welcome to the
European Microkelvin Collaboration

CAPACITIES

Report on the Transnational Access Activity carried out within MICROKELVIN

The eligibility of transnational access to a MICROKELVIN TA site implies the submission of the following:

1) <u>The Certification of visit</u>

The form “Certification of visit” must be completed and signed by the access provider in charge of the infrastructure and the leader of the project.

2) <u>A TA project report</u>

The form for the TA project report is contained within this document. It should be completed after project end by the group leader of the project. You must respect the limited number of words specified, longer descriptions will be rejected. Figures/tables may be attached at the end of the document. The document must be submitted in an editable format (doc, rtf).

3) <u>A User group questionnaire</u>

To enable the Commission to evaluate the Research Infrastructures Action, to monitor the individual contracts, and to improve the services provided to the scientific community, <u>each project leader</u> of a user-project supported under an EC Research Infrastructure contract is requested to complete a "user group questionnaire". The questionnaire must be submitted once by each user group to the Commission as soon as the experiments on the infrastructure come to end.

The user group questionnaire is not part of this document and must be completed on-line. It is accessible at:

http://cordis.europa.eu/fp7/capacities/questionnaire_en.html.

► **Please note that any publications resulting from work carried out under the MICROKELVIN TA activity must acknowledge the support of the European Community:**

> **“The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 228464 (MICROKELVIN).”**

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MICROKELVIN Transnational Access Project Report

1. General information

Project number:	**AALTO19**	
Project Title:	**Vortex waves in rotating superfluid 3He-B**	
Lead scientist:[1]	**Title:**	Dr.
	First name:	Paul
	Last name:	Walmsley
	Home institution:	University of Manchester, UK
Host scientist:[2]	**Title:**	Dr.
	First name:	Vladimir
	Last name:	Eltsov
	Home institution:	Aalto University, Finland
Project scientist:[3]	**Title:**	Dr.
	First name:	Paul
	Last name:	Walmsley
	Birth date:	16th June 1977
	Passport number:	210321791
	Research status/Position:	Research Fellow
	New User:[4]	No
	Scientific Field:	Superfluid hydrodynamics and turbulence
	Home institution:	University of Manchester, UK
	Is your home institution MICROKELVIN partner?	☐ No
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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'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	Kelvin waves on vortex lines are believed to be an important component of quantum turbulence in superfluids at low temperatures. In particular, energy transfer along the Kelvin-wave cascade should make it possible to have a finite rate of energy dissipation in the zero-temperature limit. Up to date, however, Kelvin waves as well as the Kelvin-wave cascade have not really been probed experimentally in superfluids. Our goal was to study a type of vortex motion, which is closely related to Kelvin waves on individual vortex lines: vortex waves in an array of vortices, which is produced by rotation of a long cylindrical 3He-B sample at temperatures down to 0.15 Tc. The plan was to modulate the angular velocity of rotation to create vortex waves and to study their build-up, propagation, and relaxation using nuclear magnetic resonance techniques. The immediate goal was to understand the effect of the oscillations in a vortex cluster on the frequency shift of the magnon condensate NMR mode, which was observed earlier in preliminary measurements, and to establish, whether this effect is caused by the reduction in the polarization of vortices in the cluster when vortex waves are created.
Technical description of work performed: (250 words max)	New measurements were performed using NMR to probe the magnon states in a cylindrical sample of superfluid 3He-B during modulated rotation. The effect from varying the amplitude of modulation, the time that the modulation was switched on, or the temperature (between 0.15 to 0.18 Tc) were investigated in the presence of a steady DC component of rotation at 1.4 rad/s. The frequency shift of the magnon states versus time after both starting and stopping the modulation were also studied. In order to understand the observed behaviour, various textures of the order parameter and the corresponding frequency shifts of the magnon states were calculated numerically, including the effect from azimuthal and axial flow (resulting from various configurations of vortices). This was achieved by modifying existing computer codes. A simple fitting procedure was applied to the transients produced during relaxation after stopping the modulation, enabling comparisons between the various measurements to be made. The preliminary results from simulations produced in a separate but related project by Risto Hänninen were analysed and compared to the experimental observations.
Project achievements (and difficulties encountered)**:**[5] (250 words max)	The hypothesis based upon the preliminary measurements, that the primary effect observed in the NMR magnon spectra is caused by the reduction in the polarization of the vortex array, has now been confirmed. Thus, the modulations produce highly polarized quantum turbulence. The calculations performed during the project show that the experiment is not sensitive to the axial flow produced by large-scale collective motion of the vortex array (the analogue of classical inertial waves). The transient signals produced by stopping the modulation proved to be particularly instructive. There appear to be two different processes occurring during this relaxation. The first is apparently due to the decay of the large-scale (long wavelength) vortex

	waves (inertial waves). The time scale for this process was dependent on the amplitude of modulation, temperature, and how long the modulations were switched on. There is little change in the experimental signal during this decay. The second process was characterized by the late-time exponential decay of the experimental signal with a time constant of ~300 seconds. This time scale is independent of the amplitude and duration of the modulation and thus appears to be related to the dissipation of Kelvin waves on individual vortex lines. The amplitude and duration of the modulations affect how much energy is stored in the long wavelength modes. After stopping the modulation, energy is fed from the long wavelength modes to the shorter wavelength Kelvin modes providing some evidence for the proposed Kelvin-wave cascade scenario that is believed to occur in the decay of quantum turbulence.
Expected publications and dates:	Article in Physical Review B, January 2013.
Submission date of user group questionnaire:	27/02/2012

Completed Project Reports should be returned to MICROKELVIN Management Office (Sari.Laitila@aalto.fi, Fax: +358 9 47022969).