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CAPACITIES

MICROKELVIN Transnational Access Project Report

1. General information

Project number	**AALTO07**	
Project Title:	VORTEX MOTION AND DISSIPATION AT VERY LOW TEMPERATURES IN 3He-B	
Project Acronum:		
Lead scientist:[1]	**Title:**	Mr.
	First name:	David
	Last name:	Schmoranzer
	Birth date:	28/11/1981
	Research status/Position:	graduate student
	New User:[2]	No – follow up visit
	Scientific Field:	Superfluid hydrodynamics and turbulence
	Home institution:	Department of Low Temperature Physics, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic
	Home institution is MICROKELVIN partner:	**Yes** ☐ **No X**
	Business address:	
	Street:	V. Holesovickach
	Street No.:	2
	PO Box:	
	City:	Prague
	Zip/Postal Code:	18000 Prague 8
	Country:	Czech Republic
	Telephone:	+420 22191 2558, +420 22191 2716
	Fax:	+420 22191 2567
	E-mail:	david.sch@seznam.cz

[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.
[2] 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)	Measurements of the Andreev reflection of quasiparticle excitations from an array of rectilinear vortex lines in rotating superfluid ^{3}He-B are part of current studies of superfluid dynamics in the limit T -> 0 with a rotating cryostat. The same measuring setup is also employed for a second purpose where one determines the heat release from the spin-up of the superfluid component at constant externally controlled conditions. This measurement on the conversion of vortex dissipation to heat is a continuation of earlier studies in Ref. [1]. A proper understanding of the thermal resistance arising from the Andreev reflection of quasiparticle excitations is an important part of the interpretation the heat release measurements. *References:* [1]. *Quantum turbulence in a propagating superfluid vortex front;* V.B. Eltsov, A.I. Golov, R. de Graaf, R. Hänninen, M. Krusius, V.S. L'vov, and R.E. Solntsev, Phys. Rev. Lett. **99**, 265301 (2007); preprint arXiv:0708.1095 [cond-mat.soft].
Technical description of work performed: (250 words max)	Measurements of the Andreev reflection of thermal quasiparticles from an array of rectilinear quantized vortices in superfluid ^{3}He-B were performed in the rotating cryostat of the Low Temperature Laboratory. Two sensitive quartz tuning fork resonators were used for this purpose, one as a source and another as a detector of quasiparticles (i.e. as heater and thermometer). The experiment was operated in the ballistic regime of quasiparticle propagation, at very low temperatures, approximately at 0.2 T_C or 500 μK. Depending on the rotation velocity of the cryostat, the density of quantized vortices below a small orifice of 0.3 mm diameter changes and affects the thermal resistance measured across the orifice for varying amounts of heat current. The experimental data were evaluated in two different ways. First, a steady-state power vs. temperature dependence was examined, yielding the thermal resistance of the orifice. It was then compared with another value obtained from dynamic measurements, i.e. from the thermal relaxation of the sample container volume after switching the heater fork on/off. To perform this analysis, existing software was modified and new Matlab programs were developed. Within this project, an already acquired data set was re-analysed, now studying the dynamics of the heat transport processes. In addition a new measurement was performed with increased sensitivity, thanks to ongoing improvements in the stability of the rotating cryostat and the reduction in noise levels. A simplified mathematical model was also

	developed, which was used to calculate rough quantitative estimates and, more importantly, allowed direct association of the observed dynamics with the heat transport properties through different parts of the experimental setup.
Project achievements (and difficulties encountered)**:**[5] (250 words max)	This project represents the continuation of a long and successful cooperation between the Superfluidity group in Prague and the ROTA group in Helsinki. The main accomplishment lies in the measurement of Andreev reflection on a rectilinear array of quantized vortices – an experiment performed for the first time in a system with a well-defined geometry of quantized vorticity, which is essential for comparison with theoretical calculations and numerical simulations. Another important benefit is the calibration of the thermal resistance of the orifice of the sample container (by both steady-state and dynamic methods) and of the residual heat leak to the container. These will become essential parameters for future *in situ* experiments, e.g. investigations of the dissipation from the propagation of a turbulent vortex front along the long rotating cylinder. A minor new result is the proposed mathematical model, which helped to provide insight in the heat transport dynamics, but ultimately will have to be supplemented by a direct simulation of the quasiparticle motion through the sample volume. A couple of setbacks and delays were encountered while working on this project. First, the belt conveying rotation to the cryostat broke, causing a three day delay in the measurement. The replacement belt also seems to have affected the stability of the system. Another difficulty arose from the proposed subject itself – Andreev reflection was found to be an observable, but rather weak effect, therefore the results suffer from a non-negligible degree of uncertainty. All together, these difficulties did not prevent the completion of this project and the expected goals could be fulfilled.
Expected publications and dates:	▪ The first report (a Letter publication) from the measurements on Andreev reflection is planned to be available in October 2010.
Submission date of user group questionnaire:	27.5.2010

Completed Project Reports should be returned to MICROKELVIN Management Office (Leena.Meilahti@tkk.fi, Fax: +358 9 4512969).