welcome to the European Microkelvin Collaboration

CAPACITIES

# Application Form for MICROKELVIN Transnational Access Project

## 1. General Information

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|---|---|---|
| **Project number** | **TKK 01** | |
| **Project title:** | VORTEX MOTION AND DISSIPATION AT VERY LOW TEMPERATURES IN 3He-B | |
| **Project acronym:** | | |
| **Lead scientist:**[1] | **Title:** | Mr. |
| | **First name:** | David |
| | **Last name:** | Schmoranzer |
| | **Birth date:** | 28/11/1981 |
| | **Research status/Position:** | graduate student |
| | **New User:**[2] | Yes |
| | **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** |
| | **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 |
| | **Curriculum vitae (18 lines max):**<br>2007 – present Charles University in Prague<br>PhD. student, specialization - superfluid turbulence in 4He<br>Current position: research associate (part time)<br><br>Junior researcher working in the Joint Laboratory of Low Temperature Physics on projects related to turbulence in classical fluids and superfluid 4He.<br>At the same time a graduate student (presently 2nd year) at the Faculty of Mathematics and Physics of the same Univeristy, under the supervision of Prof. Ladislav Skrbek<br><br>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 | |

[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'.

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| | 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 | | |
| | 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 | | |
| | 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<br>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 | | |
| **Other participating scientists:**[3] | **Name:** | **Position:** | **New User:**[2] |
| | 1- Ladislav Skrbek | professor | yes |
| | 2- | | |
| | 3- | | |

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

## 2. Project Information

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| **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:** | 06/05/2009 | **Completion date:** | 01/08/2009 |

**Project description (12 lines max):**

The nature of vortex motion and dissipation is an intriguing open question in superfluids at the lowest temperatures. The traditional source of friction and damping, known as mutual friction, arises from the scattering of normal excitations from a quantized vortex, when the vortex moves with respect to the reference frame provided by the normal fluid. This mechanism of dissipation approaches zero in the zero temperature limit, when the cloud of normal excitations becomes more and more rarefied. If the flow conditions are externally changed in this situation, for instance by changing the rotation velocity, how does the superfluid component and its vortices know how to respond? From measurements on both helium superfluids and Bose-Einstein condensed cold atom clouds we now know that the superfluid with its vortices, nevertheless, is coupled to the external reference frame. What provides this coupling: are there new dissipation mechanisms which govern the superfluid dynamics in the zero temperature limit?

One such mechanism is the pinning of vortices on surface roughness. In usual experimental setups superfluid 4He is known to represent the limit of strong surface pinning, while superfluid 3He-B is assumed to display weak surface friction in the presence of smooth surfaces. In the case of Bose-Einstein condensates the measurements are conducted in the absence of surfaces and pinning is not the answer. Measurements on the spin-up and spin-down of the superfluid component in 3He-B under varied conditions have shown that the superfluid remains coupled to the external reference frame down to very low densities of normal excitations, where their mean free path is much longer than the sample dimensions, and that here dissipation in vortex motion strongly depends on vortex polarization.

**Scientific objectives of the project (12 lines max):**

New experiments are starting where the spin-up of the superfluid component is studied at constant externally controlled conditions. This measurement looks at the propagation of a vortex front along a rotating column in stationary state conditions. Thus outside interference is minimized and it might be possible to measure the small increase in the density of normal excitations, which the vortex dissipation is expected to give rise to.
This measurement of the conversion of vortex dissipation to heat is a continuation of the 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 4He at temperatures above 1 K. He has completed roughly half of his experimental work. The three-month participation in the measurements on spin-up in 3He-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 4He 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 vortex dissipation in 3He-B, since in this latter case the quasiparticle density is monitored with sensitive quartz fork oscillators.

## 3. Joint Proposals / Funding

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| **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** | |

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

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The completed Application Form should be submitted to MICROKELVIN Management Office (**leena.meilahti@tkk.fi**, fax +358-9-4512969)