragement in the preparation of this report.

We would like to express our sincere obligation to Principal Dr. JOLLY ANDREWS CMI for his support and advice.

We would like to express our gratitude to all the faculties of the department for their interest and co-operation in this regard.

We extend our heartfelt gratitude to the librarian and other library staff of our college for their wholehearted co-operation.

We express our sincere thanks to our friends and family for their support in completing this report successfully.

This project has been a result of many people's hard-work and we acknowledge that and thank them with all our heart.

## ABSTRACT

In physics, the n-body problem is the problem of predicting the individual motions of a group of celestial objects interacting with each other gravitationally. Solving this problem has been motivated by the desire to understand the motions of the Sun, Moon, planets. In this project we explore the behaviour of the many-body system by comparing it with two-body system. We will analyse the two-body system containing sun and asteroid and many- body system containing sun , asteroid and other planets in the solar system. The chaotic behaviour of the many-body system is investigated by analysing the deviation in the trajectory of the asteroid under the influence of other planets and aims to quantify the many-body effect through simple mathematical techniques and python tool. We also analyse the law of conservation of energy , the fundamental principle in classical mechanics in many body system which is useful in predicting the long term behaviour of the system . Overall study emphasizes on the importance of N-body simulations and how it enables to predict the deviations that arise due to many-body effect which can be effectively used in planning space explorations accordingly.

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# Chapter 1

# Introduction

## 1.1 Introduction

In this project , we explore the dynamics of many body system and tries to quantify the many body effect using numerical method and analytical methods.The Two Body Problem is important because it is a fundamental problem in classical mechanics. It refers to the problem of predicting the motion of two celestial bodies that are gravitationally interacting with each other, such as a planet and its moon or two stars orbiting each other.It also serves as a foundation for more complex problems involving multiple bodies.Generally two body problem can be solved using mathematical equations derived from Newton's laws of motion and his law of universal gravitation. These equations can be solved using various techniques, such as numerical methods or analytical methods like Kepler's laws.The fundamental issue with the two-body problem arises from its complexity despite its apparent simplicity. While Newton's laws allow us to accurately describe the motion of two bodies under the influence of gravity, finding exact analytical solutions for their motion is only possible in a limited number of cases, such as when the bodies have circular or elliptical orbits. In most situations, especially when dealing with non-circular orbits or non-point masses, the equations governing the motion become highly nonlinear and difficult to solve analytically. This complexity makes it challenging to predict the long-term behavior of the system accurately.As celestial mechanics advanced, many systems in the universe involve more than two bodies interacting gravitationally. This realization gave rise to the concept of the many-body problem. In a many-body problem, the gravitational interactions between three or more bodies must be considered simultaneously.The many-body problem is notoriously more complex than the two-body problem. Unlike the two-body problem, where certain simplifications can sometimes yield exact solutions, the many-body problem rarely offers such straightforward solutions. The gravitational interactions between multiple bodies create a highly nonlinear system of differential equations that are exceedingly difficult to solve analytically.In this project , we study the many body problem of an asteroid under the influence of planets in the solar system. In this system, anomalous change in the center of mass of the system , leading to intricate and chaotic

# SELF BALANCING PLATFORM

Project Report Submitted To

DEPARTMENT OF PHYSICS CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA

In Partial Fulfilment of The Requirement for The Award of The Degree Of

## BACHELOR OF SCIENCE IN PHYSICS

Submitted By


**ABHAY HARIDAS - CCAVSPH001**

**ANAGHA P S - CCAVSPH003**

**ATHIRA VINAYAN – CCAVSPH006**

**NABEEL MUSTHAQUE T – CCAVSPH010**

**ANISH V U -CCAVSPH019**


Under The Supervision Of


**ASST.PROF. STIJI JOSE**

**FACULTY DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**APRIL 2024**

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

## CALICUT UNIVERSITY

## DEPARTMENT OF PHYSICS

## CERTIFICATE

This Is to Certify That the Project Report Entitled "Self-Balancing Platform" Is A Bonafide Record of Project Done by **ABHAY HARIDAS**, Reg.No. CCAVSPH001, Under My Guidance and Supervision in Partial Fulfilment of The Requirement for The Award of The Degree of BACHELOR OF PHYSICS And It Has Not Previously Formed the Basis for Any Degree, Diploma and Associateship or Fellowship.

Dr. Sudheer Sebastian K
Head Of the Department

Asst.Prof. Stiji Jose
Project Guide

# DECLARATION

I ABHAY HARIDAS (CCAVSPH001) hereby declare that the project entitled “SELF BALANCING PLATFORM” is a group project done under the supervision and guidance of Miss Stiji Jose Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024 CCAVSPH001

Submitted for the Examination Held On:

INTERNAL EXAMINER EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully.

I'm grateful to our principal, Rev.Dr. Jolly Andrews CMI for providing us various facilities.

I also express my gratitude to Prof. Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation.

I express my gratitude to Stiji Jose, Asst. Professor, whose guidance and support throughout the period helped me to complete this work successfully.

I'm also thankful to all the faculties of the department for their interest and cooperation.

I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation.

I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024

# Contents

# CHAPTER 1

## INTRODUCTION

**Control theory** is a field of applied mathematics that deals with the control of dynamical system in engineered processes and machines. The objective is to develop a model or algorithm governing the application of system inputs to drive the system to a desired state, while minimizing any delay, overshoot, or steady-state error and ensuring a level of control stability; often with the aim to achieve a degree of optimality.

## 1.1 AUTOMATIC CONTROL THEORY

The science dealing with methods for the determination of laws for controlling systems that can be realized by automatic devices. The controller used in the project is a proportional-integral-derivative controller, also referred to as a PID controller. A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. It uses a control loop feedback mechanism to control process variables and are the most accurate and stable controller. The proportional part compensates for disturbances but does not eliminate their effect. The integral part on the other hand does reduce the effect of the disturbances but may cause issues with regards to system stability. Moreover, the derivative part of the controller does improve stability margins but at the expense of increased measurement errors.

# “FINDING EXOPLANET USING TRANSIT MTHOD”

PROJECT REPORT

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

**BACHELOR OF SCIENCE**


*Submitted by*

**NITHIN VIJAY K CCAVSPH011**

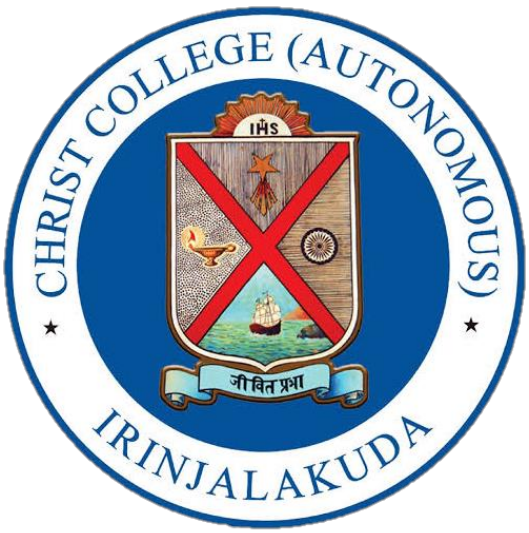
*Under the supervision of*

**DR T R GOVINDANKUTTY**

**PROFESSOR,**

**HOMI BHABHA NATIONAL INSTITUTE, MUMBAI**

**APRIL 2024**




## DEPARTMENT OF PHYSICS

# CERTIFICATE

This is to certify that the project report entitled "**FINDING EXOPLANET USING TRANSIT METHOD**" is a bona fide record of project done by **NITHIN VIJAY K** (Reg. No. CCAVSPH011) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Irinjalakuda

April 2024

Dr T R Govindankutty

# DECLARATION

I, **NITHIN VIJAY K**, hereby declare that the project work entitled **"FINDING EXOPLANET USING TRANSIT METHOD"** is a record of independent and bona fide project work carried out by me under the supervision and guidance of Dr T R Govindankutty Professor, Homi Bhabha National Institute, Mumbai and Dr Nithya KS, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda NITHIN VIJAY K

Date: CCAVSPH011

Submitted for the examination held on_____

INTERNAL EXAMINER EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully. I am grateful to our principal, Rev. Dr Jolly Andrews CMI for providing us various facilities. I also express my gratitude to Prof. Dr Sudheer Sebastian, Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr T R Govindankutty, Professor and Dr Nithya KS, Asst. Professor, whose guidance and support throughout the period helped me to complete this work successfully. I am also thankful to all the faculties of the department for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda NITHIN VIJAY K

Date:

# ABSTRACT

The quest to unravel the mysteries of the universe has led astronomers on a remarkable journey beyond the confines of our solar system. Central to this exploration, is the discovery and characterization of exoplanets — planets orbiting stars beyond our Sun. Among the various techniques employed for exoplanet detection, the transit method stands out as a powerful tool, offering unique insights into the existence and properties of these distant worlds This project will start with an introduction of exoplanets and different methods for detecting the exoplanets and it delves into the principle methodology and size determination of the exoplanet using transit method, it also specifies the merits and demerits of the transit methods and lastly this project will discusses about the finished and ongoing transit survey projects thus by shedding light on the intricacies of exoplanet detection through the transit method, this project aims to deepen our appreciation of the vast diversity of worlds beyond our own and inspire future generations of astronomers in the ongoing quest to explore the cosmos.

# Table of Contents

# CHAPTER 1 – INTRODUCTION

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## 1.1 Exoplanets

An **exoplanet** or **extrasolar planet** is a planet outside the Solar System**.**

For centuries scientists, philosophers, and science fiction writers suspected that extrasolar planets existed, but there was no way of knowing whether they were real in fact, how common they were, or how similar they might be to the planets of the Solar System.

The first evidence of a possible exoplanet, orbiting Van Maanen 2, was noted in 1917, but was not recognized as such. The astronomer Walter Sydney Adams, who later became director of the Mount Wilson Observatory, produced a spectrum of the star using Mount Wilson's 60-inch telescope. He interpreted the spectrum to be of an F-type main-sequence star, but it is now thought that such a spectrum could be caused by the residue of a nearby exoplanet that had been pulverized by the gravity of the star, the resulting dust then falling onto the star.

The first suspected scientific detection of an exoplanet occurred in 1988. Shortly afterwards, the first confirmation of detection came in 1992 from the Arecibo Observatory, with the discovery of several terrestrial-mass planets orbiting the pulsar PSR B1257+12. The first confirmation of an exoplanet orbiting a main-sequence star was made in 1995, when a giant planet was found in a four-day orbit around the nearby star 51 Pegasi later named as exoplanet 51 Pegasi b and As of 1 April 2024, there are 5,653 confirmed exoplanets in 4,161 planetary systems, with 896 systems having more than one planet

# “VERIFYING EXPANSION OF UNIVERSE USING HUBBLE’S DIAGRAM”

Project Report submitted to

## DEPARTMENT OF PHYSICS CHRIST COLLEGE

## (AUTONOMOUS) IRINJALAKUDA

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

**BACHELOR OF SCIENCE IN PHYSICS**

Submitted by

**AUSTIN FRANSIC**

**JERIN C JOHNSON**

**SHELTON STANLEY**

**SNEHA STEPHAN**

**SIVANANDANA A S**

Under the supervision of

**Dr. EDWIN JOSE**

**ASSISTANT PROFESSOR**

# DEPARTMENT OF PHYSICS

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

# APRIL 2024

# DECLARATION

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Place: IRINJALAKUDA SIVANANDANA A S

Date: 17-04-2024 CCAVSPH039

Submitted for the examination held on:

Internal Examiner: External Examiner:

# CHRIST COLLEGE (AUTONOMOUS)

# IRINJALAKUDA

# UNIVERSITY OF CALICUT


## CERTIFICATE

This is to certify that the project report entitled "**EXPANSION OF UNIVERSE USING HUBBLES' DIAGRAM**" is a bona fide record of project done by SIVANANDANA A S , Reg. No. CCAVSPH039, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Dr. Edwin Jose

Project Guide

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Place: IRINJALAKUDA SIVANANDANA A S

Date:17-04-2024

# VERIFYING EXPANSION OF UNIVERSE USING HUBBLE'S LAW

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# CHAPTER 1
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The General Theory of Relativity, formulated by Albert Einstein in 1915, fundamentally altered our understanding of gravity and the nature of spacetime. In this theory, spacetime is not just a backdrop for the events of the universe but an active participant in them. It's a four-dimensional continuum where the three dimensions of space

# YOUNGS MODULUS MEASUREMENT USING LASER

Project report submitted to

## CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

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

## BACHELOR OF PHYSICS

Submitted by


**CHRIS SABU**

**CHERIE JOBY ACHANDY**

**PARVATHY GIREESH**

**ABHISHEK M KUMAR**

**AQUEENA ROSE SHAJU**

**CCAVSPH022**

DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

UNIVERSITY OF CALICUT

MARCH 2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CALICUT UNIVERSITY

# DEPARTMENT OF PHYSICS CERTIFICATE

This is to certify that the project report entitled "**YOUNGS MODULUS MEASUREMENT USING LASER** " is a bonafide record of project done by **AQUEENA ROSE SHAJU**, **CCAVSPH022** , under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Head Of The Department

Dr. Sudheer Sebastian K

PROJECT GUIDE

Dr. XAVIER JOSEPH

# DECLARATION

I, AQUEENA ROSE SHAJU, hereby declare that the project work entitled “YOUNGS MODULUS MEASUREMENT USING LASER” is a record of independent and bonafide project work carried out by me under the supervision and guidance of Dr. XAVIER JOSEPH, Associate Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda

Date:

AQUEENA ROSE SHAJU

CCAVSPH022

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

Iam grateful to our principal, Rev. Fr. Dr. Jolly Andrews CMI for providing us with various facilities. I also express my gratitude to Dr Sudheer Sebastian K , Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Xavier Joseph, Associate Professor, whose guidance and support throughout the period helped me to complete this work successfully. I am also thankful to all the faculties of the department and lab assistants for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda AQUEENA ROSE SHAJU

Date:

# TABLE OF CONTENT

# CHAPTER 1

## STRESS

When the deforming force is applied to an object, the object deforms. In order to bring the object back to its original shape and size, there will be an opposing force generated inside the object. This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress. Thus, Stress is defined as "The restoring force per unit area of the material". It is a tensor quantity. Denoted by Greek letter σ. Measured using Pascal or N/m2. Mathematically expressed as

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Where,

F is the restoring force measured in Newton or N.

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Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The following equation gives the relation for deformation in terms of the length of a solid:

$$\varepsilon = \frac{\delta L}{L}$$

where ε is the strain due to the stress applied, δl

is the change in length and

L is the original length of the material.

The strain is a dimensionless quantity as it just defines the relative change in shape.

# "OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"

PROJECT REPORT

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

**BACHELOR OF SCIENCE**

*Submitted by*


**ANGEL MARIYA SHAJU**

**ADITHYA VV**

**ASHLIN ASOK**


*Under the supervision of*


**DR NITHYA K S**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**17 / 04 / 2024**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**CALICUT UNIVERSITY**


# CERTIFICATE

This is to certify that the project report entitled **"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a bona fide record of project done by **ANGEL MARIYA SHAJU**, Reg No. CCAVSPH004, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**Dr Nithya KS**

**Assistant Professor**
**Department of Physics**

# DECLARATION

I, **ANGEL MARIYA SHAJU**, hereby declare that the project work entitled

**"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a record of independent and bona fide project work carried out by me under the supervision and guidance of Dr Nithya KS, Assistant Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge.

Place: Irinjalakuda ANGEL MARIYA SHAJU

Date: 17 / 04 / 2024 CCAVSPH004

Submitted for the examination held on_____

INTERNAL EXAMINER EXTERNAL EXAMINER

## ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully. I am grateful to our principal, Rev.Fr. Dr Jolly Andrews CMI for providing us various facilities. I also express my gratitude to Prof. Dr Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Nithya KS, Asst. Professor, whose guidance and support throughout the period

helped me to complete this work successfully. I am also thankful to all the faculties of the department for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda ANGEL MARIYA SHAJU

Date:17 / 04 / 2024

# ABSTRACT

This study presents an optimization approach for CIGS (Copper Indium Gallium Selenide) solar cells with a Cadmium Sulphide (CdS) buffer layer, employing advanced techniques from OGHMA NANO. The optimization process focuses on enhancing the efficiency and performance of the CIGS solar cells through precise control of material properties and device architectures. OGHMA NANO techniques, including computational modelling, material synthesis, and device fabrication, are integrated to systematically investigate and improve various aspects of the CIGS solar cell structure. Through iterative experimentation and simulation, optimal parameters such as layer thickness and material parameters are identified to maximize the device efficiency. In the CIGS solar cell, the material parameters are band gap, electron affinity, electron mobility and hole mobility. The effect of these parameters on the CIGS solar cell is evaluated by

changing their values. The buffer layer present in the CIGS solar cell can be made up of different materials such as CdS, $SnO_2$, $TiO_2$, PCBM, C60.Thus we can determine the most efficient material which can be used as the buffer layer. The results demonstrate significant enhancements in the power conversion efficiency and stability of the CIGS solar cells, highlighting the potential of OGHMA NANO techniques for advancing photovoltaic technologies. This work contributes to the ongoing efforts in achieving cost-effective and sustainable energy solutions through the development of high-performance thin-film solar

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# CHAPTER 1

## 1.1 INTRODUCTION

In modern era the attention towards the renewable source of energy is increasing over the years because the growing trends of energy is increasing day by day. In photovoltaic applications second generation solar radiation collector are efficient and reliable, they are less costly and the fabrication process is simple because their absorbing medium is very narrow which is also known as thin-film solar cell (TFSC). Manufacturing cost of TFSC is less as matched to conventional photovoltaic devices. Thin film solar cells, based on CIGS and perovskites, continue to enhance their market share as promising energy conversion devices for indoor and outdoor applications. Copper Indium Gallium Selenide (CIGS) has been known for its high absorption coefficient, tuneable band gap and flexibility. Nevertheless, the use of toxic, regulated elements (Cd) and reliance on rare
elements creates a huge barrier in the efforts to enhance the commercial market of CIGS. Normally, the structure of CIGS solar cell starts with soda lime glass substrate and Mo back contact on the bottom, following CIGS as the interlayer, on the top are ZnO/Al:ZnO and n-type CdS as window layer and it is usually fabricated by co-evaporation process and precursor reaction process. Buffer layer is an intermediate layer film between the absorber and window layers with two main objectives, to provide structural stability to the device and to fix the electrostatic conditions inside the absorber layer. Cadmium sulphide (CdS) is a prominent candidate to be used as a buffer layer. The benefit of CIGS is that bandgap can be adjusted from 1 to 1.7 eV. Thickness of the absorber layer of thin film CIGS solar cell is varying from 1.5 to 2.5 μm thick. The Thick absorber layer
needs more materials for their fabrication which increase the solar cell cost because of the use of indium and gallium. Indium and gallium materials are limited and the researchers want to limit the thickness of absorber layer. Hence, the use of lesser amount of material leads to limited overall cost of fabrication process of CIGS TFSC.

# XRD ANALYSIS OF COPPER

PROJECT REPORT SUBMITTED TO

**DEPARTMENT OF PHYSICS CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

## BACHELOR OF SCIENCE IN PHYSICS

SUBMITTED BY


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| **AISWARYA LAKSHMI V K** | **CCAVSPH016** |


UNDER THE SUPERVISION OF


**MS. IRENE JOY V**

FACULTY DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA



FEBRUARY 2024

# ACKNOWLEDGEMENT

I express our sincere gratitude to Ms. Irene Joy V, Faculty of Physics Department, whose guidance and support throughout the training period helped us to complete this work successfully. We are thankful to Dr. Sudheer Sebastian, Professor, Head of Department of Physics, for providing proper help and encouragement in the preparation of this report. We are thankful to our class teacher, Dr. Ajith R, Assistant Professor of Physics Department for providing proper help and encouragement in the preparation of this report. We would like to express our sincere obligation to Rev. Fr. Dr. Jolly Andrews CMI, Principal, Christ College Irinjalakuda for providing various facilities. We express our gratitude to all the faculties of the department for their interest and cooperation in this regard. Our sincere thanks to all our friends and family for their support in completing this project successfully.

# ABSTRACT

This project focuses on the determination of the lattice parameter of copper using X-ray diffraction (XRD) analysis. The lattice parameter is a fundamental parameter in crystallography, defining the size and shape of the unit cell in a crystal lattice. The value of the lattice parameter is calculated and compared to the original value obtained from the source website, using Origin 8. The properties and applications of copper and X-ray diffraction is explored.

# Table of Contents

# Chapter 1: Introduction

As an X-ray incident beam leaves a crystal, its atomic planes cause the beam to interfere with itself. X-ray diffraction is the term for this phenomenon. The year 1914 saw the discovery of x-ray diffraction by crystals, for which Max von Laue received the Nobel Prize.

An analytical method for examining physical attributes is called X-ray diffraction, or XRD. You may get in-depth details on the chemical makeup, crystallographic structure, and other characteristics. The XRD method's basic idea is that when X-rays hit a surface, it interacts with the electron cloud around the nucleus, causing dispersion of the radiation.

Here, we make use of XRD to determine certain parameters of copper in its powdered form.

## 1.1: Copper

Copper (atomic number 29) is a natural occurring metal found in rocks, soil, water, etc. It is a soft, malleable, and ductile metal with very high thermal and electrical conductivity. Copper is considered a crucial element for both plants and animals, as it one of the essential micronutrients, and is absorbed through the soil by plants, and through food by animals.

Copper is one of the few metals that can occur in nature in a directly usable metallic form (native metals). This led to very early human use in several regions, from c. 8000 BC. Thousands of years later, it was the first metal to be smelted from sulfide ores, c. 5000 BC; the first metal to be cast into a shape in a mold, c. 4000 BC; and the first metal to be purposely alloyed with another metal, tin, to create bronze, c. 3500 BC.

Common copper compounds are copper (II) salts, which have long been used as pigments and frequently provide minerals like azurite, malachite, and turquoise blue or green hues.

# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

Project Report

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

**BACHELOR OF SCIENCE**


*Submitted by*

**ALBIN DAVIS** **CCAVSPH017**

**GILSA GEORGE U** **CCAVSPH027**

**JOEPAUL JOHNSON** **CCAVSPH029**

*Under the supervision of*

**Dr. ANJU PAULSON**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**MARCH 2024**

# CERTIFICATE

This is to certify that the project report entitled **"ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"** is a bonafide record of project done by **GILSA GEORGE U**, Reg.No. CCAVSPH027, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**DR.ANJU PAULSON**

Project guide &

Assistant Professor

Department Of Physics

Christ College (Autonomous),

Irinjalakuda

**MARCH 2024**

# DECLARATION

I, Gilsa George U, hereby declare that the work presented in this report entitled **"ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"** is based on the original work done by me under the guidance of Dr. Anju Paulson, Assistant 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: 17/04/2024

GILSA GEORGE U
REG No: CCAVSPH027

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEGMENT

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.

I am grateful to our principal, **Rev.Dr. JOLLY ANDREWS CMI** for providing us various facilities.

I also express my gratitude to **Dr. SUDHEER SEBASTIAN K**., Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda , for his encouragement and support for the preparation.

I would like to acknowledge the motivation and guidance given by my project adviser**, Dr. ANJU PAULSON**, throughout my project which helped me in the successful completion of this 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 is always with me, and I am always in need of his blessings all my life time.

GILSA GEORGE U

REG No.: CCAVSPH027

# ABSTRACT

UV-Vis spectroscopy serves as a fundamental analytical technique for probing molecular structures and elucidating electronic transitions in a wide range of substances.Coconut oil is a widely used natural product renowned for its versatile applications in food, cosmetics, and pharmaceuticals. Understanding its molecular composition and quality characteristics is crucial for ensuring its efficacy and safety in various applications. UV-Vis spectroscopy emerges as a powerful analytical tool capable of providing valuable insights into the chemical composition and quality attributes of coconut oil.

This project aims to employ UV-Vis spectroscopy to investigate the refractive index, purity, and hence adulterations in coconut oil. Initially, the spectral profile of coconut oil will be analyzed to identify characteristic absorption and transmission bands associated with its major constituents, such as fatty acids, carotenoids, and antioxidants. Subsequently, the project will explore the application of UV-Vis spectroscopy for assessing the quality parameters of coconut oil,by finding refractive index corresponding to various wavelengths.The project's significance lies in its potential to offer a rapid, cost-effective, and non-destructive method for evaluating the quality of coconut oil, thus facilitating its quality control and assurance in industrial settings.

# ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES

# INDEX

# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

## 1. INTRODUCTION

UV-Visible spectroscopy is a powerful technique used to analyse the absorption of light by molecules in the ultraviolet and visible regions of the electromagnetic spectrum. Coconut oil, being a natural product, contains various organic compounds that can exhibit absorption in these regions.

The UV-Visible spectrum of coconut oil will likely show absorption peaks corresponding to the various constituents present in the oil. These could include fatty acids, triglycerides, tocopherols (vitamin E), carotenoids, and other minor components. Coconut oil is a rich source of short and medium-chain saturated fatty acids and account for 70% of these fatty acids and it has a low content of unsaturated fatty acids with a negligible content of both ω-6 and ω-3 polyunsaturated fatty acids

1. **Carotenoids**: Coconut oil may contain carotenoids, which are responsible for the color of the oil. Carotenoids typically absorb in the visible range, giving rise to yellow to orange colors. Thus, you might expect absorption peaks in the visible region, typically between 400-500 nm.
2. **Tocopherols (Vitamin E)**: Vitamin E compounds are antioxidants found in coconut oil. They can absorb light in the UV region, with peaks typically observed around 280-290 nm.
3. **Fatty Acids and Triglycerides**: These compounds might exhibit absorption in both the UV and visible regions, depending on their chemical structures. Peaks might appear at various wavelengths depending on the specific fatty acids present and their degree of unsaturation.

# Unraveling Asteroid Trajectories: Insights from Many Body Systems

A Project report submitted to

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA**

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

**BACHELOR OF SCIENCE IN PHYSICS**


Submitted by

**MALAVIKA A P - CCAVSPH038**

**MILAN PRASAD - CCAVSPH009**

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Under the supervision of

**Dr. Ajith R**




Department of Physics

Christ College (Autonomous), Irinjalakuda

CALICUT UNIVERSITY


**APRIL 2024**

**CERTIFICATE**

This is to certify that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is the bonafide work done by MALAVIKA A P (CCAVSPH038), MILAN PRASAD (CCAVSPH009), ANET RANS SUNNY (CCAVSPH018), SALEEL SAHU (CCAVSPH035), JOSEPH JOY K (CCAVSPH030) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE IN PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Place: Irinjalakuda
Date:17/04/2024

**D. Ajith R**
Project Guide
Department of Physics
Christ College(Autonomous),
Irinjalakuda.

## DECLARATION

**MALAVIKA A P(CCAVSPH038), MILAN PRASAD(CCAVSPH009), ANET RANS SUNNY(CCAVSPH018), SALEEL SAHU(CCAVSPH035), JOSEPH JOY K(CCAVSPH030)** hereby declare that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is a record of independent and bonafide project work carried out by us under the supervision and guidance of Dr. Ajith R, Department of Physics, Christ College Irinjalakuda.

The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

MALAVIKA A P(CCAVSPH038)
MILAN PRASAD(CCAVSPH009)
ANET RANS SUNNY(CCAVSPH018)
SALEEL SAHU(CCAVSPH035)
JOSEPH JOY K(CCAVSPH030)

Place: Irinjalakuda
Date:17/04/2024

## ACKNOWLEDGEMENT

We express our sincere gratitude to our project guide Dr. AJITH R who helped us in this endeavour, his constant guidance and willingness to share his vast knowledge made us understand this project and its manifestations in great depths and helped us to complete the assigned tasks on time. Without his help, co-operation, guidance and encouragement the project could not have been what it evolved to be.

We are thankful to Dr. SUDHEER SEBASTIAN, Head of Department, for providing proper help and encouragement in the preparation of this report.

We would like to express our sincere obligation to Principal Dr. JOLLY ANDREWS CMI for his support and advice.

We would like to express our gratitude to all the faculties of the department for their interest and co-operation in this regard.

We extend our heartfelt gratitude to the librarian and other library staff of our college for their wholehearted co-operation.

We express our sincere thanks to our friends and family for their support in completing this report successfully.

This project has been a result of many people's hard-work and we acknowledge that and thank them with all our heart.

## ABSTRACT

In physics, the n-body problem is the problem of predicting the individual motions of a group of celestial objects interacting with each other gravitationally. Solving this problem has been motivated by the desire to understand the motions of the Sun, Moon, planets. In this project we explore the behaviour of the many-body system by comparing it with two-body system. We will analyse the two-body system containing sun and asteroid and many- body system containing sun , asteroid and other planets in the solar system. The chaotic behaviour of the many-body system is investigated by analysing the deviation in the trajectory of the asteroid under the influence of other planets and aims to quantify the many-body effect through simple mathematical techniques and python tool. We also analyse the law of conservation of energy , the fundamental principle in classical mechanics in many body system which is useful in predicting the long term behaviour of the system . Overall study emphasizes on the importance of N-body simulations and how it enables to predict the deviations that arise due to many-body effect which can be effectively used in planning space explorations accordingly.

# Contents

# List of Figures

# Chapter 1

# Introduction

## 1.1 Introduction

In this project , we explore the dynamics of many body system and tries to quantify the many body effect using numerical method and analytical methods.The Two Body Problem is important because it is a fundamental problem in classical mechanics. It refers to the problem of predicting the motion of two celestial bodies that are gravitationally interacting with each other, such as a planet and its moon or two stars orbiting each other.It also serves as a foundation for more complex problems involving multiple bodies.Generally two body problem can be solved using mathematical equations derived from Newton's laws of motion and his law of universal gravitation. These equations can be solved using various techniques, such as numerical methods or analytical methods like Kepler's laws.The fundamental issue with the two-body problem arises from its complexity despite its apparent simplicity. While Newton's laws allow us to accurately describe the motion of two bodies under the influence of gravity, finding exact analytical solutions for their motion is only possible in a limited number of cases, such as when the bodies have circular or elliptical orbits. In most situations, especially when dealing with non-circular orbits or non-point masses, the equations governing the motion become highly nonlinear and difficult to solve analytically. This complexity makes it challenging to predict the long-term behavior of the system accurately.As celestial mechanics advanced, many systems in the universe involve more than two bodies interacting gravitationally. This realization gave rise to the concept of the many-body problem. In a many-body problem, the gravitational interactions between three or more bodies must be considered simultaneously.The many-body problem is notoriously more complex than the two-body problem. Unlike the two-body problem, where certain simplifications can sometimes yield exact solutions, the many-body problem rarely offers such straightforward solutions. The gravitational interactions between multiple bodies create a highly nonlinear system of differential equations that are exceedingly difficult to solve analytically.In this project , we study the many body problem of an asteroid under the influence of planets in the solar system. In this system, anomalous change in the center of mass of the system , leading to intricate and chaotic

# SELF BALANCING PLATFORM

Project Report Submitted To

DEPARTMENT OF PHYSICS CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA

In Partial Fulfilment of The Requirement for The Award of The Degree Of

## BACHELOR OF SCIENCE IN PHYSICS

Submitted By


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Under The Supervision Of


**ASST.PROF. STIJI JOSE**

**FACULTY DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**APRIL 2024**

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

## CALICUT UNIVERSITY

## DEPARTMENT OF PHYSICS

## CERTIFICATE

This Is to Certify That the Project Report Entitled "Self-Balancing Platform" Is A Bonafide Record of Project Done by **ABHAY HARIDAS**, Reg.No. CCAVSPH001, Under My Guidance and Supervision in Partial Fulfilment of The Requirement for The Award of The Degree of BACHELOR OF PHYSICS And It Has Not Previously Formed the Basis for Any Degree, Diploma and Associateship or Fellowship.

Dr. Sudheer Sebastian K
Head Of the Department

Asst.Prof. Stiji Jose
Project Guide

# DECLARATION

I ABHAY HARIDAS (CCAVSPH001) hereby declare that the project entitled “SELF BALANCING PLATFORM” is a group project done under the supervision and guidance of Miss Stiji Jose Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024 CCAVSPH001

Submitted for the Examination Held On:

INTERNAL EXAMINER EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully.

I'm grateful to our principal, Rev.Dr. Jolly Andrews CMI for providing us various facilities.

I also express my gratitude to Prof. Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation.

I express my gratitude to Stiji Jose, Asst. Professor, whose guidance and support throughout the period helped me to complete this work successfully.

I'm also thankful to all the faculties of the department for their interest and cooperation.

I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation.

I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda ABHAY HARIDAS

Date: 17-04-2024

# Contents

# CHAPTER 1

## INTRODUCTION

**Control theory** is a field of applied mathematics that deals with the control of dynamical system in engineered processes and machines. The objective is to develop a model or algorithm governing the application of system inputs to drive the system to a desired state, while minimizing any delay, overshoot, or steady-state error and ensuring a level of control stability; often with the aim to achieve a degree of optimality.

## 1.1 AUTOMATIC CONTROL THEORY

The science dealing with methods for the determination of laws for controlling systems that can be realized by automatic devices. The controller used in the project is a proportional-integral-derivative controller, also referred to as a PID controller. A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. It uses a control loop feedback mechanism to control process variables and are the most accurate and stable controller. The proportional part compensates for disturbances but does not eliminate their effect. The integral part on the other hand does reduce the effect of the disturbances but may cause issues with regards to system stability. Moreover, the derivative part of the controller does improve stability margins but at the expense of increased measurement errors.

# NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER

Project report submitted by

**ANNA VARGHESE (REG No.: CCAVSPH021)**

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**BACHELOR OF SCIENCE IN PHYSICS**


Supervising Guide

**Dr. Sudheer Sebastian K.**

Professor, Department of Physics

Christ College (Autonomous), Irinjalakuda

**CALICUT UNIVERSITY**

**2024**

# CERTIFICATE

This is to certify that the project work entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER"** is a bona fide work done by **Ms. ANNA VARGHESE, Ms. EV VISHNUPRIYA, Ms. ALINA NA, Mr. HEMANTH SURESH & Mr. AMALDEV CA** Department of Physics, Christ College (Autonomous) Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Bachelor of Science in Physics under the University of Calicut.

**Dr. SUDHEER SEBASTIAN K.**
Professor
Head of Department of Physics
Christ College (Autonomous)
Irinjalakuda

Place: Irinjalakuda
Date: 17/04/2024

# DECLARATION

We hereby declare that the work presented in this report entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHINE OXIDE AS HOLE TRANSPORT LAYER"** is based on the original work done by me under the guidance of Dr. Sudheer Sebastian K., Professor, Head of 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: 17/04/2024

# ACKNOWLEDGEMENTS

We take this opportunity to express our deep sense of gratitude and extend our thanks to all the people who have inspired and motivated us during our course and project.

Firstly, We would like to acknowledge the motivation and guidance given by our project adviser, **Dr. SUDHEER SEBASTIAN K.**, Professor, Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda, throughout our project.

Our special word of thanks to **Ms. Denet Rose 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.

We are thankful to all our classmates, teaching and non-teaching staff of the Dept. of Physics. We are indebted to our family for their constant source of inspiration.

We thank God, Almighty, Who is always with us, and we are always in need of his blessings all our life time.

# ABSTRACT

Numerical simulation study of $MAPbI_3/FA_{0.5}MA_{0.5}Pb_{0.5}Sn_{0.5}I_3$ based bilayer inverted perovskite solar cell is done in this work. The enhancement of device performance also depends on the electron transport layer and hole transport layer. As an effective hole transport layer, PEDOT:PSS is widely utilized due to its favourable electrical conductivity, transparency, and film-forming characteristics. Its efficient hole transportation capability significantly contributes to the overall improvement of organic electronic devices. However, it is important to note that PEDOT:PSS does have some drawbacks, such as its acidic nature and hygroscopicity, which can result in the degradation of solar cells. Graphene oxide is a good replacement for PEDOT:PSS due to its extraordinary electrical properties. In this work we introduce graphene oxide as hole transport layer instead of PEDOT:PSS and extensive simulation study is carried out.

Keywords: bilayer inverted perovskite solar cell, hole transport layer, graphene oxide, simulation study

# CONTENTS

# CHAPTER 1: INTRODUCTION

The light from the Sun is a non-vanishing renewable source of energy which is free from environmental pollution and noise. It can easily compensate the energy drawn from the non -renewable source of energy such as fossil fuel and petroleum deposits inside the earth[1]. Everyday sun sends out tremendous amount of energy in the form of heat and radiations called solar energy. Solar energy is a limitless source of energy which is available at no cost [2] [3]. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly harvested into solar energy with the use of small and tiny photovoltaic (PV) solar cells [4] [5]. The Sun is assumed as a big spherical gaseous cloud made up of hydrogen and helium atoms. This big spherical gaseous cloud is mainly composed of several hydrogen nuclei combining to form helium energy with the emission of energy from the fusion of the hydrogen nuclei in inner core of the Sun via nuclear fusion [6].

During this process of fusion, four hydrogen atoms combine to form one helium atom with a loss of mass which is radiated as thermal energy [2] [5] - [6]. This radiant energy produced by fusion reactions is free from any pollutant, gases, or other reaction by-product. This is why it is the major driving force of all the clean energy technology, in view of the climatic disturbance caused by the emission of carbon from the fossil fuels deposits. One of the biggest advantages of solar energy is that it is free reachable to common people and available in abundant supply compared to that of the price of various fossil fuels and oils in the past decade [2] - [8].

Solar power generation has been developed as one of the most demanding renewable sources of electricity. It has several advantages compared to other forms of energy like fossils fuels

# YOUNGS MODULUS MEASUREMENT USING LASER

Project report submitted to

## CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

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

## BACHELOR OF PHYSICS

Submitted by


**CHRIS SABU**

**CHERIE JOBY ACHANDY**

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**ABHISHEK M KUMAR**

**AQUEENA ROSE SHAJU**

**CCAVSPH022**

DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

UNIVERSITY OF CALICUT

MARCH 2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CALICUT UNIVERSITY

# DEPARTMENT OF PHYSICS CERTIFICATE

This is to certify that the project report entitled "**YOUNGS MODULUS MEASUREMENT USING LASER** " is a bonafide record of project done by **AQUEENA ROSE SHAJU**, **CCAVSPH022** , under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Head Of The Department

Dr. Sudheer Sebastian K

PROJECT GUIDE

Dr. XAVIER JOSEPH

# DECLARATION

I, AQUEENA ROSE SHAJU, hereby declare that the project work entitled “YOUNGS MODULUS MEASUREMENT USING LASER” is a record of independent and bonafide project work carried out by me under the supervision and guidance of Dr. XAVIER JOSEPH, Associate Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda

Date:

AQUEENA ROSE SHAJU

CCAVSPH022

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

Iam grateful to our principal, Rev. Fr. Dr. Jolly Andrews CMI for providing us with various facilities. I also express my gratitude to Dr Sudheer Sebastian K , Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Xavier Joseph, Associate Professor, whose guidance and support throughout the period helped me to complete this work successfully. I am also thankful to all the faculties of the department and lab assistants for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda AQUEENA ROSE SHAJU

Date:

# TABLE OF CONTENT

# CHAPTER 1

## STRESS

When the deforming force is applied to an object, the object deforms. In order to bring the object back to its original shape and size, there will be an opposing force generated inside the object. This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress. Thus, Stress is defined as "The restoring force per unit area of the material". It is a tensor quantity. Denoted by Greek letter σ. Measured using Pascal or N/m2. Mathematically expressed as

$$\sigma = \frac{F}{A}$$

Where,

F is the restoring force measured in Newton or N.

A is the area of cross-section measured in m2. σ

is the stress measured using N/m2 or Pa

## STRAIN

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The following equation gives the relation for deformation in terms of the length of a solid:

$$\varepsilon = \frac{\delta L}{L}$$

where ε is the strain due to the stress applied, δl

is the change in length and

L is the original length of the material.

The strain is a dimensionless quantity as it just defines the relative change in shape.

# "OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"

PROJECT REPORT

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

**BACHELOR OF SCIENCE**

*Submitted by*


**ANGEL MARIYA SHAJU**

**ADITHYA VV**

**ASHLIN ASOK**


*Under the supervision of*


**DR NITHYA K S**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**


**17 / 04 / 2024**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**CALICUT UNIVERSITY**


# CERTIFICATE

This is to certify that the project report entitled **"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a bona fide record of project done by **ANGEL MARIYA SHAJU**, Reg No. CCAVSPH004, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**Dr Nithya KS**

**Assistant Professor**
**Department of Physics**

# DECLARATION

I, **ANGEL MARIYA SHAJU**, hereby declare that the project work entitled

**"OPTIMIZATION OF CIGS SOLAR CELL WITH CADMIUM SULPHIDE BUFFER LAYER USING OGHMA NANO"** is a record of independent and bona fide project work carried out by me under the supervision and guidance of Dr Nithya KS, Assistant Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge.

Place: Irinjalakuda ANGEL MARIYA SHAJU

Date: 17 / 04 / 2024 CCAVSPH004

Submitted for the examination held on_____

INTERNAL EXAMINER EXTERNAL EXAMINER

## ACKNOWLEDGEMENT

I express my eternal gratitude to the Almighty, under whose divine guidance, I was able to complete this work successfully. I am grateful to our principal, Rev.Fr. Dr Jolly Andrews CMI for providing us various facilities. I also express my gratitude to Prof. Dr Sudheer Sebastian K, Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Nithya KS, Asst. Professor, whose guidance and support throughout the period

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Place: Irinjalakuda ANGEL MARIYA SHAJU

Date:17 / 04 / 2024

# ABSTRACT

This study presents an optimization approach for CIGS (Copper Indium Gallium Selenide) solar cells with a Cadmium Sulphide (CdS) buffer layer, employing advanced techniques from OGHMA NANO. The optimization process focuses on enhancing the efficiency and performance of the CIGS solar cells through precise control of material properties and device architectures. OGHMA NANO techniques, including computational modelling, material synthesis, and device fabrication, are integrated to systematically investigate and improve various aspects of the CIGS solar cell structure. Through iterative experimentation and simulation, optimal parameters such as layer thickness and material parameters are identified to maximize the device efficiency. In the CIGS solar cell, the material parameters are band gap, electron affinity, electron mobility and hole mobility. The effect of these parameters on the CIGS solar cell is evaluated by

changing their values. The buffer layer present in the CIGS solar cell can be made up of different materials such as CdS, $SnO_2$, $TiO_2$, PCBM, C60.Thus we can determine the most efficient material which can be used as the buffer layer. The results demonstrate significant enhancements in the power conversion efficiency and stability of the CIGS solar cells, highlighting the potential of OGHMA NANO techniques for advancing photovoltaic technologies. This work contributes to the ongoing efforts in achieving cost-effective and sustainable energy solutions through the development of high-performance thin-film solar

**INDEX**

# CHAPTER 1

## 1.1 INTRODUCTION

In modern era the attention towards the renewable source of energy is increasing over the years because the growing trends of energy is increasing day by day. In photovoltaic applications second generation solar radiation collector are efficient and reliable, they are less costly and the fabrication process is simple because their absorbing medium is very narrow which is also known as thin-film solar cell (TFSC). Manufacturing cost of TFSC is less as matched to conventional photovoltaic devices. Thin film solar cells, based on CIGS and perovskites, continue to enhance their market share as promising energy conversion devices for indoor and outdoor applications. Copper Indium Gallium Selenide (CIGS) has been known for its high absorption coefficient, tuneable band gap and flexibility. Nevertheless, the use of toxic, regulated elements (Cd) and reliance on rare
elements creates a huge barrier in the efforts to enhance the commercial market of CIGS. Normally, the structure of CIGS solar cell starts with soda lime glass substrate and Mo back contact on the bottom, following CIGS as the interlayer, on the top are ZnO/Al:ZnO and n-type CdS as window layer and it is usually fabricated by co-evaporation process and precursor reaction process. Buffer layer is an intermediate layer film between the absorber and window layers with two main objectives, to provide structural stability to the device and to fix the electrostatic conditions inside the absorber layer. Cadmium sulphide (CdS) is a prominent candidate to be used as a buffer layer. The benefit of CIGS is that bandgap can be adjusted from 1 to 1.7 eV. Thickness of the absorber layer of thin film CIGS solar cell is varying from 1.5 to 2.5 μm thick. The Thick absorber layer
needs more materials for their fabrication which increase the solar cell cost because of the use of indium and gallium. Indium and gallium materials are limited and the researchers want to limit the thickness of absorber layer. Hence, the use of lesser amount of material leads to limited overall cost of fabrication process of CIGS TFSC.

# “VERIFYING EXPANSION OF UNIVERSE USING HUBBLE’S DIAGRAM”

Project Report submitted to

## DEPARTMENT OF PHYSICS CHRIST COLLEGE

## (AUTONOMOUS) IRINJALAKUDA

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

**BACHELOR OF SCIENCE IN PHYSICS**

Submitted by

**AUSTIN FRANSIC**

**JERIN C JOHNSON**

**SHELTON STANLEY**

**SNEHA STEPHAN**

**SIVANANDANA A S**

Under the supervision of

**Dr. EDWIN JOSE**

**ASSISTANT PROFESSOR**

# DEPARTMENT OF PHYSICS

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

# APRIL 2024

# DECLARATION

I **SIVANANDANA A S,** hereby declare that the project work entitled **"Expansion of Universe using Hubble's Diagram"** is recorded of independent and bona fide project work carried out by Me under the supervision and guidance of Mr. Edwin Jose, Asst. Professor, Department of Physics, Christ College Autonomous Irinjalakuda.

The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar tile of any other university or institute

Place: IRINJALAKUDA SIVANANDANA A S

Date: 17-04-2024 CCAVSPH039

Submitted for the examination held on:

Internal Examiner: External Examiner:

# CHRIST COLLEGE (AUTONOMOUS)

# IRINJALAKUDA

# UNIVERSITY OF CALICUT


## CERTIFICATE

This is to certify that the project report entitled "**EXPANSION OF UNIVERSE USING HUBBLES' DIAGRAM**" is a bona fide record of project done by SIVANANDANA A S , Reg. No. CCAVSPH039, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Dr. Edwin Jose

Project Guide

# ACKNOWLEDGEMENT

I would like to take the opportunity to express my preferred thanks and gratitude to all people who have helped me with sound advice and able guidance

Above all, I express my eternal gratitude to lord almighty under whose divine guidance; I have been able to complete this work successfully.

I would like to express my sincere obligation to Rev. DR. Jolly Andrews CMI, our principal for providing various facilities.

I am thankful to Prof. Sudheer Sebastian K, Head of the Department for providing proper help and encouragement in the preparation of this report.

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I express my sincere thanks to my friends and family for their support in completing this report successfully.

Place: IRINJALAKUDA SIVANANDANA A S

Date:17-04-2024

# VERIFYING EXPANSION OF UNIVERSE USING HUBBLE'S LAW

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# CHAPTER – 3

## PLOTTING AND ANLYSIS



# CHAPTER – 4

# CHAPTER 1
# INTRODUCTION

## *1.1 - EXPANSION OF UNIVERSE*

The universe, an enigmatic expanse of space-time and matter, has a history as intricate and compelling as any epic saga. At the heart of this cosmic narrative lies the phenomenon of universe expansion—a concept that has transformed our understanding of existence itself. From the primordial singularity to the accelerating cosmos of today, the history of universe expansion unveils a mesmerizing tale of cosmic evolution, punctuated by pivotal moments of discovery and revelation.

The General Theory of Relativity, formulated by Albert Einstein in 1915, fundamentally altered our understanding of gravity and the nature of spacetime. In this theory, spacetime is not just a backdrop for the events of the universe but an active participant in them. It's a four-dimensional continuum where the three dimensions of space

# NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER

Project report submitted by

**ANNA VARGHESE (REG No.: CCAVSPH021)**

**EV VISHNUPRIYA (REG No.: CCAVSPH026)**

**ALINA NA (REG No.:CCAVSPH036)**

**HEMANTH SURESH (REG No.: CCAVSPH028)**

**AMALDEV CA (REG No.: CCAVSPH002)**

for the award of the degree of

**BACHELOR OF SCIENCE IN PHYSICS**


Supervising Guide

**Dr. Sudheer Sebastian K.**

Professor, Department of Physics

Christ College (Autonomous), Irinjalakuda

**CALICUT UNIVERSITY**

**2024**

# CERTIFICATE

This is to certify that the project work entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER"** is a bona fide work done by **Ms. ANNA VARGHESE, Ms. EV VISHNUPRIYA, Ms. ALINA NA, Mr. HEMANTH SURESH & Mr. AMALDEV CA** Department of Physics, Christ College (Autonomous) Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Bachelor of Science in Physics under the University of Calicut.

**Dr. SUDHEER SEBASTIAN K.**
Professor
Head of Department of Physics
Christ College (Autonomous)
Irinjalakuda

Place: Irinjalakuda
Date: 17/04/2024

# DECLARATION

We hereby declare that the work presented in this report entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHINE OXIDE AS HOLE TRANSPORT LAYER"** is based on the original work done by me under the guidance of Dr. Sudheer Sebastian K., Professor, Head of 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: 17/04/2024

# ACKNOWLEDGEMENTS

We take this opportunity to express our deep sense of gratitude and extend our thanks to all the people who have inspired and motivated us during our course and project.

Firstly, We would like to acknowledge the motivation and guidance given by our project adviser, **Dr. SUDHEER SEBASTIAN K.**, Professor, Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda, throughout our project.

Our special word of thanks to **Ms. Denet Rose 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.

We are thankful to all our classmates, teaching and non-teaching staff of the Dept. of Physics. We are indebted to our family for their constant source of inspiration.

We thank God, Almighty, Who is always with us, and we are always in need of his blessings all our life time.

# ABSTRACT

Numerical simulation study of $MAPbI_3/FA_{0.5}MA_{0.5}Pb_{0.5}Sn_{0.5}I_3$ based bilayer inverted perovskite solar cell is done in this work. The enhancement of device performance also depends on the electron transport layer and hole transport layer. As an effective hole transport layer, PEDOT:PSS is widely utilized due to its favourable electrical conductivity, transparency, and film-forming characteristics. Its efficient hole transportation capability significantly contributes to the overall improvement of organic electronic devices. However, it is important to note that PEDOT:PSS does have some drawbacks, such as its acidic nature and hygroscopicity, which can result in the degradation of solar cells. Graphene oxide is a good replacement for PEDOT:PSS due to its extraordinary electrical properties. In this work we introduce graphene oxide as hole transport layer instead of PEDOT:PSS and extensive simulation study is carried out.

Keywords: bilayer inverted perovskite solar cell, hole transport layer, graphene oxide, simulation study

# CONTENTS

# CHAPTER 1: INTRODUCTION

The light from the Sun is a non-vanishing renewable source of energy which is free from environmental pollution and noise. It can easily compensate the energy drawn from the non -renewable source of energy such as fossil fuel and petroleum deposits inside the earth[1]. Everyday sun sends out tremendous amount of energy in the form of heat and radiations called solar energy. Solar energy is a limitless source of energy which is available at no cost [2] [3]. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly harvested into solar energy with the use of small and tiny photovoltaic (PV) solar cells [4] [5]. The Sun is assumed as a big spherical gaseous cloud made up of hydrogen and helium atoms. This big spherical gaseous cloud is mainly composed of several hydrogen nuclei combining to form helium energy with the emission of energy from the fusion of the hydrogen nuclei in inner core of the Sun via nuclear fusion [6].

During this process of fusion, four hydrogen atoms combine to form one helium atom with a loss of mass which is radiated as thermal energy [2] [5] - [6]. This radiant energy produced by fusion reactions is free from any pollutant, gases, or other reaction by-product. This is why it is the major driving force of all the clean energy technology, in view of the climatic disturbance caused by the emission of carbon from the fossil fuels deposits. One of the biggest advantages of solar energy is that it is free reachable to common people and available in abundant supply compared to that of the price of various fossil fuels and oils in the past decade [2] - [8].

Solar power generation has been developed as one of the most demanding renewable sources of electricity. It has several advantages compared to other forms of energy like fossils fuels

# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

Project Report

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

**BACHELOR OF SCIENCE**


*Submitted by*

**ALBIN DAVIS** **CCAVSPH017**

**GILSA GEORGE U** **CCAVSPH027**

**JOEPAUL JOHNSON** **CCAVSPH029**

*Under the supervision of*

**Dr. ANJU PAULSON**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**MARCH 2024**

# CERTIFICATE

This is to certify that the project report entitled **"ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"** is a bonafide record of project done by **GILSA GEORGE U**, Reg.No. CCAVSPH027, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

**DR.ANJU PAULSON**

Project guide &

Assistant Professor

Department Of Physics

Christ College (Autonomous),

Irinjalakuda

**MARCH 2024**

# DECLARATION

I, Gilsa George U, hereby declare that the work presented in this report entitled **"ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"** is based on the original work done by me under the guidance of Dr. Anju Paulson, Assistant 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: 17/04/2024

GILSA GEORGE U
REG No: CCAVSPH027

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEGMENT

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.

I am grateful to our principal, **Rev.Dr. JOLLY ANDREWS CMI** for providing us various facilities.

I also express my gratitude to **Dr. SUDHEER SEBASTIAN K**., Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda , for his encouragement and support for the preparation.

I would like to acknowledge the motivation and guidance given by my project adviser**, Dr. ANJU PAULSON**, throughout my project which helped me in the successful completion of this 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 is always with me, and I am always in need of his blessings all my life time.

GILSA GEORGE U

REG No.: CCAVSPH027

# ABSTRACT

UV-Vis spectroscopy serves as a fundamental analytical technique for probing molecular structures and elucidating electronic transitions in a wide range of substances.Coconut oil is a widely used natural product renowned for its versatile applications in food, cosmetics, and pharmaceuticals. Understanding its molecular composition and quality characteristics is crucial for ensuring its efficacy and safety in various applications. UV-Vis spectroscopy emerges as a powerful analytical tool capable of providing valuable insights into the chemical composition and quality attributes of coconut oil.

This project aims to employ UV-Vis spectroscopy to investigate the refractive index, purity, and hence adulterations in coconut oil. Initially, the spectral profile of coconut oil will be analyzed to identify characteristic absorption and transmission bands associated with its major constituents, such as fatty acids, carotenoids, and antioxidants. Subsequently, the project will explore the application of UV-Vis spectroscopy for assessing the quality parameters of coconut oil,by finding refractive index corresponding to various wavelengths.The project's significance lies in its potential to offer a rapid, cost-effective, and non-destructive method for evaluating the quality of coconut oil, thus facilitating its quality control and assurance in industrial settings.

# ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES

# INDEX

# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

## 1. INTRODUCTION

UV-Visible spectroscopy is a powerful technique used to analyse the absorption of light by molecules in the ultraviolet and visible regions of the electromagnetic spectrum. Coconut oil, being a natural product, contains various organic compounds that can exhibit absorption in these regions.

The UV-Visible spectrum of coconut oil will likely show absorption peaks corresponding to the various constituents present in the oil. These could include fatty acids, triglycerides, tocopherols (vitamin E), carotenoids, and other minor components. Coconut oil is a rich source of short and medium-chain saturated fatty acids and account for 70% of these fatty acids and it has a low content of unsaturated fatty acids with a negligible content of both ω-6 and ω-3 polyunsaturated fatty acids

1. **Carotenoids**: Coconut oil may contain carotenoids, which are responsible for the color of the oil. Carotenoids typically absorb in the visible range, giving rise to yellow to orange colors. Thus, you might expect absorption peaks in the visible region, typically between 400-500 nm.
2. **Tocopherols (Vitamin E)**: Vitamin E compounds are antioxidants found in coconut oil. They can absorb light in the UV region, with peaks typically observed around 280-290 nm.
3. **Fatty Acids and Triglycerides**: These compounds might exhibit absorption in both the UV and visible regions, depending on their chemical structures. Peaks might appear at various wavelengths depending on the specific fatty acids present and their degree of unsaturation.

# NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER

Project report submitted by

**ANNA VARGHESE (REG No.: CCAVSPH021)**

**EV VISHNUPRIYA (REG No.: CCAVSPH026)**

**ALINA NA (REG No.:CCAVSPH036)**

**HEMANTH SURESH (REG No.: CCAVSPH028)**

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Supervising Guide

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**CALICUT UNIVERSITY**

**2024**

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**Dr. SUDHEER SEBASTIAN K.**
Professor
Head of Department of Physics
Christ College (Autonomous)
Irinjalakuda

Place: Irinjalakuda
Date: 17/04/2024

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# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

Project Report

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

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*Submitted by*

**ALBIN DAVIS** **CCAVSPH017**

**GILSA GEORGE U** **CCAVSPH027**

**JOEPAUL JOHNSON** **CCAVSPH029**

*Under the supervision of*

**Dr. ANJU PAULSON**

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

**MARCH 2024**

# CERTIFICATE

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**DR.ANJU PAULSON**

Project guide &

Assistant Professor

Department Of Physics

Christ College (Autonomous),

Irinjalakuda

**MARCH 2024**

# DECLARATION

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Place: Irinjalakuda
Date: 17/04/2024

GILSA GEORGE U
REG No: CCAVSPH027

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEGMENT

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.

I am grateful to our principal, **Rev.Dr. JOLLY ANDREWS CMI** for providing us various facilities.

I also express my gratitude to **Dr. SUDHEER SEBASTIAN K**., Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda , for his encouragement and support for the preparation.

I would like to acknowledge the motivation and guidance given by my project adviser**, Dr. ANJU PAULSON**, throughout my project which helped me in the successful completion of this 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 is always with me, and I am always in need of his blessings all my life time.

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REG No.: CCAVSPH027

# ABSTRACT

UV-Vis spectroscopy serves as a fundamental analytical technique for probing molecular structures and elucidating electronic transitions in a wide range of substances.Coconut oil is a widely used natural product renowned for its versatile applications in food, cosmetics, and pharmaceuticals. Understanding its molecular composition and quality characteristics is crucial for ensuring its efficacy and safety in various applications. UV-Vis spectroscopy emerges as a powerful analytical tool capable of providing valuable insights into the chemical composition and quality attributes of coconut oil.

This project aims to employ UV-Vis spectroscopy to investigate the refractive index, purity, and hence adulterations in coconut oil. Initially, the spectral profile of coconut oil will be analyzed to identify characteristic absorption and transmission bands associated with its major constituents, such as fatty acids, carotenoids, and antioxidants. Subsequently, the project will explore the application of UV-Vis spectroscopy for assessing the quality parameters of coconut oil,by finding refractive index corresponding to various wavelengths.The project's significance lies in its potential to offer a rapid, cost-effective, and non-destructive method for evaluating the quality of coconut oil, thus facilitating its quality control and assurance in industrial settings.

# ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES

# INDEX

# "ANALYSIS AND STUDY OF COCONUT OIL USING UV-VISIBLE SPECTROPHOTOMETER AND DETERMINATION OF THEIR REFRACTIVE INDICES"

## 1. INTRODUCTION

UV-Visible spectroscopy is a powerful technique used to analyse the absorption of light by molecules in the ultraviolet and visible regions of the electromagnetic spectrum. Coconut oil, being a natural product, contains various organic compounds that can exhibit absorption in these regions.

The UV-Visible spectrum of coconut oil will likely show absorption peaks corresponding to the various constituents present in the oil. These could include fatty acids, triglycerides, tocopherols (vitamin E), carotenoids, and other minor components. Coconut oil is a rich source of short and medium-chain saturated fatty acids and account for 70% of these fatty acids and it has a low content of unsaturated fatty acids with a negligible content of both ω-6 and ω-3 polyunsaturated fatty acids

1. **Carotenoids**: Coconut oil may contain carotenoids, which are responsible for the color of the oil. Carotenoids typically absorb in the visible range, giving rise to yellow to orange colors. Thus, you might expect absorption peaks in the visible region, typically between 400-500 nm.
2. **Tocopherols (Vitamin E)**: Vitamin E compounds are antioxidants found in coconut oil. They can absorb light in the UV region, with peaks typically observed around 280-290 nm.
3. **Fatty Acids and Triglycerides**: These compounds might exhibit absorption in both the UV and visible regions, depending on their chemical structures. Peaks might appear at various wavelengths depending on the specific fatty acids present and their degree of unsaturation.

# Unraveling Asteroid Trajectories: Insights from Many Body Systems

A Project report submitted to

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA**

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

**BACHELOR OF SCIENCE IN PHYSICS**


Submitted by

**MALAVIKA A P - CCAVSPH038**

**MILAN PRASAD - CCAVSPH009**

**ANET RANS SUNNY - CCAVSPH018**

**SALEEL SAHU - CCAVSPH035**

**JOSEPH JOY K - CCAVSPH030**

Under the supervision of

**Dr. Ajith R**




Department of Physics

Christ College (Autonomous), Irinjalakuda

CALICUT UNIVERSITY


**APRIL 2024**

**CERTIFICATE**

This is to certify that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is the bonafide work done by MALAVIKA A P (CCAVSPH038), MILAN PRASAD (CCAVSPH009), ANET RANS SUNNY (CCAVSPH018), SALEEL SAHU (CCAVSPH035), JOSEPH JOY K (CCAVSPH030) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE IN PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Place: Irinjalakuda
Date:17/04/2024

**D. Ajith R**
Project Guide
Department of Physics
Christ College(Autonomous),
Irinjalakuda.

## DECLARATION

**MALAVIKA A P(CCAVSPH038), MILAN PRASAD(CCAVSPH009), ANET RANS SUNNY(CCAVSPH018), SALEEL SAHU(CCAVSPH035), JOSEPH JOY K(CCAVSPH030)** hereby declare that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is a record of independent and bonafide project work carried out by us under the supervision and guidance of Dr. Ajith R, Department of Physics, Christ College Irinjalakuda.

The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

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## ABSTRACT

In physics, the n-body problem is the problem of predicting the individual motions of a group of celestial objects interacting with each other gravitationally. Solving this problem has been motivated by the desire to understand the motions of the Sun, Moon, planets. In this project we explore the behaviour of the many-body system by comparing it with two-body system. We will analyse the two-body system containing sun and asteroid and many- body system containing sun , asteroid and other planets in the solar system. The chaotic behaviour of the many-body system is investigated by analysing the deviation in the trajectory of the asteroid under the influence of other planets and aims to quantify the many-body effect through simple mathematical techniques and python tool. We also analyse the law of conservation of energy , the fundamental principle in classical mechanics in many body system which is useful in predicting the long term behaviour of the system . Overall study emphasizes on the importance of N-body simulations and how it enables to predict the deviations that arise due to many-body effect which can be effectively used in planning space explorations accordingly.

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# List of Figures

# Chapter 1

# Introduction

## 1.1 Introduction

In this project , we explore the dynamics of many body system and tries to quantify the many body effect using numerical method and analytical methods.The Two Body Problem is important because it is a fundamental problem in classical mechanics. It refers to the problem of predicting the motion of two celestial bodies that are gravitationally interacting with each other, such as a planet and its moon or two stars orbiting each other.It also serves as a foundation for more complex problems involving multiple bodies.Generally two body problem can be solved using mathematical equations derived from Newton's laws of motion and his law of universal gravitation. These equations can be solved using various techniques, such as numerical methods or analytical methods like Kepler's laws.The fundamental issue with the two-body problem arises from its complexity despite its apparent simplicity. While Newton's laws allow us to accurately describe the motion of two bodies under the influence of gravity, finding exact analytical solutions for their motion is only possible in a limited number of cases, such as when the bodies have circular or elliptical orbits. In most situations, especially when dealing with non-circular orbits or non-point masses, the equations governing the motion become highly nonlinear and difficult to solve analytically. This complexity makes it challenging to predict the long-term behavior of the system accurately.As celestial mechanics advanced, many systems in the universe involve more than two bodies interacting gravitationally. This realization gave rise to the concept of the many-body problem. In a many-body problem, the gravitational interactions between three or more bodies must be considered simultaneously.The many-body problem is notoriously more complex than the two-body problem. Unlike the two-body problem, where certain simplifications can sometimes yield exact solutions, the many-body problem rarely offers such straightforward solutions. The gravitational interactions between multiple bodies create a highly nonlinear system of differential equations that are exceedingly difficult to solve analytically.In this project , we study the many body problem of an asteroid under the influence of planets in the solar system. In this system, anomalous change in the center of mass of the system , leading to intricate and chaotic

# XRD ANALYSIS OF COPPER

PROJECT REPORT SUBMITTED TO

**DEPARTMENT OF PHYSICS CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA**

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

## BACHELOR OF SCIENCE IN PHYSICS

SUBMITTED BY


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UNDER THE SUPERVISION OF


**MS. IRENE JOY V**

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FEBRUARY 2024

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An analytical method for examining physical attributes is called X-ray diffraction, or XRD. You may get in-depth details on the chemical makeup, crystallographic structure, and other characteristics. The XRD method's basic idea is that when X-rays hit a surface, it interacts with the electron cloud around the nucleus, causing dispersion of the radiation.

Here, we make use of XRD to determine certain parameters of copper in its powdered form.

## 1.1: Copper

Copper (atomic number 29) is a natural occurring metal found in rocks, soil, water, etc. It is a soft, malleable, and ductile metal with very high thermal and electrical conductivity. Copper is considered a crucial element for both plants and animals, as it one of the essential micronutrients, and is absorbed through the soil by plants, and through food by animals.

Copper is one of the few metals that can occur in nature in a directly usable metallic form (native metals). This led to very early human use in several regions, from c. 8000 BC. Thousands of years later, it was the first metal to be smelted from sulfide ores, c. 5000 BC; the first metal to be cast into a shape in a mold, c. 4000 BC; and the first metal to be purposely alloyed with another metal, tin, to create bronze, c. 3500 BC.

Common copper compounds are copper (II) salts, which have long been used as pigments and frequently provide minerals like azurite, malachite, and turquoise blue or green hues.

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CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA



FEBRUARY 2024

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Common copper compounds are copper (II) salts, which have long been used as pigments and frequently provide minerals like azurite, malachite, and turquoise blue or green hues.

# YOUNGS MODULUS MEASUREMENT USING LASER

Project report submitted to

## CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

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

## BACHELOR OF PHYSICS

Submitted by


**CHRIS SABU**

**CHERIE JOBY ACHANDY**

**PARVATHY GIREESH**

**ABHISHEK M KUMAR**

**AQUEENA ROSE SHAJU**

**CCAVSPH022**

DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

UNIVERSITY OF CALICUT

MARCH 2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CALICUT UNIVERSITY

# DEPARTMENT OF PHYSICS CERTIFICATE

This is to certify that the project report entitled "**YOUNGS MODULUS MEASUREMENT USING LASER** " is a bonafide record of project done by **AQUEENA ROSE SHAJU**, **CCAVSPH022** , under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Head Of The Department

Dr. Sudheer Sebastian K

PROJECT GUIDE

Dr. XAVIER JOSEPH

# DECLARATION

I, AQUEENA ROSE SHAJU, hereby declare that the project work entitled “YOUNGS MODULUS MEASUREMENT USING LASER” is a record of independent and bonafide project work carried out by me under the supervision and guidance of Dr. XAVIER JOSEPH, Associate Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda

Date:

AQUEENA ROSE SHAJU

CCAVSPH022

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

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Place: Irinjalakuda AQUEENA ROSE SHAJU

Date:

# TABLE OF CONTENT

# CHAPTER 1

## STRESS

When the deforming force is applied to an object, the object deforms. In order to bring the object back to its original shape and size, there will be an opposing force generated inside the object. This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress. Thus, Stress is defined as "The restoring force per unit area of the material". It is a tensor quantity. Denoted by Greek letter σ. Measured using Pascal or N/m2. Mathematically expressed as

$$\sigma = \frac{F}{A}$$

Where,

F is the restoring force measured in Newton or N.

A is the area of cross-section measured in m2. σ

is the stress measured using N/m2 or Pa

## STRAIN

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The following equation gives the relation for deformation in terms of the length of a solid:

$$\varepsilon = \frac{\delta L}{L}$$

where ε is the strain due to the stress applied, δl

is the change in length and

L is the original length of the material.

The strain is a dimensionless quantity as it just defines the relative change in shape.

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**D. Ajith R**
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# List of Figures

# Chapter 1

# Introduction

## 1.1 Introduction

In this project , we explore the dynamics of many body system and tries to quantify the many body effect using numerical method and analytical methods.The Two Body Problem is important because it is a fundamental problem in classical mechanics. It refers to the problem of predicting the motion of two celestial bodies that are gravitationally interacting with each other, such as a planet and its moon or two stars orbiting each other.It also serves as a foundation for more complex problems involving multiple bodies.Generally two body problem can be solved using mathematical equations derived from Newton's laws of motion and his law of universal gravitation. These equations can be solved using various techniques, such as numerical methods or analytical methods like Kepler's laws.The fundamental issue with the two-body problem arises from its complexity despite its apparent simplicity. While Newton's laws allow us to accurately describe the motion of two bodies under the influence of gravity, finding exact analytical solutions for their motion is only possible in a limited number of cases, such as when the bodies have circular or elliptical orbits. In most situations, especially when dealing with non-circular orbits or non-point masses, the equations governing the motion become highly nonlinear and difficult to solve analytically. This complexity makes it challenging to predict the long-term behavior of the system accurately.As celestial mechanics advanced, many systems in the universe involve more than two bodies interacting gravitationally. This realization gave rise to the concept of the many-body problem. In a many-body problem, the gravitational interactions between three or more bodies must be considered simultaneously.The many-body problem is notoriously more complex than the two-body problem. Unlike the two-body problem, where certain simplifications can sometimes yield exact solutions, the many-body problem rarely offers such straightforward solutions. The gravitational interactions between multiple bodies create a highly nonlinear system of differential equations that are exceedingly difficult to solve analytically.In this project , we study the many body problem of an asteroid under the influence of planets in the solar system. In this system, anomalous change in the center of mass of the system , leading to intricate and chaotic

# NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER

Project report submitted by

**ANNA VARGHESE (REG No.: CCAVSPH021)**

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**HEMANTH SURESH (REG No.: CCAVSPH028)**

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for the award of the degree of

**BACHELOR OF SCIENCE IN PHYSICS**


Supervising Guide

**Dr. Sudheer Sebastian K.**

Professor, Department of Physics

Christ College (Autonomous), Irinjalakuda

**CALICUT UNIVERSITY**

**2024**

# CERTIFICATE

This is to certify that the project work entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHENE OXIDE AS HOLE TRANSPORT LAYER"** is a bona fide work done by **Ms. ANNA VARGHESE, Ms. EV VISHNUPRIYA, Ms. ALINA NA, Mr. HEMANTH SURESH & Mr. AMALDEV CA** Department of Physics, Christ College (Autonomous) Irinjalakuda in partial fulfilment of the requirements for the award of Degree of Bachelor of Science in Physics under the University of Calicut.

**Dr. SUDHEER SEBASTIAN K.**
Professor
Head of Department of Physics
Christ College (Autonomous)
Irinjalakuda

Place: Irinjalakuda
Date: 17/04/2024

# DECLARATION

We hereby declare that the work presented in this report entitled **"NUMERICAL SIMULATION STUDY OF INVERTED BILAYER PEROVSKITE SOLAR CELL WITH GRAPHINE OXIDE AS HOLE TRANSPORT LAYER"** is based on the original work done by me under the guidance of Dr. Sudheer Sebastian K., Professor, Head of 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: 17/04/2024

# ACKNOWLEDGEMENTS

We take this opportunity to express our deep sense of gratitude and extend our thanks to all the people who have inspired and motivated us during our course and project.

Firstly, We would like to acknowledge the motivation and guidance given by our project adviser, **Dr. SUDHEER SEBASTIAN K.**, Professor, Head of the Dept. of Physics, Christ College (Autonomous) Irinjalakuda, throughout our project.

Our special word of thanks to **Ms. Denet Rose 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.

We are thankful to all our classmates, teaching and non-teaching staff of the Dept. of Physics. We are indebted to our family for their constant source of inspiration.

We thank God, Almighty, Who is always with us, and we are always in need of his blessings all our life time.

# ABSTRACT

Numerical simulation study of $MAPbI_3/FA_{0.5}MA_{0.5}Pb_{0.5}Sn_{0.5}I_3$ based bilayer inverted perovskite solar cell is done in this work. The enhancement of device performance also depends on the electron transport layer and hole transport layer. As an effective hole transport layer, PEDOT:PSS is widely utilized due to its favourable electrical conductivity, transparency, and film-forming characteristics. Its efficient hole transportation capability significantly contributes to the overall improvement of organic electronic devices. However, it is important to note that PEDOT:PSS does have some drawbacks, such as its acidic nature and hygroscopicity, which can result in the degradation of solar cells. Graphene oxide is a good replacement for PEDOT:PSS due to its extraordinary electrical properties. In this work we introduce graphene oxide as hole transport layer instead of PEDOT:PSS and extensive simulation study is carried out.

Keywords: bilayer inverted perovskite solar cell, hole transport layer, graphene oxide, simulation study

# CONTENTS

# CHAPTER 1: INTRODUCTION

The light from the Sun is a non-vanishing renewable source of energy which is free from environmental pollution and noise. It can easily compensate the energy drawn from the non -renewable source of energy such as fossil fuel and petroleum deposits inside the earth[1]. Everyday sun sends out tremendous amount of energy in the form of heat and radiations called solar energy. Solar energy is a limitless source of energy which is available at no cost [2] [3]. The major benefit of solar energy over other conventional power generators is that the sunlight can be directly harvested into solar energy with the use of small and tiny photovoltaic (PV) solar cells [4] [5]. The Sun is assumed as a big spherical gaseous cloud made up of hydrogen and helium atoms. This big spherical gaseous cloud is mainly composed of several hydrogen nuclei combining to form helium energy with the emission of energy from the fusion of the hydrogen nuclei in inner core of the Sun via nuclear fusion [6].

During this process of fusion, four hydrogen atoms combine to form one helium atom with a loss of mass which is radiated as thermal energy [2] [5] - [6]. This radiant energy produced by fusion reactions is free from any pollutant, gases, or other reaction by-product. This is why it is the major driving force of all the clean energy technology, in view of the climatic disturbance caused by the emission of carbon from the fossil fuels deposits. One of the biggest advantages of solar energy is that it is free reachable to common people and available in abundant supply compared to that of the price of various fossil fuels and oils in the past decade [2] - [8].

Solar power generation has been developed as one of the most demanding renewable sources of electricity. It has several advantages compared to other forms of energy like fossils fuels

# YOUNGS MODULUS MEASUREMENT USING LASER

Project report submitted to

## CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

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

## BACHELOR OF PHYSICS

Submitted by


**CHRIS SABU**

**CHERIE JOBY ACHANDY**

**PARVATHY GIREESH**

**ABHISHEK M KUMAR**

**AQUEENA ROSE SHAJU**

**CCAVSPH022**

DEPARTMENT OF PHYSICS

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

UNIVERSITY OF CALICUT

MARCH 2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CALICUT UNIVERSITY

# DEPARTMENT OF PHYSICS CERTIFICATE

This is to certify that the project report entitled "**YOUNGS MODULUS MEASUREMENT USING LASER** " is a bonafide record of project done by **AQUEENA ROSE SHAJU**, **CCAVSPH022** , under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Head Of The Department

Dr. Sudheer Sebastian K

PROJECT GUIDE

Dr. XAVIER JOSEPH

# DECLARATION

I, AQUEENA ROSE SHAJU, hereby declare that the project work entitled “YOUNGS MODULUS MEASUREMENT USING LASER” is a record of independent and bonafide project work carried out by me under the supervision and guidance of Dr. XAVIER JOSEPH, Associate Professor, Department of Physics, Christ College (Autonomous), Irinjalakuda. The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

Place: Irinjalakuda

Date:

AQUEENA ROSE SHAJU

CCAVSPH022

Submitted for the examination held on_____

INTERNAL EXAMINER

EXTERNAL EXAMINER

# ACKNOWLEDGEMENT

Iam grateful to our principal, Rev. Fr. Dr. Jolly Andrews CMI for providing us with various facilities. I also express my gratitude to Dr Sudheer Sebastian K , Head of the Department, for his encouragement and support for the preparation. I express my gratitude to Dr Xavier Joseph, Associate Professor, whose guidance and support throughout the period helped me to complete this work successfully. I am also thankful to all the faculties of the department and lab assistants for their interest and cooperation. I extend my gratitude to the librarian and other library staffs of my college for their wholehearted cooperation. I express my sincere thanks to my friends and family for their support in accomplishing this project.

Place: Irinjalakuda AQUEENA ROSE SHAJU

Date:

# TABLE OF CONTENT

# CHAPTER 1

## STRESS

When the deforming force is applied to an object, the object deforms. In order to bring the object back to its original shape and size, there will be an opposing force generated inside the object. This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress. Thus, Stress is defined as "The restoring force per unit area of the material". It is a tensor quantity. Denoted by Greek letter σ. Measured using Pascal or N/m2. Mathematically expressed as

$$\sigma = \frac{F}{A}$$

Where,

F is the restoring force measured in Newton or N.

A is the area of cross-section measured in m2. σ

is the stress measured using N/m2 or Pa

## STRAIN

Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The following equation gives the relation for deformation in terms of the length of a solid:

$$\varepsilon = \frac{\delta L}{L}$$

where ε is the strain due to the stress applied, δl

is the change in length and

L is the original length of the material.

The strain is a dimensionless quantity as it just defines the relative change in shape.

# Unraveling Asteroid Trajectories: Insights from Many Body Systems

A Project report submitted to

**DEPARTMENT OF PHYSICS**

**CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA**

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

**BACHELOR OF SCIENCE IN PHYSICS**


Submitted by

**MALAVIKA A P - CCAVSPH038**

**MILAN PRASAD - CCAVSPH009**

**ANET RANS SUNNY - CCAVSPH018**

**SALEEL SAHU - CCAVSPH035**

**JOSEPH JOY K - CCAVSPH030**

Under the supervision of

**Dr. Ajith R**




Department of Physics

Christ College (Autonomous), Irinjalakuda

CALICUT UNIVERSITY


**APRIL 2024**

**CERTIFICATE**

This is to certify that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is the bonafide work done by MALAVIKA A P (CCAVSPH038), MILAN PRASAD (CCAVSPH009), ANET RANS SUNNY (CCAVSPH018), SALEEL SAHU (CCAVSPH035), JOSEPH JOY K (CCAVSPH030) under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF SCIENCE IN PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Place: Irinjalakuda
Date:17/04/2024

**D. Ajith R**
Project Guide
Department of Physics
Christ College(Autonomous),
Irinjalakuda.

## DECLARATION

**MALAVIKA A P(CCAVSPH038), MILAN PRASAD(CCAVSPH009), ANET RANS SUNNY(CCAVSPH018), SALEEL SAHU(CCAVSPH035), JOSEPH JOY K(CCAVSPH030)** hereby declare that the project entitled **Unraveling Asteroid Trajectories: Insights from Many Body Systems** is a record of independent and bonafide project work carried out by us under the supervision and guidance of Dr. Ajith R, Department of Physics, Christ College Irinjalakuda.

The information and data given in the report is authentic to the best of our knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar title of any other university or institute.

MALAVIKA A P(CCAVSPH038)
MILAN PRASAD(CCAVSPH009)
ANET RANS SUNNY(CCAVSPH018)
SALEEL SAHU(CCAVSPH035)
JOSEPH JOY K(CCAVSPH030)

Place: Irinjalakuda
Date:17/04/2024

## ACKNOWLEDGEMENT

We express our sincere gratitude to our project guide Dr. AJITH R who helped us in this endeavour, his constant guidance and willingness to share his vast knowledge made us understand this project and its manifestations in great depths and helped us to complete the assigned tasks on time. Without his help, co-operation, guidance and encouragement the project could not have been what it evolved to be.

We are thankful to Dr. SUDHEER SEBASTIAN, Head of Department, for providing proper help and encouragement in the preparation of this report.

We would like to express our sincere obligation to Principal Dr. JOLLY ANDREWS CMI for his support and advice.

We would like to express our gratitude to all the faculties of the department for their interest and co-operation in this regard.

We extend our heartfelt gratitude to the librarian and other library staff of our college for their wholehearted co-operation.

We express our sincere thanks to our friends and family for their support in completing this report successfully.

This project has been a result of many people's hard-work and we acknowledge that and thank them with all our heart.

## ABSTRACT

In physics, the n-body problem is the problem of predicting the individual motions of a group of celestial objects interacting with each other gravitationally. Solving this problem has been motivated by the desire to understand the motions of the Sun, Moon, planets. In this project we explore the behaviour of the many-body system by comparing it with two-body system. We will analyse the two-body system containing sun and asteroid and many- body system containing sun , asteroid and other planets in the solar system. The chaotic behaviour of the many-body system is investigated by analysing the deviation in the trajectory of the asteroid under the influence of other planets and aims to quantify the many-body effect through simple mathematical techniques and python tool. We also analyse the law of conservation of energy , the fundamental principle in classical mechanics in many body system which is useful in predicting the long term behaviour of the system . Overall study emphasizes on the importance of N-body simulations and how it enables to predict the deviations that arise due to many-body effect which can be effectively used in planning space explorations accordingly.

# Contents

# List of Figures

# Chapter 1

# Introduction

## 1.1 Introduction

In this project , we explore the dynamics of many body system and tries to quantify the many body effect using numerical method and analytical methods.The Two Body Problem is important because it is a fundamental problem in classical mechanics. It refers to the problem of predicting the motion of two celestial bodies that are gravitationally interacting with each other, such as a planet and its moon or two stars orbiting each other.It also serves as a foundation for more complex problems involving multiple bodies.Generally two body problem can be solved using mathematical equations derived from Newton's laws of motion and his law of universal gravitation. These equations can be solved using various techniques, such as numerical methods or analytical methods like Kepler's laws.The fundamental issue with the two-body problem arises from its complexity despite its apparent simplicity. While Newton's laws allow us to accurately describe the motion of two bodies under the influence of gravity, finding exact analytical solutions for their motion is only possible in a limited number of cases, such as when the bodies have circular or elliptical orbits. In most situations, especially when dealing with non-circular orbits or non-point masses, the equations governing the motion become highly nonlinear and difficult to solve analytically. This complexity makes it challenging to predict the long-term behavior of the system accurately.As celestial mechanics advanced, many systems in the universe involve more than two bodies interacting gravitationally. This realization gave rise to the concept of the many-body problem. In a many-body problem, the gravitational interactions between three or more bodies must be considered simultaneously.The many-body problem is notoriously more complex than the two-body problem. Unlike the two-body problem, where certain simplifications can sometimes yield exact solutions, the many-body problem rarely offers such straightforward solutions. The gravitational interactions between multiple bodies create a highly nonlinear system of differential equations that are exceedingly difficult to solve analytically.In this project , we study the many body problem of an asteroid under the influence of planets in the solar system. In this system, anomalous change in the center of mass of the system , leading to intricate and chaotic

# “VERIFYING EXPANSION OF UNIVERSE USING HUBBLE’S DIAGRAM”

Project Report submitted to

## DEPARTMENT OF PHYSICS CHRIST COLLEGE

## (AUTONOMOUS) IRINJALAKUDA

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

**BACHELOR OF SCIENCE IN PHYSICS**

Submitted by


**AUSTIN FRANSIC**

**JERIN C JOHNSON**

**SHELTON STANLEY**

**SNEHA STEPHAN**

**SIVANANDANA A S**


Under the supervision of

**Dr. EDWIN JOSE**

**ASSISTANT PROFESSOR**

# DEPARTMENT OF PHYSICS

# CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

# APRIL 2024

# DECLARATION

I **SIVANANDANA A S,** hereby declare that the project work entitled **"Expansion of Universe using Hubble's Diagram"** is recorded of independent and bona fide project work carried out by Me under the supervision and guidance of Mr. Edwin Jose, Asst. Professor, Department of Physics, Christ College Autonomous Irinjalakuda.

The information and data given in the report is authentic to the best of my knowledge. The report has not been previously submitted for the award of any Degree, Diploma, Associateship or other similar tile of any other university or institute

Place: IRINJALAKUDA SIVANANDANA A S

Date: 17-04-2024 CCAVSPH039

Submitted for the examination held on:

Internal Examiner: External Examiner:

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# IRINJALAKUDA

# UNIVERSITY OF CALICUT


## CERTIFICATE

This is to certify that the project report entitled "**EXPANSION OF UNIVERSE USING HUBBLES' DIAGRAM**" is a bona fide record of project done by SIVANANDANA A S , Reg. No. CCAVSPH039, under my guidance and supervision in partial fulfilment of the requirement for the award of the degree of BACHELOR OF PHYSICS and it has not previously formed the basis for any Degree, Diploma and Associateship or Fellowship.

Dr. Edwin Jose

Project Guide

# ACKNOWLEDGEMENT

I would like to take the opportunity to express my preferred thanks and gratitude to all people who have helped me with sound advice and able guidance

Above all, I express my eternal gratitude to lord almighty under whose divine guidance; I have been able to complete this work successfully.

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Place: IRINJALAKUDA SIVANANDANA A S

Date:17-04-2024

# VERIFYING EXPANSION OF UNIVERSE USING HUBBLE'S LAW

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# CHAPTER – 3

## PLOTTING AND ANLYSIS



# CHAPTER – 4

# CHAPTER 1
# INTRODUCTION

## *1.1 - EXPANSION OF UNIVERSE*

The universe, an enigmatic expanse of space-time and matter, has a history as intricate and compelling as any epic saga. At the heart of this cosmic narrative lies the phenomenon of universe expansion—a concept that has transformed our understanding of existence itself. From the primordial singularity to the accelerating cosmos of today, the history of universe expansion unveils a mesmerizing tale of cosmic evolution, punctuated by pivotal moments of discovery and revelation.

The General Theory of Relativity, formulated by Albert Einstein in 1915, fundamentally altered our understanding of gravity and the nature of spacetime. In this theory, spacetime is not just a backdrop for the events of the universe but an active participant in them. It's a four-dimensional continuum where the three dimensions of space

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**SNEHA STEPHAN**

**SIVANANDANA A S**


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**ASSISTANT PROFESSOR**

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