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) The Certification of visit

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) A TA project report

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) A User group questionnaire

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, each project leader 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:	AALTO15A	
Project Title:	Dynamics of quantized vortices in superfluids & superconductors	
Lead scientist:[1]	**Title:**	professor
	First name:	Edouard
	Last name:	Sonin
	Home institution:	Racah Institute of Physics, Hebrew University of Jerusalem
Project scientist:	**Title:**	professor
	First name:	Edouard
	Last name:	Sonin
	Birth date:	08/11/1936
	Passport number:	13341147
	Research status/Position:	professor emeritus
	New User:[2]	No
	Scientific Field:	condensed matter physics
	Home institution:	Racah Institute of Physics
	Is your home institution MICROKELVIN partner?	X 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] 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)	Prof. Sonin has studied the axially propagating motion of vortices in a rotating column of superfluid He [1]. The central questions are the configuration of the propagating vortices and an analysis of the laminar dynamics at not too low temperatures (where the mutual friction dissipation $\alpha \sim 1$). The calculations start from an analysis of the axially expanding motion of a single vortex in a rotating and otherwise vortex-free cylinder. They then proceed to the case of many vortices which move along the cylinder as a precessing and propagating front followed by a uniformly twisted bundle of vortices. The calculations apply for laminar motion and are based on the balance of energy and of linear and angular momenta in stationary state propagation. The stability of this state has been examined. The results are compared to experimental and numerical work, which has been going on in the Low Temperature Laboratory of the Aalto University. An analytic theory of the axial vortex motion in rotation, which is consistent with experiment and numerical vortex filament calculation, would provide a much better understanding of the rich dynamics in the different regimes of mutual friction. It will provide important guidance for future research. **References:** [1] *"Equilibrium rotation of a vortex bundle terminating on a lateral wall",* E.B. Sonin and S.K. Nemirovskii, Phys. Rev. B **84**, 054506 (2011).
Technical description of work performed: (250 words max)	The analysis is based on the equations of vortex dynamics in the two-fluid hydrodynamics of helium superfluids. Recent progress in experiment and numerical vortex filament calculations has guided the choices of selecting possible parameter ranges and approximations for working out useful solutions.
Project achievements (and difficulties encountered)**:**[5] (250 words max)	The parameters of precessing vortex front propagation were derived for the first time from the basic hydrodynamic principles, the general two-fluid vortex dynamics equations. This allows checking previous qualitative estimations for the laminar regime. An analysis of the Ostermeier-Glaberson instability, arising from the axial currents generated by the twisted configuration of the vortex bundle behind the propagating vortex front, opens a way to discuss the transition from laminar vortex flow to turbulence, which is based on a more solid theoretical foundation than before. This is planned to be done in the future.
Expected publications and dates:	▪ A publication on this work is expected before the end of 2011. ▪ The results will also be part of a book on superfluid vortex dynamics, planned for publication at the end of 2012. ▪ Further discussion of analytic solutions will be important for current interests to clarify superfluid vortex dynamics in the

	very low-temperature limit, $T \rightarrow 0$, when mutual friction approaches zero.
Submission date of user group questionnaire:	30 September, 2011  prof. Edouard Sonin

Completed Project Reports should be returned to MICROKELVIN Management Office (laitila@neuro.hut.fi, Fax: +358 9 47022969).