Proposal of Erasmus+ Traineeships

Faculty of Exact and Natural Sciences,
University of Zielona Góra

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Modelling of Quantum Wires and Waveguides

Supervisor(s):
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Description:
This project focuses on the modeling of quantum wires and waveguides, a rapidly developing area of research. It is known that the geometry of quantum systems, such as quantum wires and waveguides, influences the spectrum of particles within these systems. The project examines scattering processes in specific types of wires or waveguides and analyzes resonance phenomena. During the Erasmus+ Traineeship, the student will gain familiarity with key results in the area of quantum wires and waveguides, reconstruct S-matrix and generalized eigenfunctions, and apply these findings to simulate particle behavior in these structures. The project combines analytical and programming tools.

Entry Requirements:
Basic knowledge of quantum theory at the undergraduate level, mathematics at the undergraduate level, and basic programming skills.

Modelling of Extrasolar Planetary Systems

Supervisor(s):
Andrzej Maciejewski (Institute of Astronomy, a.maciejewski@ia.uz.zgora.pl)
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Description:
According to the Extrasolar Planets Encyclopaedia, over 5000 extrasolar planets have been discovered, many within planetary systems. This project studies the dynamics of extrasolar planets. During the Erasmus+ Traineeship, the student will learn contemporary methods and tools for modeling and studying multi-planetary system dynamics. Training topics include:

1. Methods of planet detection
2. Fitting Keplerian orbits to observations
3. Models of multi-planetary systems
4. Numerical integration of N-body systems
5. Stability of multi-planetary systems

The project combines analytical and programming tools.

Entry Requirements:
Basic knowledge of classical mechanics, mathematics at the undergraduate level, and basic programming skills.

Self-Assembly of Metamaterials in the Drying Process

Supervisor:
Andrzej Drzewinski (Institute of Physics, a.drzewinski@if.uz.zgora.pl)

Description:
The evaporation of a liquid droplet on a solid substrate is a common phenomenon. For droplets of colloidal suspension, the drying process leaves a characteristic deposit on the substrate. This project investigates how various factors (surface morphology, solution pH, salinity, air humidity, temperature) influence deposit formation. Completing this project will broaden the student's understanding of applied physics.

Entry Requirements:
Knowledge of physics and mathematics at the undergraduate level.

Unraveling the Pulsar Emission Mechanism: Analysis of Single Pulse Observations from Polish LOFAR Radio Telescopes

Supervisor(s):
Wojciech Lewandowski (Institute of Astronomy, w.lewandowski@ia.uz.zgora.pl)
Rahul Basu (Institute of Astronomy, w.lewandowski@ia.uz.zgora.pl)

Description:
Pulsars are neutron stars with extreme properties, such as immense density and strong magnetic fields. Despite extensive research, their radio emission mechanism remains largely unsolved. This project provides an opportunity to analyze data from modern radio telescopes like LOFAR and the Giant Metrewave Radio Telescope in India, focusing on automating data analysis pipelines and scientifically interpreting the results.

Entry Requirements:
Basic knowledge of astronomy, electrodynamics, mathematics, and Linux programming skills.

Automation of Data Analysis Based on Exoplanet Observations

Supervisor(s):
Magdalena Szkudlarek (Institute of Astronomy, msz@astro.ia.uz.zgora.pl)
Michał Zejmo (Institute of Astronomy, michalzejmo@gmail.com)

Description:
Exoplanets have become a major field of research in modern astronomy. The ARIEL mission will observe 1000 exoplanets to survey atmospheric chemistry. This project, part of the ExoClock project, allows students to automate observation scheduling, data validation, photometry, model fitting, and data upload, using our PlaneWave CDK 20" telescope in Chile.

Entry Requirements:
Basic knowledge of astronomy and programming skills in Python.