Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**AALTO 40**	
Project Title:	**Dissipation losses from Kelvin waves and the Kelvin-wave cascade**	
Lead scientist:[1]	**Title:**	Professor
	First name:	Edouard
	Last name:	Sonin
	Home institution:	Racah Institute of Physics, Hebrew University
Host scientist:[2]	**Title:**	Senior researcher, Ph.D.
	First name:	Risto
	Last name:	Hänninen
	Home institution:	O.V. Lounasmaa Laboratory, Aalto University
Project scientist:[3]	**Title:**	Professor
	First name:	Edouard
	Last name:	Sonin
	Birth date:	
	Passport number:	
	Research status/Position:	professor
	New User:[4]	
	Scientific Field:	Condensed matter physics
	Home institution:	
	Is your home institution MICROKELVIN partner?	No
	Business address:	
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Curriculum vitae (18 lines max):

Edouard Sonin is a Professor Emeritus at the Racah Institute of Physics and a widely known expert of hydrodynamic theory in superfluids, superconductors, and magnetically ordered media. He comes originally from the Ioffe Institute in St. Petersburg (Russian Academy of Sciences) from where he moved to the Racah Institute in 1997. He is the author of a widely cited review on superfluid vortex dynamics [1]. His recent review on spin superfluidity [2] was listed as one of the top downloaded articles of Advances in Physics in January 2011.

References:

[1] E. B. Sonin, Rev. Mod. Phys. **59**, 87-155 (1987).

[2] E. B. Sonin, Adv. Phys. . **59**, 181-255 (2010).

Five most recent publications:

1. E. B. Sonin, Quantum spin Hall effect in 2D topological insulators, in: *Spintronic IV*, edited by H.-J. M. Drouhin, J.-E. Wegrowe, and M. Razeghi, Proc. of SPIE Vol. **8100**

[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'.

	(SPIE, Bellingham, WA, 2011), article 8110003.		
	2. E. B. Sonin, Dynamics of twisted vortex bundles and laminar propagation of the vortex front, Phys. Rev. B **85**, 024515 (2012).		
	3. E. B. Sonin, Dynamics of helical vortices and helical-vortex rings, Europhys. Lett. **97**, 46002 (2012).		
	4. E. B. Sonin, Symmetry of Kelvin-wave dynamics and the Kelvin-wave cascade in the $T = 0$ limit in superfluid turbulence, Phys. Rev. B **85**, 104516 (2012).		
	5. E. B. Sonin, Transverse force on a vortex and vortex mass: effects of free bulk and vortex-core bound quasiparticles, Phys. Rev. B **87**, 134515 (2013).		
Other participating scientists:[5]	**Name:**	**Position:**	**New User:**[2]

2. Project Information

Name of host infrastructure:	Low Temperature Laboratory, Aalto University, Espoo, Finland			
Access provider / Infrastructure Director:	**Name:** Prof. Matti Krusius		**E-mail address:** mkrusius@neuro.hut.fi	
Planned project dates:	**Start date:**	25/8/2013	**Completion date:**	9/9/2013

Project description (12 lines max):

Current measurements display larger dissipation in helium superfluids from vortex motion in the zero temperature limit, $T \longrightarrow 0$, than what standard mutual friction theory predicts. These measurements also extrapolate to a finite value at $T = 0$ which is not possible if simple direct mutual friction damping is considered. One current assumption is that these observations might be ascribed to a Kelvin-wave cascade propagating on individual vortex lines. However, recent numerical calculations with the vortex filament method on a single vortex reconnection event between two inter-linked vortex rings at mutual friction values down to $\alpha \sim 10^{-3}$ show no evidence for the presence of a Kelvin-wave cascade: the increased dissipation after the reconnection is explained by direct mutual friction damping of Kelvin wave excitations, without any indication for nonlinear interactions connecting different Kelvin modes. We plan to discuss how measurements and vortex filament calculations can be further extended to search for the existence of the Kelvin wave cascade.

Scientific objectives of the project (12 lines max):

The description of vortex motion in the very low temperature limit is one of the prime goals in the Microkelvin Joint Research Activities (JRA3 Task 1). This regime is also of central interest for drafting parts of the monograph on superfluid vortex dynamics which prof. Sonin is working on.

One of the tasks is to estimate numerically the energy flux from the Kelvin-wave cascade in different physical situations (or different Kelvin spectra) and to compare this flux with theoretical predictions and the direct dissipation from mutual friction. This comparison should reveal e.g. the importance of finite size effects (due to a finite resolution of the calculation) and, more generally, guide us to find the proper parameter values for the regimes where the Kelvin-wave cascade is at its strongest, such that it might become also experimentally observable.

Technical description of work to be performed (20 lines max):

During his 2-week visit in the Low Temperature Laboratory, prof. Sonin will get acquainted with the ongoing numerical simulation calculations of dissipation losses from vortex reconnections using the vortex filament model with Biot-Savart integration along the line vortices. The plan is to develop the calculations to a next step in pinpointing the origin for the dissipation observed experimentally in the $T \longrightarrow 0$ limit. Also the measurements on vortex dynamics in the rotating cryostat at the lowest temperatures will be reviewed, to discuss the physical interpretation of the results and a redesign of the measurement setup.

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

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**Yes**
Specify:	**Vortex dynamics in the zero temperature limit – JRA3 Task 1**

Is this proposal submitted to any funding programmes?	**No**
If yes, please specify:	**None**

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