

## REYES MENTORSHIP PROGRAM

Summer 2023

### Mentor Project Description

#### **Overview:**

The purpose of the REYES mentorship program is to match highly motivated students with experts to work together for a summer project. The project would cover an expanse of 4-8 weeks and would be done remotely. Students will be matched with the mentors based on their academic level and their area of interest.

**Start Date:** June 26, 2023

**Duration:** 4-8 weeks

**Location:** Works remotely with the ability to meet the mentor once a week via Zoom, Skype, or suggested platform by the mentor.

The projects offered in summer 2023 and the details of the mentors are provided below:

#### **Project 1 Title: *Cancer Stem Cells and Exosomes - Potential biomarker in cancer detection***

**Mentor:** Amrita Tiwari

**Mentor's Institution(s):** Cambridge Court World School

**Desired outcome of project:** Literature Review

**Suitable Mentees:** Undergraduate and graduate students

**Duration of the project:** 4-6 weeks

**Project Description:** The project includes the study of cancer stem cells - exosomes as potential biomarkers in the detection of various cancer. How this CSC-exo plays a crucial role in the interaction between CSCs and their microenvironment. We will also discuss the signal transduction pathways followed in various cancers and the role of specific cancer stem cell exosomes in tumor heterogeneity and in formulating tumor-specific immunotherapy.

#### **Project 2 Title: *Chiral symmetry of QCD and effective chiral Lagrangians***

**Mentor:** Akaki Rusetsky

**Mentor's Institution(s):** HISKP, University ob Bonn

**Desired outcome of project:** Literature Review

**Suitable Mentees:** Undergraduate students and Graduate Students

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**Duration of the project:** 6- 8 weeks

**Project Description:** Chiral symmetry of QCD is a consequence of the fact that light quark masses are much smaller than the hadronic scale related to the QCD mass gap. We shall consider (partially) conserved currents, related to this symmetry, and derive a set of Ward identities for the Green functions of composite operators. We shall further consider the realization of chiral symmetry on hadronic fields and derive effective Lagrangians that lead to the same tower of Ward identities. The issues of power counting and renormalization will be addressed.

**Project 3 Title: *Nuclear Mentoring Project***

**Mentor:** Raúl Briceño, Andrew Jackura, Vincent Mathieu, Dimitra Pefkou, Wyatt Smith

**Mentor's Institution(s):** University of California Berkeley, Lawrence Berkeley National Lab, Indiana University, University of Barcelona, MIT

**Desired outcome of project:** Literature Review, Job Shadowing

**Suitable Mentees:** High School and Undergraduate students

**Duration of the project:** 8 weeks

**Project Description:** Want to learn some of the basics in nuclear physics? Who better to learn from than a friendly group of experts from all around the globe?

**Project 4 Title: *Hadronic Physics***

**Mentor:** Sergi Gonzalez-Solis

**Mentor's Institution(s):** Los Alamos National Laboratory

**Desired outcome of project:** Literature Review, Original Research

**Suitable Mentees:** High School, Undergraduate and Graduate students

**Duration of the project:** 6-8 weeks

**Project Description:** At the middle and high school level, the mentees will learn basic concepts of nuclear and particle physics, from the Rutherford experiment to the quark model. Topics of strong interactions will be covered at undergraduate and graduate level, including basic properties of QCD such as confinement and asymptotic freedom as well as concepts of chiral symmetry, the Goldstone's theorem and the effective Lagrangian. We will read and analyze research papers with students and think about potential fruitful areas of research. Also, projects will be proposed, which can generate longer-term collaborations between students embarking on a research career and mentors.

**Project 5 Title: *Exotic hadrons in particle physics experiments***

**Mentor:** Fernando Romero-López

**Mentor's Institution(s):** MIT

**Desired outcome of project:** Literature Review

**Suitable Mentees:** High School, Undergraduate

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**Duration of the project:** 4-6 weeks

**Project Description:** Several new hadrons have been discovered in the last few years in particle physics experiments such as the Large Hadron Collider. The goal of this project is to do literature review, and identify those hadrons, their properties and what makes them receive the name of exotics.

**Project 6 Title:** *Exploring Frontiers in Cosmology, Collider Physics, and Nuclear Science*

**Mentor:** Sokratis Trifinopoulos

**Mentor's Institution(s):** MIT

**Desired outcome of project:** Original Research

**Suitable Mentees:** Graduate students

**Duration of the project:** More than 8 weeks [beyond REYES program]

**Project Description:** The student may choose a topic from cosmology (axion clusters and their impact on LSS, further study of the axion model), collider physics (BSM at the Muon Collider), ML and nuclear physics (explore possibilities for the NuCLR).

**Project 7 Title:** *Review of CP-violation in atoms and molecules*

**Mentor:** Matt Grau

**Mentor's Institution(s):** Old Dominion University

**Desired outcome of project:** Literature Review, Job shadowing

**Suitable Mentees:** Undergraduates, Graduate Students

**Duration of the project:** 6 - 8 weeks

**Project Description:** In the field of AMO precision measurement we use different atoms and molecules as sensitive probes of new types of CP violation. These measurements can test for new physics with a reach competitive with or even exceeding the capabilities of the LHC. Each proposed atom or molecule experiment has a unique sensitivity, some to CP-violation arising in electrons, and other due to nuclear effects. There is currently no comprehensive review and compilation of the various proposed species, nor a direct comparison of their sensitivity. For this project we will learn how precision measurement experiments can search for new physics, and compile the various current and proposed techniques into a single review.

**Project 8 Title:** *Predict treatment response in breast cancer patients*

**Mentor:** Jiangwen Sun

**Mentor's Institution(s):** Old Dominion University

**Desired outcome of project:** Literature Review, Job shadowing, Original Research

**Suitable Mentees:** Undergraduates, Graduate Students

**Duration of the project:** 6 - 8 weeks

**Project Description:** Breast cancer has become the world's most diagnosed cancer and leads to the most cancer-related death among women. Neoadjuvant chemotherapy is a standard treatment to downstage the tumor before surgical tumor removal. There is large variation in the

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response to this standard treatment among breast cancer patients. Precise prediction of the treatment response helps to optimize the surgery strategy for individual patients. In this project, we will attempt to develop machine learning models that predict patient treatment response from data of diverse modalities, including clinical information, medical images, and pathology slides.

**Project 9 Title: *Promoting Ethical and Robust Cybersecurity Strategizing Measures in Organizations***

**Mentor:** Angelina Boatright

**Mentor's Institution(s):** Old Dominion University

**Desired outcome of project:** Original Research

**Suitable Mentees:** High School, Undergraduates Students

**Duration of the project:** 4-6 weeks

**Project Description:** Establishing methods of monitoring cybersecurity needs based on individual models, utilizing personality characteristics to leverage cybersecurity support.

**Project 10 Title: *Ecological and Evolutionary Drivers of Cooperative Breeding***

**Mentor:** Chi Wei

**Mentor's Institution(s):** Old Dominion University

**Desired outcome of project:** Original Research, Literature Review

**Suitable Mentees:** Undergraduates and Graduate Students

**Duration of the project:** 6-8 weeks

**Project Description:** This project will explore the ecological and evolutionary factors that influence the occurrence and persistence of cooperative breeding in birds, with a specific focus on community assembly processes. Cooperative breeding refers to a social system where individuals other than the parents assist in raising offspring. Community assembly theory, on the other hand, focuses on understanding how ecological and evolutionary processes shape the structure and composition of species assemblages within communities. By integrating these two perspectives, we seek to uncover the ecological and evolutionary mechanisms that underlie the occurrence and maintenance of cooperative breeding strategies in bird communities.

**Project 11 Title: *X-ray powder and single crystal diffraction fundamentals***

**Mentor:** Silvina Pagola

**Mentor's Institution(s):** Old Dominion University

**Desired outcome of project:** Literature Review

**Suitable Mentees:** High School, Undergraduates and Graduate Students

**Duration of the project:** 4-6 weeks

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**Project Description:** This project focuses on a literature search, which may involve not only peer-reviewed journal publications and books, but also instructional materials available on the Internet, which are written and presented at an instructional level understandable by high-school and college students in STEM fields.

X-ray powder and single crystal diffraction techniques are scarcely taught in the undergraduate curriculum of two- and four-year colleges and universities in the USA. Most chemistry and biochemistry, material sciences and physics students would be very much benefited from practicing these methods as undergraduates. The expected project results are a compilation of websites, journal publications, or videos, with the above objective, and a PowerPoint presentation by one or all the participants, in which the results and their newly acquired understanding of the topics investigated is summarized.

**Project 12 Title: *Mathematical modeling of engineering dynamical systems***

**Mentor:** Flavio Cesar Nieto Ruiz

**Mentor's Institution(s):** Instituto Tecnológico de Celaya

**Desired outcome of project:** Original Research

**Suitable Mentees:** Undergraduates Students

**Duration of the project:** 4-6 weeks

**Project Description:** A mathematical interpretation of engineering dynamical systems is presented. Using the state-space representation technique, the mentees will identify the most critical states in a system. Moreover, programming skills will be presented in order to comprehend the system's outputs.

**Project 13 Title: *Analysis of cognitive theories for reasoning for complexity in STEM education;***

**Project 14 Title: *Circular economy in the food industry: An analysis of water treatment and green energy;***

**Project 15 Title: *Circular economy and value chain technological development of green energies***

**Mentor:** Omar Israel Gonzalez Peña

**Mentor's Institution(s):** Tecnológico de Monterrey

**Desired outcome of project:** Original research, Literature review, Shadowing experience

**Suitable Mentees:** Undergraduates Students

**Duration of the project:** More than 8 weeks [beyond REYES program]

**Project Description:** (Project 16) Since employers internationally require professionals with complexity reasoning skills, it is important to analyze the cognitive theories that are associated with this meta-competence. Likewise, we seek to analyze how reasoning for complexity is promoted and measured with validated and reliable instruments in order to correlate them

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with data obtained from exams and academic performance in STEM areas with statistical tools and Artificial Intelligence. (Project 17) An energy analysis of water treatment by advanced oxidation will be carried out, integrating energy saving processes by circular economy involving microbial fuel cells in the food industry.(Project 18) The various Rs associated with the circular economy in industrial processes for the technological development of green energies will be reviewed together with the principles of the value chain. Likewise, equations with a holistic vision of the interconnected processes will be proposed to dimension the relevant factors.

## **Project 16 Title: *Exploring model selection techniques for data analysis***

**Mentor: Michael Doering**

**Mentor's Institution(s): The George Washington University**

**Desired outcome of project: Original Research**

**Suitable Mentees: High School students;Undergraduates Students**

**Duration of the project: 6-8 weeks**

**Project Description:** Initial lectures followed by hands-on experience for max. 2-3 students. After an initial period of a few lectures on statistics, we will turn to the analysis of data using model selection. Application to analysis of photoproduction data.

## **Project 17 Title: *Design and application of evolutionary algorithms***

**Mentor: Diego Oliva**

**Mentor's Institution(s): Universidad de Guadalajara**

**Desired outcome of project: Original research**

**Suitable Mentees: Undergraduate and Graduate Students**

**Duration of the project: 6-8 weeks**

**Project Description:** Design and application of evolutionary algorithms

## **Project 18 Title: *Medical Image Segmentation and Treatment***

**Mentor: Itzel Niasandiu Aranguren Navarro**

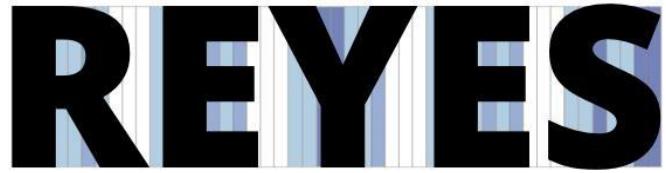
**Mentor's Institution(s): Universidad de Guadalajara**

**Desired outcome of project: Literature Review**

**Suitable Mentees:Middle School students, High School students, Undergraduate students**

**Duration of the project: 4-6 weeks**

**Project Description:** A review of the State of the art on various techniques implemented in the segmentation and treatment of medical images. In terms of artificial vision, optimization, and artificial intelligence.



**Project 19 Title: *Metaheuristic Algorithms and Applications***

**Mentor:** Arturo Valdivia González

**Mentor's Institution(s):** Universidad de Guadalajara

**Desired outcome of project:** Literature Review

**Suitable Mentees:** Undergraduate students

**Duration of the project:** 4-6 weeks

**Project Description:** This Metaheuristic Algorithms and Applications offers an exciting exploration of captivating class topics, including nature-inspired optimization, swarm intelligence, simulated annealing, crow search algorithm, evolutionary algorithms, and hybrid metaheuristics. Students will delve into cutting-edge research, uncovering the power of these techniques in solving complex problems. Join us on this thrilling journey to expand your problem-solving skills and witness the synergy of optimization and computational intelligence.

**Project 20 Title: *Port Tariffs***

**Mentor:** Alejandra Gomez-Padilla

**Mentor's Institution(s):** Universidad de Guadalajara

**Desired outcome of project:** Literature Review

**Suitable Mentees:** Undergraduate students

**Duration of the project:** 6-8 weeks

**Project Description:** Ports charge different tariffs to the shipping companies, and these tariffs may influence the decision of using or not a certain port. The objective is to analyze the elements that are considered to establish the tariffs charged. A comparison should be done of the methodologies to fix tariffs.

**Project 21 Title: *Administration and industry in science and technology***

**Mentor:** Brenda Liliana Aguiñaga Serrano

**Mentor's Institution(s):** Universidad de Guadalajara

**Desired outcome of project:** Original research, Literature review, Shadowing experience

**Suitable Mentees:** Undergraduate students

**Duration of the project:** More than 8 weeks [Beyond REYES program]

**Project Description:** Students will be exposed to techniques of work measurement; method of work; project formulation and evaluation; and optimization method.

**Project 22 Title: *Isochoric preservation for biological samples***

**Mentor:** Abril Adriana Angulo Sherman

**Mentor's Institution(s):** Universidad de Guadalajara

**Desired outcome of project:** Literature review

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**Suitable Mentees:** High School students, Undergraduate students, Graduate Students

**Duration of the project:** 6-8 weeks

**Project Description:** Isochoric preservation is a nivlel techniques that has been considered in recent years as an alternative to other freezing biological samples preservation techniques. The late may potentially apply to either food or tissue cryopreservation. Isochoric preservation is based on water behavior inside an isochoric container during freezing conditions. This project will focus on literature review about the topic to determine the actual state of isochoric preservation.

**Project 23 Title:** *Propose clusters or industrial districts as a pole of regional economic development.*

**Mentor:** Gabriel Salvador Fregoso Jasso

**Mentor's Institution(s):** Universidad de Guadalajara

**Desired outcome of project:** Original Research

**Suitable Mentees:** Undergraduate students, Graduate Students

**Duration of the project:** 4-6 weeks

**Project Description:** The research's main objective is to form specialists to propose clusters or industrial districts as a pole of regional economic development. The study is carried out on business clusters in various industrial sectors. The study involves the small businesses of some regions, which are mostly family businesses. Although it is a regional study, the competitive context is located internationally. The project is designed to ensure that the student is involved in the research, prepares articles for journals, and participates in scientific dissemination forums as a speaker. Where you can share experiences and learn from other research.

**Project 24 Title:** *Internationalization of research & technology*

**Mentor:** María Cruz Cuevas Álvarez

**Mentor's Institution(s):** Universidad Juárez Autónoma de Tabasco

**Desired outcome of project:** Literature Review

**Suitable Mentees:** Undergraduate students, Graduate Students

**Duration of the project:** 6-8 weeks

**Project Description:** Internationalization of the curriculum, Intercultural Competence, Research competences, International collaboration

**Project 25 Title:** *Catchment Rainwater System*

**Mentor:** JUAN LUIS CARO BECERRA

**Mentor's Institution(s):** Universidad Politécnica de la Zona Metropolitana de Guadalajara

**Desired outcome of project:** Shadowing Experience

**Suitable Mentees:** High School Students

**Duration of the project:** 6-8 weeks

**Project Description:** It is recommended that they be smooth materials, such as: galvanized sheet metal, brick slabs to connect with rainwater downspouts, in the case of having a two-water roof, a gutter is recommended for the conduction of water to the cisterns.

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**Project 26 Title: CLIMATE CHANGES PLANS AT UNIVERSITY**

**Mentor: CARLOS MANUEL WELSH-RODRIGUEZ**

**Mentor's Institution(s): UNIVERSIDAD VERACRUZANA**

**Desired outcome of project: Literature Review**

**Suitable Mentees: Undergraduate Students**

**Duration of the project: 4-6 weeks**

**Project Description:** "THE BIGGEST THREAT TO LIFE AT EARTH IS PROBABLY THE CLIMATE CHANGE, SO, IT IS NECESSARY AND IMPORTANTE GET THE ACTION PLANS AT SOME UNIVERSITIES ABROAD. WHAT ARE THEY DOING? THE ACTION BASIS AND THE FUTURE ACTIONS TO FACE IT."

**Project 28 Title: Model building and fits for particle scattering**

**Mentor: Maxim Mai**

**Mentor's Institution(s): University of Bonn**

**Desired outcome of project: Original research, Literature review**

**Suitable Mentees: Undergraduate and Graduate Students**

**Duration of the project: 4-6 weeks**

**Project Description:** We discuss scattering amplitudes as a tool to address experimental data and extract properties of resonances. The focus will be put on discussion of principles behind such amplitudes and fits to experimental or simulated data. The level of data analysis vs mathematical principles will be adjusted depending on the students priorities.

**Project 29 Title: Monte Carlo Methods in Statistical Field Theories**

**Mentor: Ivan Mauricio Burbano Aldana, Marco A. Carrillo, Siddhant Mal**

**Mentor's Institution(s): University of California, Berkeley, Old Dominion University**

**Desired outcome of project: Literature review**

**Suitable Mentees: Undergraduate and Graduate Students**

**Duration of the project: 6-8 weeks**

**Project Description:** Analyze the statistical properties of simple field theories of interest with the use of computer simulations. We will study the theoretical basics of these theories, both in the continuum and on the lattice, and learn how to explore their statistical properties using Monte Carlo methods. Some of the theories we might study are the Ising model, the  $\phi^4$  theory, or the  $O(n)$  model. These theories are also of interest in the quantum setting, and we will discuss the deep relationship between the statistics of the classical theories in  $d+1$  spatial dimensions and the dynamics of the quantum theories in  $d$  spatial dimensions.

**Project 30 Title: Use of polysaccharides from agro-industrial waste for tissue applications: A sustainable approach**

**Mentor: Lorena Garcia Uriostegui**

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**Mentor's Institution(s): University of Guadalajara**

**Desired outcome of project: Literature review and Original Research**

**Suitable Mentees: Undergraduate and Graduate Students**

**Duration of the project: 4-6 weeks**

**Project Description:** Development of protocols to: 1) optimize the extraction process of lignocellulosic macromolecules from waste of agro- industry; 2) Modification of lignocellulosic materials to prepare of scaffold-type biomaterials useful in biomedical applications.

**Project 31 Title: *Propose clusters or industrial districts as a pole of regional economic development.***

**Mentor: Gabriel Salvador Fregoso Jasso**

**Mentor's Institution(s): University of Guadalajara**

**Desired outcome of project: Original Research**

**Suitable Mentees: Undergraduate and Graduate Students**

**Duration of the project: 4-6 weeks**

**Project Description:** The research's main objective is to form specialists to propose clusters or industrial districts as a pole of regional economic development. The study is carried out on business clusters in various industrial sectors. The study involves the small businesses of some regions, which are mostly family businesses. Although it is a regional study, the competitive context is located internationally.

The program is designed to ensure that the student is involved in the research, prepares articles for journals, and participates in scientific dissemination forums as a speaker. Where you can share experiences and learn from other research.

**Project 32 Title: *Anting by birds***

**Mentor: Deborah Waller**

**Mentor's Institution(s): ODU**

**Desired outcome of project: Literature review**

**Suitable Mentees: middle school, high school, undergraduate and graduate students**

**Duration of the project: 4-6 weeks**

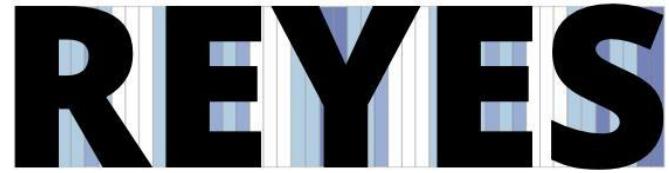
**Project Description:** Anting by birds. Birds place ants in their feathers and allow them to crawl over their bodies. They probably do this so that the ants will kill ectoparasites like lice. However, there is much to be learned about the anting process including which ant species are involved and what kind of chemicals the ants produce that might help eliminate ectoparasites. A literature review will reveal which bird species indulge in anting, which ant species are selected and whether the bird behaviors influence the process. Students will find and review papers related to anting every week and we will compile the information into a review paper on anting.

**Project 33 Title: Marketing, Digital Marketing, Strategic Marketing**

**Mentor: Marcos Pérez Mendoza**

**Mentor's Institution(s): Universidad Juárez Autónoma de Tabasco**

**Desired outcome of project: Literature review**



**Suitable Mentees: Undergraduate students**

**Duration of the project: More than 8 weeks [beyond the REYES time period]**

**Project Description:** Strategies related to digital and strategic marketing for HEIs, enterprises, entrepreneurship or start-ups.