Proposal of Erasmus+ traineeships

Faculty of Physics and Astronomy,
Zielona Góra University

Modelling of quantum wires and waveguides

Supervisor(s):
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Description.
The project belongs to the intensively developed line of research *quantum wires and waveguides*. It is known that the geometry of quantum systems, as quantum wires and waveguides, affects the spectrum of particles living in these systems. The project is addressed to the problem of scattering process in the special types of wires or/and waveguides and analysis of resonances phenomena. During the Erasmus+ Traineeship, the student will get to know with the most known results in the area of quantum wires and waveguides, obtain additional auxiliary results, as reconstruction of S-matrix and generalized eigenfuntions, and apply them to the simulation behavior of particles living in the mentioned structures. The project combines analytical and programming tools.

Entry requirements: basic knowledge in quantum theory on the first degree level, knowledge of mathematics on the first degree level, basic programming skills

Modelling of extrasolar planetary systems

Supervisor(s):
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Description.
According to http://exoplanet.eu/The Extrasolar Planets Encyclopaedia, till now more than 5000 of extrasolar planets were discovered, and most of them are members of planetary systems. This is why the study of problems connected with extrasolar planets is very popular and attractive activity. A lot of interesting information about extrasolar planets can be found on the site `http://exoplanets.nasa.gov/discovery/missions/#first-planetary-disk-observed`

The project is dedicated to study dynamics of extrasolar planets. During the Erasmus+ Traineeship, the student will get to know with contemporary fundamental methods and tools for modelling and study dynamics of multi-planetary system. All the training is focussed around the following topics:

1. Methods of planet detections.
2. Fitting Keplerian orbits to observation.
3. Multi-planetary systems models.
4. Numerical integration of N body systems.
5. Stability of multi-planetary sytems.

The project combines analytical and programming tools.

Entry requirements: basic knowledge in classical mechanics on the first degree level, knowledge of mathematics on the first degree level, basic programming skills.

Self-assembly of metamaterials in the drying process

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

Description.
The evaporation of a droplet of liquid lying on a solid substrate is a common phenomenon in nature. In the case of a droplet of colloidal suspension, the drying process leaves a characteristic deposit on the substrate. Understanding the process of drying colloidal fluids with different properties in different environmental conditions is important for many medical and pharmaceutical applications. The project is aimed at students who want to investigate how and why deposits are influenced by surface morphology, the pH value of the solution, and its salinity, as well as air humidity or temperature. Completion of the project allows the student to broaden their understanding of fundamental and applied physics

Entry requirements: The student should master the knowledge and skills in physics and mathematics at the first year level.

Unraveling the pulsar emission mechanism: analysis of single pulse observations from Polish LOFAR radio telescopes

Supervisor(s):
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Description.
Pulsars are amongst the most extreme objects in the universe. They are born as neutron stars in supernova explosions, and their physical properties are truly remarkable. Just 20 kilometers wide they contain more mass than our Sun, hence their density is as large as it gets: up to a billion tones per cubic cm (comparable to an atomic nucleus), which leads to enormous gravity. When you couple this with extremely strong magnetic fields (billions of times stronger than we can create in our physics laboratories) it creates truly extreme objects. They were discovered over 55 years ago, and yet after all those years of the research the mystery of their radio emission remains largely unsolved. With the advancement of new observational instruments and methods we are aiming to change that. During the Erasmus+ Traineeship the student will have a chance to work with the observational data gathered with some of the most modern radio telescopes, such as LOFAR (LOw Frequency Array, a pan-European radio telescope network) and the Giant Metrewave Radio Telescope in India. His job will be to facilitate the analysis process, including automatization and scripting of the data analysis pipeline, and a full scientific interpretation of the results

Entry requirements: basic knowledge of astronomy, electrodynamics and mathematics on the first degree level. Basic programming skills in Linux environments.

Automation of data analysis based on exoplanet observations

Supervisor(s):
Magdalena Szkudlarek (Institute of Astronomy, msz@astro.ia.uz.zgora.pl)
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Description.
Exoplanets, or planets orbiting other stars, have recently become one of the hottest topics in modern astronomy. The first discovery was not so long ago, only 30 years have passed. The Kepler space mission (2009 - 2018) was the main engine of the revolution, it discovered over 3000 exoplanets. At the moment, we have observed over 5,000 of them only in our relatively close neighborhood. Current and future space missions and ground-based observations will increase that number, as we might expect at a very high rate. ARIEL is one of the upcoming space missions which will observe 1000 exoplanets and make the first large-scale survey of the chemistry of exoplanet atmospheres. The mission requires detailed and very accurate data of the transit, i.e. when the planet crosses in front of its parent star's disc. ExoClock is a project which helps to collect those data, its main task is to monitor transiting exoplanets in order to keep their ephemerides up-to-date.

During the Erasmus+ Traineeship, the student will be a part of the ExoClock project and will have the opportunity to collect data from our new PlaneWave CDK 20" telescope placed in Chile. The observations will be carried live and fully remotely. The goal of this training is to automate:

1. observation scheduling
2. data validation
3. data reduction
4. photometry
5. model fitting
6. upload of data to the ExoClock project website

Entry requirements: basic knowledge in astronomy, basic programming skills in Python.