welcome to the European Microkelvin Collaboration

CAPACITIES

Application Form for MICROKELVIN Transnational Access Project

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 Temperture Physics, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic
	Home institution is MICROKELVIN partner:	**Yes** ☐ **No X**
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Curriculum vitae (18 lines max):

2007 – present Charles University in Prague
PhD. student, specialization - superfluid turbulence in 4He
Current position: research associate (part time)

Junior researcher working in the Joint Laboratory of Low Temperature Physics on projects related to turbulence in classical fluids and superfluid ^{4}He.

At the same time a graduate student (presently 2nd year) at the Faculty of Mathematics and Physics, under the supervision of Prof. Ladislav Skrbek

2002 – 2007 Charles University in Prague – M.Sc. in Physics (Cond. Matt.)

Five most recent publications:

1) Blazkova M., Schmoranzer D., Skrbek L.: Transition from laminar to turbulent drag in flow due to a vibrating quartz fork, *Phys. Rev. E*, Vol. **75**, Issue 2, 2007

2) Blaauwgeers, R; Blazkova, M; Clovecko, M, et al.: Quartz Tuning Fork: Thermometer, Pressure- and Viscometer for Helium Liquids, *J. Low Temp. Phys.*, Vol. **146**, Issue 5-6, p. 537-562., 2007

3) Blazkova, M; Clovecko, M; Eltsov, VB, et al.: Vibrating quartz fork - A tool for cryogenic helium research, *J. Low Temp. Phys.*, Vol. **150**, Issue 3-4, p. 525-535, 2008

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[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'.

<table>
<tr><td rowspan="2"></td><td colspan="3">4) Blazkova, M; Chagovets, TV; Rotter, M, et al.: Cavitation in liquid helium observed in a flow due to a vibrating quartz fork, J. Low Temp. Phys., Vol. 150, Issue 3-4, p. 194-199, 2008</td></tr>
<tr><td colspan="3">5) Blazkova, M; Schmoranzer, D; Skrbek, L.: On cavitation in liquid helium in a flow due to a vibrating quartz fork, Low Temperature Physics, Vol. 34, Issue 4-5, p. 298-307, 2008
6) Blazkova, M; Schmoranzer, D; Skrbek, L, et al.: Generation of turbulence by vibrating forks and other structures in superfluid He-4, Phys. Rev. B, Vol. 79, Issue 5, 2009</td></tr>
<tr><td rowspan="4">Other participating scientists:[3]</td><td>Name:</td><td>Position:</td><td>New User:[2]</td></tr>
<tr><td>1- Ladislav Skrbek</td><td>professor</td><td>yes</td></tr>
<tr><td>2-</td><td></td><td></td></tr>
<tr><td>3-</td><td></td><td></td></tr>
</table>

[3] Please list all participating user group members. Expand the table, if necessary.

2. Project Information

Name of host infrastructure:	Low Temperature Laboratory, Helsinki University of Technology (TKK)			
Access provider / Infrastructure Director:	**Name:** Prof. Matti Krusius		**E-mail address:** krusius@cc.hut.fi	
	Prof. Mikko Paalanen		paalanen@neuro.hut.fi	
Planned project dates:	**Start date:**	28/02/2010 23/03/2010	**Completion date:**	13/03/2010 11/04/2010

Project description (12 lines max):

This is a four-week follow-up visit which is carried out in two two-week sections. David visited the Low Temperature Laboratory from May 6 to August 1 this past summer. At that point a new measurement setup was assembled, tested, and installed in the rotating nuclear demagnetization cryostat. Right after his departure the cryostat was cooled down for the first time, since it was moved in the new laboratory building, where it had been under reconstruction from the beginning of 2008. During the autumn of 2009 the cryostat operation was trimmed and improved so that heat leaks and temperatures are now lower than before reconstruction. Simultaneously the measurement which David helped setting up has been largely completed.

During this follow-up visit David will have a possibility to familiarize himself with hands-on measurements how the experimental setup functions. It uses NMR methods for vortex measurements and quartz tuning fork oscillators for quasiparticle density measurements. The first measurement with the reconstructed cryostat deals with the thermal properties of the measuring setup. Using two quartz tuning fork probes, one as heater and the other as detector, the thermal resistance between the sample and the refrigerator is determined. The measurement is performed in the collisionless regime of quasiparticle transport at 0.20 T_c temperature in the sample volume. The thermal resistance is dominated by an orifice of 0.3 mm diameter which separates the sample volume from a sintered heat exchanger, which provides the thermal contact between the liquid ^{3}He volume and the nuclear cooling stage. The measurement yields as a side product the residual heat leak to the sample volume which proves to be about 10 pW. This heat flow through the thermal resistance of the orifice limits the minimum temperature of the sample volume. In rotation the thermal resistance increases linearly with the angular velocity Ω. The linear increase is clear proof that the phenomenon is caused by rectilinear vortex lines which appear at a density $2\Omega/\kappa$ in rotation and block heat transfer through the orifice, owing to the Andreev reflection of quasiparticle excitations from the vortical superfluid flow fields ($\kappa = h/2m_3$ is the superfluid quantum of circulation).

This is by no means the first measurement of Andreev scattering from vortices in superfluid ^{3}He-B, but it is the first time with vortices in a well-defined configuration which can now be analyzed and compared to direct calculations. A report will be we prepared on the results where we provide a comparison to calculations, with David as coauthor.

Scientific objectives of the project (12 lines max):

The above measurements of Andreev reflection are part of current studies where the main goal is spin-up of the superfluid component at constant externally controlled conditions. Here we examine the propagation of a vortex front along a rotating superfluid column in stationary state conditions. Outside interference is thereby minimized and it might become possible to measure the small increase in the density of normal excitations, or in other words the temperature rise, which turbulent vortex dissipation is expected to give rise to.

This measurement of the conversion of vortex dissipation to heat is a continuation of our earlier studies in Ref. [1].

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 to be performed (20 lines max):

David Schmoranzer is preparing his Ph.D. thesis on thermally driven superfluid - normal fluid counterflow turbulence in superfluid ^{4}He at temperatures above 1 K. He has completed roughly half of his experimental work. The four-month participation in measurements on vortices in rotating ^{3}He-B at the lowest temperatures will provide him new perspectives of superfluid helium studies. It will also familiarize him with the concepts of superfluid turbulence in the limit of ballistic quasiparticle densities (commonly known as quantum turbulence). His measuring tool in superfluid ^{4}He turbulence is the quartz tuning fork oscillator. This is one of the unifying features between his Ph.D. studies at home and the measurements on vortices in ^{3}He-B. In this latter case the quasiparticle density is monitored with tuning fork oscillators. We hope that the measurements on Andreev reflection will become a chapter in David's Ph.D. thesis.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**Yes ☐ No X**
Specify: Part of general effort to understand quantum turbulence in the zero temperature limit	

Is this proposal submitted to any funding programmes?	**Yes ☐ No X**
If yes, please specify:	**Only to MicroKelvin collaboration**

The completed application form should be submitted to the MICROKELVIN Management Office