



## Institute of Physics of the Polish Academy of Sciences



Job ID: # JOB 28/2024

### Job Description

**Job Title: Research assistant, Junior postdoctoral researcher.**

#### Job Summary:

The winning candidate will work as a research assistant at the [International Centre for Interfacing Magnetism and Superconductivity with Topological Matter - MagTop](#) of the Institute of Physics of the Polish Academy of Sciences. The Centre and the junior postdoctoral researcher position are supported by the MagTop project (FENG.02.01-IP.05-0028/23) implemented as part of the MAB FENG action of the Foundation for Polish Science co-financed by the European Union from the 2nd Priority funds of the Programme European Funds for Smart Economy 2021-2027 (FENG).

The position involves the theoretical implementation and analysis of quantum gates and small quantum algorithms using topological superconductors formed from chains of magnetic adatoms connected to conventional (or *s*-wave) superconductors. Additionally, the PD will help investigate potential microscopic mechanisms behind the STM-ESR manipulations of the magnetic adatoms in superconductors.

#### Job Description:

**Background:** Magnetic adatoms (such as Fe, Mn, or Co) in *s*-wave superconductors (such as Nb, Al, or Rh) provide a viable platform for realising a topological quantum computer based on Majorana zero modes (MZMs), or Majorana qubits (MQs). However, manipulating coherently these quantum degrees of freedom in such systems remains an open challenge, mainly because the system parameters (such as the exchange couplings) are difficult to control experimentally in real time. Moreover, MQs alone do not provide a universal set of quantum gates, which limits their utility. We have recently put forward a new type of quantum bit, a Yu-Shiba-Rusinov qubit (YSRQ), stemming from two nearby magnetic impurities on a superconductor, which we conjectured that it could facilitate the implementation of a universal set of quantum gates together with MQs (see Fig. 1).

**Aim:** The main goal in this part is to resolve this conjecture by explicitly calculating the quantum coherent properties of the device in Fig. 1 and beyond. In a first step, the PD will determine the low-energy Hamiltonian describing the device, and then use it as input for constructing the necessary set of quantum gates (*e.g.*, the SWAP gate between the YSRQ and the MQs). He/she will estimate the fidelities of the gates in the presence of errors in the gate operations, which can be implemented experimentally by rotating the magnetisation profile in STM-ESR setups, as well as in the presence of environmental degrees of freedom, such as phonons, magnons, and low-energy quasiparticles. For that, the PD will establish the density matrix that describes the dissipative dynamics of the hybrid qubits system, and complement the analytical

calculations with numerical simulation using [QuTiP: The Quantum Toolbox in Python](#).

Once this task is completed, we will explore networks of such hybrids, and develop small scale quantum algorithms, such as Deutsch-Jozsa. The outcome, could have far reaching implications in the design of quantum devices out of magnetic adatoms in superconductors, in particular whether a functioning quantum processor is pertinent in current or near-future experiments.

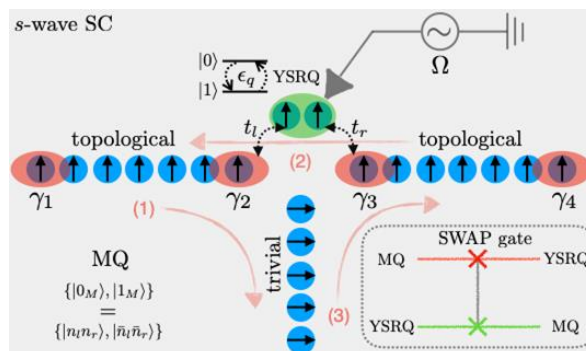


Fig. 1. Scheme for implementing universal quantum computation with hybrid YSRQ—MQs. The magnetic adatoms (black arrows) deposited on top of an s-wave SC form three YSR chains in a T-junction geometry that facilitate their processing via braiding (not-universal). The left and right chains host MZMs at their ends, the inner ones coupling to the YSRQ (green), while the lower chain is non-topological. A SWAP gate with the YSRQ facilitates both the MQ readout and the implementation of the missing quantum gate (phase gate).

#### Requirements:

- A PhD degree in Physics or in related fields, such as e.g., condensed matter theory and/or quantum information theory held for no longer than five years, is required,
- Knowledge of machine learning approaches will be an asset,
- Experience in the theory of open quantum systems will be an asset,
- Experience in using various programming languages (especially Python and Mathematica) will be an asset,
- Very good knowledge of written and spoken English is required.

**Main research field:** Physics

**Sub Research Field:** Condensed Matter Physics, Quantum Information

**Career Stage:** Junior Postdoctoral Researcher – a person holding a doctoral degree for no longer than five years. The period of five years is counted from the year of obtaining the doctoral degree.

**Research Profile** ([details](#)): Recognized Researcher (R2)

**Type of Contract:** Initial employment for a fixed term of 24 months, including a 3-month probationary period. Prolongation of employment for a further 33 months will be based on performance and a successful completion of an evaluation.

**Status:** Full-time employee

**Salary:** The person will be employed as a full-time research assistant (or adjunct in case of a person with longer experience very well suited to the tasks of the project) for a maximum period of 57 months (with all employee benefits and an additional medical insurance package) with a gross salary of PLN 11 200 per month, which is



approximately PLN 8 300 net/month. The MagTop project (FENG.02.01-IP.05-0028/23) is implemented as part of the MAB FENG action of the Foundation for Polish Science co-financed by the European Union from the 2nd Priority funds of the Programme European Funds for Smart Economy 2021-2027 (FENG).

### Contact

More information can be obtained from:

prof. dr Mircea Trif (e-mail: [mtrif@MagTop.ifpan.edu.pl](mailto:mtrif@MagTop.ifpan.edu.pl)) and prof. dr hab. Tomasz Dietl (e-mail: [dietl@MagTop.ifpan.edu.pl](mailto:dietl@MagTop.ifpan.edu.pl)); and: <https://magtop.ifpan.edu.pl/>

Please make contact.

### Application details

**Application deadline: 20.08.2024.** Later applications will not be considered.

#### Required materials:

- Detailed scientific CV (up to 3 pages),
- Scan of PhD diploma,
- Full list of publications,
- Cover/motivation letter, please mention earliest possible starting date (up to 1 page),
- Contact details for two researchers who can provide references.
- A statement by the candidate of consent to the processing of personal data for the purposes of recruitment (as below).

All required materials for the position must be sent to [open\\_positions@MagTop.ifpan.edu.pl](mailto:open_positions@MagTop.ifpan.edu.pl) and [rekrutacja@ifpan.edu.pl](mailto:rekrutacja@ifpan.edu.pl) with the Job ID# as a subject.



## DATA PROCESSING UNDER CONSENT FOR THE PURPOSES OF RECRUITMENT

Under Art. 13 sections 1 and 2 of the Regulation of the European Parliament and of the Council (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Resolution), EU OJ L 119 of 04.05.2016, page 1, as amended, hereinafter referred to as "GDPR", we hereby inform as follows:

1. The Data Controller of the provided personal data is the Institute of Physics of the Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warsaw, phone (22) 116-2111, e-mail [director@ifpan.edu.pl](mailto:director@ifpan.edu.pl).
2. Contact details to the Data Protection Officer are as follows: e-mail [iodo@ifpan.edu.pl](mailto:iodo@ifpan.edu.pl)
3. Your personal data shall be processed for the purpose of carrying out the recruitment process for the position of Research Assistant (Junior Postdoctoral Researcher)
4. Processing of your personal data in scope of: full name, date of birth, correspondence address, information about education and course of past employment shall take place under Art. 22<sup>1</sup> § 1 of the Act of 26 June 1974 - Labour Code. In the scope in which you sent to us more personal data than indicated above, we process your data under the consent granted by you.
5. Your personal data shall be stored for 1 month from completion of the recruitment process. If you grant consent for processing of personal data for future recruitments, we shall process your data until withdrawal of the consent by you, however, no longer than for the period of 6 months from the day of submittal of the application by you.
6. Provision of the abovementioned data in the scope indicated above is a statutory requirement resulting from Art. 22<sup>1</sup> § 1 of the Act of 26 June 1974 - Labour Code, in the remaining scope it is voluntary. Failure to provide the data referred to in Art. 22<sup>1</sup> § 1 of the Act of 26 June 1974 - Labour Code precludes consideration of your candidacy for the offered position.
7. You have the right to access your personal data, to rectify them, erase them, restrict their processing.
8. You may submit a complaint to the Inspector General for the Protection of Personal Data.
9. You have the right to withdraw the consent to process your personal data in the scope in which they were provided at any time. Withdrawing the consent does not affect the lawfulness of processing carried out on the basis of consent before its withdrawal.

Consent content:

☐ *I grant my consent to the Institute of Physics of the Polish Academy of Sciences to process my personal data contained in the sent recruitment documents for the purpose of carrying out the recruitment process for the position of Research Assistant (Junior Postdoctoral Researcher).*

If you want us to consider your candidacy also in the future recruitment processes, please grant the additional consent:

☐ *I grant my consent to the Institute of Physics of the Polish Academy of Sciences to process my personal data contained in the sent recruitment documents in future recruitment processes taking place during 6 months from the day of appearance of this job advertisement.*