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European Microkelvin Collaboration

CAPACITIES

Report on the Transnational Access Activity carried out within MICROKELVIN

The eligibility of transnational access to a MICROKELVIN TA site implies the submission of the following:

1) The Certification of visit

The form "Certification of visit" must be completed and signed by the access provider in charge of the infrastructure and the leader of the project.

2) A TA project report

The form for the TA project report is contained within this document. It should be completed after project end by the group leader of the project. You must respect the limited number of words specified, longer descriptions will be rejected. Figures/tables may be attached at the end of the document. The document must be submitted in an editable format (doc, rtf).

3) A User group questionnaire

To enable the Commission to evaluate the Research Infrastructures Action, to monitor the individual contracts, and to improve the services provided to the scientific community, each project leader of a user-project supported under an EC Research Infrastructure contract is requested to complete a "user group questionnaire". The questionnaire must be submitted once by each user group to the Commission as soon as the experiments on the infrastructure come to end.

The user group questionnaire is not part of this document and must be completed on-line. It is accessible at:

http://cordis.europa.eu/fp7/capacities/questionnaire_en.html.

► **Please note that any publications resulting from work carried out under the MICROKELVIN TA activity must acknowledge the support of the European Community:**

> **"The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 228464 (MICROKELVIN)."**

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MICROKELVIN Transnational Access Project Report

1. General information

Project number:	**AALTO31**	
Project Title:	**Fluctuations and work in driven open quantum systems: From theory to experiment**	
Lead scientist:[1]	**Title:**	Prof. Dr.
	First name:	Joachim
	Last name:	Ankerhold
	Home institution:	Institute for Theoretical Physis, Condensed Matter Theory Group, University of Ulm
Host scientist:[2]	**Title:**	Prof. Dr.
	First name:	Jukka
	Last name:	Pekola
	Home institution:	O.V. Lounasmaa Laboratory (Low Temperature Laboratory), Aalto University School of Science, Espoo
Project scientist:[3]	**Title:**	Dipl.-Phys.
	First name:	Vera
	Last name:	Gramich
	Birth date:	19.08.1985
	Passport number:	
	Research status/Position:	PhD student
	New User:[4]	no
	Scientific Field:	Low Temperature Physics, Nanoelectronics, Condensed Matter Physics
	Home institution:	Institute for Theoretical Physics, Condensed Matter Theory Group, University of Ulm
	Is your home institution MICROKELVIN partner?	no
	Business address:	
	Street:	Albert-Einstein-Allee 11
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	E-mail:	vera.gramich@uni-ulm.de

[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.

[2] The host scientist is supervising the work of the visiting project scientist at the infrastructure.

[3] The project scientist is the person who will be visiting the infrastructure.

[4] Indicate 'Yes' only if the user has never visited the infrastructure before this specific project, otherwise write 'No'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	The advent of new fabrication techniques as well as the ability to tailor quantum matter on ever smaller scales has been pushed towards new horizons in the last few decades and has lead to fascinating developments in low temperature and solid state physics. For condensed matter systems it turned out that superconducting devices are particularly important as they allow us to observe and analyse quantum phenomena on ever growing scales with unprecedented accuracy. In particular, the long experimental expertise in the PICO group of the O.V. Lounasmaa Laboratory combined with the theoretical know-how of J. Ankerhold and V. Gramich. has made a new approach possible on two such superconducting quantum circuits, namely the Cooper pair sluice and the SINIS turnstile. The objective of this project focuses on (i) the extension of an experimentally feasible detection of the Lamb shift (environmentally induced energy shift of the two lowest-lying energy levels) in a driven two-level system with a superconducting island (the Cooper pair sluice) and (ii) the study of switching experiments in a SNS junction below 300 mK, using the SINIS turnstile for thermometry (S=superconductor, N=normal metal, I=insulator).
Technical description of work performed: (250 words max)	With respect to the first goal (i), a careful theoretical analysis and understanding of the usually neglected Lamb shift terms was carried out using the Floquet-Born-Markov master equation approach which is convenient for describing periodically driven systems as is the case here. The study of the dynamics was supported by various numerical simulations and was then applied to a physical system – the Cooper pair pump. Here we focused on how realistic this proposal is for a measurement scheme of the Lamb shift in a broadband environment, if an existing set-up is used. Regarding the second issue (ii), the SNS-SINIS samples were designed and fabricated at the host institution, where we have been involved in the junction fabrication process using standard electron-beam lithography and three-angle shadow deposition in an UHV evaporator. Several transport measurements in He-3/He-4 dilution refrigerators were carried out.
Project achievements (and difficulties encountered)[5]: (250 words max)	(i): It turned out that the Lamb shift terms affect the dynamics significantly and become more and more important close to the degeneracies in the quasi-energy spectrum of the Floquet states. Even for a simple single frequency drive which serves as a toy model, just acting on experimental parameters, we can increase the environmental affect. We think after many discussions with the experimentalists from the PICO group, that it is possible to gain experimental access to these Lamb shift terms in a relatively easy manner. The logical consequence to ask for the definition of work performed in such a driven (open) quantum system is however still an open question which can be addressed to the Cooper pair sluice in future.

	(ii): After performing the switching experiments (from the superconductive state to the normal state) in the superconducting state, just before the switching occurs, a small overheating is observed due to a voltage drop across the junction. Here, the classical electron-phonon interaction was used to design a new measurement set-up because the order of magnitude for this rising voltage is nanovolts. This work is still an ongoing process: new samples are fabricated and data have to be treated and analysed more carefully.
Expected publications and dates:	Article in Phys. Rev. Lett. or EPL, submission will be in autumn 2013
Submission date of user group questionnaire:	19.08.2013

Completed Project Reports should be returned to MICROKELVIN Management Office (Mari.Karni@aalto.fi, Fax: +358 9 47022969).

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CAPACITIES

CERTIFICATION OF VISIT

at MICROKELVIN Transnational Access Site

I herewith confirm that the following project was carried out at our Transnational Access Site

O.V. Lounasmaa Laboratory, Aalto University School of Science

in the context of MICROKELVIN Transnational Access:

AALTO31 - Fluctuations and work in driven open quantum systems: From theory to experiment

The amount of access[1] delivered to the project group (project users) is as follows:

	Participant name	Duration of stay (start – end date)	Amount of access[2]
Project leader:	Joachim Ankerhold	16.8.-15.9.	0
Project user 1:	Vera Gramich	15.5.-15.8.	93
Project user 2:			
Project user ...:[3]			
Total amount of access delivered to project group:			**93**

Espoo, August 20

Location and date

Signature of access provider

Jukka Pekola

Espoo, August 20

Location and date

Signature of project leader

Joachim Ankerhold

Completed Certification of Visit should be returned to MICROKELVIN Management Office
(sari.laitila@aalto.fi, fax: +358 9 47022969)

[1] TKK Helsinki, CNRS Crenoble, or Lancaster University

[2] The amount of access is defined as the time, in days, spent by the user at the infrastructure for this project, including weekends and public holidays (e.g., a scientist who spent 5 days at the infrastructure must indicate '5'). The total amount of access of the project group is the sum of access days of each project user.

[3] Please, expand if necessary.