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European Microkelvin Collaboration

CAPACITIES

MICROKELVIN Transnational Access Project Report

1. General information

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
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	Home institution is MICROKELVIN partner:	**Yes** ☐ **No X**
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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'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	The nature of vortex motion and dissipation is an intriguing open question in superfluids at the lowest temperatures. The traditional source of friction in vortex motion, 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. A second question is the coupling between the superfluid and its reference frame fixed to the laboratory. If the flow conditions are externally changed in the low temperature limit where thermal excitations move ballistically and only interact with the container walls, then 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 know that the superfluid with its vortices, nevertheless, is coupled to the external reference frame, for instance, when the rotation velocity of the rotating refrigerator is changed. Also current measurements on turbulent vortex motions extrapolate to non-zero dissipation in the $T \rightarrow 0$ limit. What is the origin of these unexpected phenomena: are there novel mechanisms which govern the superfluid dynamics in the zero temperature limit? Today this task is simplified by the fact that these studies can be performed on different types of superfluids, namely on superfluid 4He, 3He-B, and on Bose-Einstein condensates. These have different properties and thus the limiting low temperature behavior of superfluids in general can perhaps be reconstructed by comparing results from various different types of measurements. The goal of the present experiments is to find the basic facts about these features in superfluid 3He-B. David Schmoranzer is preparing his Ph.D. thesis on turbulence in superfluid 4He in his home institute with professor Skrbek. Participation in present work with superfluid 3He-B will provide him a wider perspective of the underlying physics.
Technical description of work performed: (250 words max)	New experiments have been started 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 superfluid column in stationary state conditions. Outside interference is thereby minimized and it might be possible to measure the small increase in the density of normal excitations, or in other words the temperature rise, 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]. During the summer months of 2009 the development of the NMR and quartz tuning fork measuring probes was carried out, the devices were inserted in the sample container, and the entire measuring setup was installed in the cryostat. In early August 2009 the experiment was cooled down. Currently at the end of August tests are conducted to reduce noise and interferences in the measurement probes. Simultaneously the heat leaks to the experiment from uncontrolled electrical ground currents are reduced to acceptable levels. It is projected that this work will be completed

	in the middle of September 2009. Test measurements in the superfluid state would then start in early October 2009. *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).
Project achievements (and difficulties encountered)**:**[5] (250 words max)	David Schmoranzer participated in the development and installation of the measuring probes. He learned quickly the various tasks and became a vital dependable part of the entire effort. It is hoped that he will be able to use this experience in his thesis work. Secondly, owing to delays in the reconstruction of the rotating refrigerator installation, the work did not reach during his visit the stage where he would have had a chance to experience actual measurements. For this reason it is planned that David would participate a second time in this work in November – December 2009 for 2 – 4 weeks. At that point we expect that the experiment will be producing new physical information about dissipation in vortex motions in the T → 0 limit.
Expected publications and dates:	It is planned that a report about the first results from the present measurements would be available in a year from now. This report would then be part of David Schmoranzer's Ph.D. thesis work.
Submission date of user group questionnaire:	August, 2009

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