

## Data of the Proposal

Proposal type and identifier: STARTING-151294  
 Panel: Mathematics, Computing Sciences, Informatics  
 Principal investigator: András Gilyén  
 Title: Quantum Generalizations of Markov Chain Monte Carlo Methods  
 Duration: 48 months  
 Support (for the duration)  
 (about 2.5 Euro/ kHUF): 55 422 thousand HUF

Scientometric rank in Hungary: D1

For scientometric details and for a link to MTMT database of publications, [see this page](#)

(Publication output was assessed by comparing the applicant's H-index, number of independent citations received in last complete year, and number of publications in the last five years to publication age-matched Hungarian researchers of the same scientific discipline. Data from MTMT; publications have 200% weight in the rank. For a complete description of the calculations, please refer to <http://tudomanymetria.com>.)

## Review

### 1. Principal Investigator: Intellectual capacity and creativity

There is no doubt about the PI's ability to conduct ground-breaking research, as he is one of the authors of recent breakthrough results in the field of quantum algorithms. This is reflected in his publication and citation record, which is especially impressive given that the PI is within five years of receiving his PhD. He has held postdoc and research positions at top institutions and has currently obtained a Marie Curie fellowship, along with a research agreement sponsored by Amazon.

The international reputation of the PI is also demonstrated by the number of invited talks at workshops and conferences, including highly reputed events such as QIP. This all leads to the conclusion that, despite the relatively early stage of his scientific career, the PI certainly has the required expertise and capacity to lead this project to success.

Evaluation: ***5.0 - The scientific track record and research achievements are excellent, internationally recognized and highly valued in terms of quality and contribution to science, the publication and artistic track record and other research activities.***

### 2.1. Ground-breaking nature and ambition of the research project

The purpose of the project is to study the quantum generalization of Markov Chain Monte Carlo (MCMC) methods. Given the fundamental importance of classical MCMC methods for the simulation of complex systems, these aims are highly significant for the field of quantum algorithms, potentially leading to simulations that are not currently feasible. It is very likely that the results obtained will have a high impact in a variety of fields.

The objectives build upon recent promising results obtained (among others) by the PI, addressing some of the issues faced by previously known approaches. These results are based on novel ideas that will need further expansion, and new techniques will need to be developed to address the mixing times in both continuous and discrete time settings, as well as other objectives of the project. The aims are certainly ambitious and go beyond the state of the art.

Evaluation: ***5.0 - The research project is of the world-class quality: it addresses a problem of very high importance and interest, demonstrates exceptional novelty and innovative approaches and has no weaknesses.***

### 2.2. Scientific approach

The proposed project is highly ambitious. The goals aim at important open problems, and the research methods are well-designed and promising. The proposed starting point is a combination of the newly developed techniques of the PI with other recent approaches; however, developing novel methods will certainly be necessary to achieve the project objectives.

The proposed research timeline is adequate. The project involves the PI, a postdoctoral researcher, and a PhD student. The tasks are well organized, and the involvement of all participants is appropriate and justified.

Evaluation: **5.0 - The research project is of the world-class quality: it addresses a problem of very high importance and interest, demonstrates exceptional novelty and innovative approaches and has no weaknesses.**

2.3.1. The potential impact and feasibility of the research project / 1 - scientific impact

It is expected that the results of the project will have a high international impact. The results are very likely to be published in top-tier journals, given their importance to the field and the PI's publication profile.

Evaluation: **2.0 - The project will have a substantial impact on the advancement of the research field(s) or discipline(s) and the project results are likely to be published by academic publishers or journals of the highest academic rank.**

2.3.2. The potential impact and feasibility of the research project / 2 - feasibility

The research project is based on novel techniques developed by the PI and has a well-designed methodology. The PI is well-connected within the international community working on quantum algorithms and related fields. The proposed team is well-suited for the project, and the facilities provided by the Renyi Institute are more than adequate.

As a theoretical project, the primary risks involve the possibility that the proposed techniques may not work or that the goals could be achieved by another group. The proposal includes a sufficiently broad range of problems and several alternative approaches, which help mitigate these risks. However, the project's risks and their management are not directly addressed in the proposal.

Evaluation: **1.5**

2.3.3. The potential impact and feasibility of the research project / 3 - high-risk/high-gain nature

The methods developed by the PI have proven useful in addressing some issues in previous approaches to quantum MCMC methods, but understanding the mixing times is another challenge, and there is no guarantee that the proposed methods will be successful. The ideas behind the project objectives are promising, but predicting the outcomes is difficult, particularly regarding the proposed applications to quantum SDP solvers. Nevertheless, the potential gains are very high, and the PI's expertise makes the project feasible.

Evaluation: **1.5**

2.3.4. The potential impact and feasibility of the research project / 4 - benefits for society

The expected theoretical findings will be of great value in understanding quantum algorithms and clarifying the quantum advantage. There is also high potential for these findings to lead to new practical algorithms that could impact various fields. For this type of theoretical project, the actual benefits for society are difficult to predict, but the value of the theoretical findings for the scientific community is beyond doubt.

Given the scientific record of the PI and his established international connections, the project results will likely lead to publications in top-tier journals and have ample opportunities for dissemination at workshops and conferences.

Evaluation: **2.0 - The project will have a substantial opportunity to disseminate key findings to a broader audience, and the project results are likely to be published as patents.**

**Weighted sum of scores: 9.75**

## DECLARATION

I declare that I and the applicant have no conflict of interest other than what I will describe in the "Confidential remarks to the committee chair" section.

A conflict of interest exists between applicant and reviewer, evaluation committee member, evaluation committee chair if there is

- close relative (family member) or personal relationship;
- employment relationship at present or in the last three years, superior-subordinate relationship (including indirect superior-subordinate relationship at executive level), colleagues in the same organizational unit (university or research institute department, research group);
- PhD student/advisor relationship (anytime);
- joint scientific project, participation in joint contract or research cooperation – at present or in the last three years;
- lack of objectivity out of any other reason or circumstance.

I accept that the proposal contains confidential professional information, it is an intellectual property of the applicant(s). It is forbidden to use the data in the proposal, to copy the proposal or a part of it, or to store it in any format – except for evaluation purposes.

I accept that I have to treat the proposal and my review confidentially and that the NKFI Office handles my data confidentially.

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