



# Institute of Physics of the Polish Academy of Sciences

## Scholarship for a PhD Student



**Job ID: #JOB 27/2023**

### Job Description

**Job Title:** PhD student – scholarship holder

**Job Summary:**

Scalar field dark matter from an ultracold atomic physics perspective

**Job Description:**

The „fuzzy” or wave dark matter model which has received a lot of attention recently postulates that the dark matter that accounts for most of the matter of the universe is like a Bose-Einstein condensate with a wavelength on the order of the size of a galaxy. In this project, we want to take advantage of the many parallels between the now very developed description of matter waves in atomic Bose-Einstein condensates and the fuzzy dark matter model to obtain a more nuanced and accurate representation of the postulated fuzzy dark matter. In particular, wave dark matter simulations to date have not included higher energy, lower wavelength modes far outside of the main condensate. Generally the study of coherence and other quantum properties of wave dark matter is in its infancy, and has only started to go beyond the zero temperature approximation. We will work with the group of prof. Nick Proukakis in Newcastle University who have recently carried out pioneering studies of wave dark matter from this angle.

We will apply the wave matter descriptions developed to describe condensates of ultracold atoms to include the effect of the neglected higher energy waves into dark matter simulations. The approach is based on stochastic nonlinear Schrödinger equations, where the noise part is responsible for nonzero temperature. By including these shorter wavelength phenomena we plan to get a more accurate picture of the fuzzy dark matter. There are also many quantum effects to explore in the wave dark matter model generally, which have not been taken into account previously. We hope that the new results will also allow us to investigate how such waves of fuzzy dark matter would affect „small” tracer particles such as globular clusters or dwarf galaxies. If the effect is observable, it might allow for real astronomical observations to distinguish between the predictions of fuzzy dark matter and the more standard dark matter model to determine which of them is closer to reality.

Requirements:

- Research experience in theoretical physics, cosmology, or theoretical astronomy.
- Good programming skills or a strong willingness to learn them.
- Sufficient proficiency in the English language for efficient scientific interaction.
- Master’s degree in physics (or an equivalent that qualifies one for PhD studies in physics in the country of issue).
- Experience with ultracold gases, cosmology, or quantum physics will be a strong advantage, as will experience with numerical calculations, particularly in writing programs to solve differential equations.
- To be employed, the candidate must be accepted into the PhD school in which the Institute of Physics participates. Applications for the position are through recruitment to the School, online at [warsaw4phd.eu](http://warsaw4phd.eu).

**Main research field:** Physics, Astronomy

**Sub Research Field:** quantum mechanics, quantum gases, dark matter, cosmology

**Career Stage:** Early stage researcher or 0-4 yrs (Post-graduate)

**Research Profile** ([details](#)): First Stage Researcher (R1)

**Type of Contract:** Fixed term (48 months)

**Status:** Full-time

**Salary:** grant funding for 48 months – 5000 PLN per month (4250 PLN net) in the first two years, later 6000 PLN per month (4550 PLN net), from an NCN Preludium Bis project.

## Contact

More information can be obtained from

Piotr Deuar (e-mail: [deuar@ifpan.edu.pl](mailto:deuar@ifpan.edu.pl))

<http://www.ifpan.edu.pl/~deuar/>

Please make contact.

## Application details

**Application deadline: 04.06.2023** Later applications will not be considered.

### Required materials:

- Scientific CV
- Cover letter
- Scan of MsC diploma or equivalent (or an explanation of when one is expected)
- Academic record (for finalized semesters)
- Recommended: A recommendation letter by an academic, or their contact email.

All materials should be submitted in electronic form by application to the PhD school [warsaw4phd.eu](http://warsaw4phd.eu), choosing the project: "*Scalar field dark matter from an ultracold atomic physics perspective*". The application system will be active from 22 May 2023.

Results regarding the position will be made available by 8 July 2023.