welcome to the European Microkelvin Collaboration

CAPACITIES

Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	Aalto11	
Project Title:	Quasiparticle excitations generated by superfluid turbulence	
Project acronym		
Lead scientist:[1]	**Title:**	Prof.
	First name:	Victor
	Last name:	L'vov
	Birth date:	
	Research status/Position:	Prof.
	New User:[2]	No
	Scientific Field:	Turbulence in helium superfluids
	Home institution:	Weizmann Institute of Science, Rehovot, Israel
	Home institution is MICROKELVIN partner:	**No**
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	E-mail:	Victor.Lvov@weizmann.ac.il http://lvov.weizmann.ac.il
	Curriculum vitae (18 lines max): Prof. L'vov is a senior member of the permanent staff at the Weizmann Institute and a widely known expert of hydrodynamic theory in both viscous and superfluid flow. He comes from the Institute of Thermodynamics in Novosibirsk (Russian Academy of Sciences) from where he moved to the Weizmann Institute in the early nineties.	
	Five most recent publications (on helium superfluids):	
	V.S. L'vov, S.V. Nazarenko, and L. Skrbek, Energy Spectra of Developed Turbulence in Helium Superfluids, *J. Low Temp. Phys*. **145**, 125 - 142 (2006).	
	V.S. L'vov, S.V. Nazarenko, and O. Rudenko, Bottleneck crossover between classical and quantum superfluid turbulence, *Phys. Rev. B* **76**, 024520 (2007). DOI: 10.1103/PhysRevB.76.024520	
	V. S. L'vov, S. V. Nazarenko, and O. Rudenko, Gradual eddy-wave crossover in superfluid turbulence, *J. of Low Temp. Phys*. **153**, 140-161 (2008). DOI:s10909-008-9844-0	
	V.B. Eltsov, R. de Graaf, R. Hanninen, M. Krusius, R.E. Solntsev, V.S. L'vov, A.I. Golov, and P.M. Walmsley,Turbulent dynamics in rotating helium	

[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'.

	superfluids, ***Progress in Low Temperature Physics***, XVI pp. 46-146 (2009), DOI:0.1016/S0079-6417(08)00002-4 ; arXiv:0803.3225 V.S. L'vov and S.V. Nazarenko, Spectrum of Kelvin-wave turbulence in superfluids, *Pis'ma v ZhETF* **91**, 464 (2010) ; arXiv :0911.2065v5

	Name:	**Position:**	**New User:**[2]
Other participating scientists:[3]	1- Sergey V. Nazarenko	professor University of Warwick, UK	yes
	2- Oleksii Rudenko	Ph.D. student Weizmann Institute, Israel	yes

2. Project Information

Name of host infrastructure:	Low Temperature Laboratory, Aalto University, Espoo, Finland			
Access provider / Infrastructure Director:	**Name:** Prof. Matti Krusius Prof. Grigory Volovik		**E-mail address:** krusius@cc.hut.fi volovik@boojum.hut.fi	
	Prof. Mikko Paalanen		paalanen@neuro.hut.fi	
Planned project dates:	**Start date:**	6/8/2010	**Completion date:**	29/8/2010

Project description (12 lines max):

Dissipation from the motion of quantized vortices at the very lowest temperatures is of great current interest in the study of coherent quantum systems. At higher temperatures the source of dissipation is the damping in vortex motion known as mutual friction. It arises from the scattering of normal excitations from a vortex which 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 rarefied. In a rotating cryostat one can explore the motion of vortices as a response to a change in the rotation velocity, and by comparing the results for different initial conditions. The unsettled question concerns the zero temperature limit: Is dissipation in vortex motion indeed approaching zero or are there new mechanisms which govern the superfluid dynamics and become measurable at the lowest temperatures?

The MicroKelvin collaboration provides an opportunity to study these questions experimentally in the fermion superfluid 3He-B by means of a rotating cryostat. With this apparatus 3He-B is cooled to below 0.2 Tc in rotation which can be controlled to within ± 1 circulation quantum. Measurements on the spin-up and spin-down of the superfluid component under varied conditions have shown that vortices respond instantaneously to changes in the rotation velocity down to very low densities of normal excitations, where their mean free path is much longer than the sample diameter. However, dissipation strongly depends on vortex polarization and on reconnections both in the bulk volume and on the surface of the container, *i.e.* on whether vortex flow is laminar or turbulent. Two different types of vortex motion have been studied at the lowest temperatures: the turbulent propagation of a precessing vortex front along the rotating column of superfluid [1] where dissipation approaches a constant but finite value, and the laminar spin down or spin up of the superfluid component after an abrupt change of rotation velocity [2], where dissipation in the bulk volume is caused by mutual friction and thus vanishes, when $T \to 0$.

References:

[1] V.B. Eltsov, A.I. Golov, R. de Graaf, R. Hänninen, M. Krusius, V.S. L'vov, and R.E. Solntsev, Quantum turbulence in propagating superfluid vortex front, *Phys. Rev. Letts*, **99**, 265301 (2007); DOI:10.1103//PhysRevLett.99.265301

[2] V.B. Eltsov, R. de Graaf, P.J. Heikkinen, J.J. Hosio, R. Hänninen, M. Krusius, and V.S. L'vov, Super stability of laminar vortex flow in superfluid 3He-B, arXiv:1005.0546v1

Scientific objectives of the project (12 lines max):

Professor L'vov has studied (together with his student Oleksii Rudenko and his colleague Sergey Nazarenko) the free decay of homogeneous and isotropic superfluid turbulence. In particular, they have paid attention to the cross-over regime from the hydrodynamic Richardson – Kolmogorov energy cascade to Kelvin waves propagating on single vortex lines. They find that a bottleneck will arise in the energy transfer between the two branches with increasing vortex polarization. In his most recent work he has reanalyzed the properties of the energy spectrum of Kelvin waves. The upcoming project concerns the mechanisms of dissipation in different types of vortex motion at the lowest temperatures, as studied via the generation of quasiparticle

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

excitations.

The visit takes place at a time when newly measured information exists on quasiparticle generation in turbulent vortex front propagation. This measurement monitors the propagation of a vortex front along a rotating column in stationary state conditions, whereby outside interference is minimized and it becomes possible to measure a small increase in the density of quasiparticle excitations as a function of time, while the vortex front moves along column. This measurement on the conversion of vortex dissipation to quasiparticles is a continuation of an earlier collaboration in Ref. [1]. The new mechanism of zero temperature dissipation is assumed to be associated with quasiparticle emission from 1-dimensional vortex core states [2].

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).

[2] The Universe in a Helium Droplet; G.E. Volovik (Clarendon Press, Oxford, 2003).

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

The three-week visit is used to develop the interpretation of ongoing measurements on the release of quasiparticle excitations during the propagation of a turbulent vortex front along a rotating column of superfluid 3He-B.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**Yes**
Specify:	**Quantum turbulence in the zero temperature limit**

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

The completed Application Form should be submitted to MICROKELVIN Management Office (**Katariina.Toivonen@neuro.hut.fi**, fax +358-9-47022969)