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:	**Lancs18**	
Project Title:	**The superfluid 3He AB interface: friction and orbital viscosity**	
Lead scientist:[1]	**Title:**	Dr.
	First name:	Manuel
	Last name:	Arrayás
	Home institution:	Universidad Rey Juan Carlos
Host scientist:[2]	**Title:**	Dr.
	First name:	Richard
	Last name:	Haley
	Home institution:	Lancaster University
Project scientist:[3]	**Title:**	Dr
	First name:	Manuel
	Last name:	Arrayás
	Birth date:	21/07/1972
	Passport number:	AC899408
	Research status/Position:	Reader
	New User:[4]	No
	Scientific Field:	Low temperature plasma physics
	Home institution:	Universidad Rey Juan Carlos
	Is your home institution MICROKELVIN partner?	No
	Business address:	
	Street:	Camino del Molino s/n, Edif. Biblioteca, Desp. 008
	PO Box:	
	City:	Fuenlabrada, Madrid
	Zip/Postal Code:	29843
	Country:	Spain
	Telephone:	+34 914888460
	Fax:	
	E-mail:	manuel.arrayas@urjc.es

[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)	During the last visit we realised that friction on the moving interface must be important in impeding the growth of instabilities. This led us to examine the unexplained non-linear dissipation observed for an oscillating interface. The motion of the interface must induce changes in the local texture on either side of the interface. These changes will be damped by orbital viscosity. Our preliminary crude estimates indicated that this could be a dominant mechanism for the observed dissipation. Our primary objective is to include orbital viscosity in our model for the moving interface and use it to describe the subsequent dissipation. This is of crucial importance to understand the interface dynamics at low temperatures. We have measurements of the dissipation caused by an oscillating interface that we have been unable to explain, even qualitatively. We believe that orbital viscosity could offer a solution to this. We will first concentrate on using orbital viscosity to calculate the dissipation from a changing texture in the distorted B-phase. We will then apply this to simple model textures such as the flare-out texture on the B-phase side of the interface. The resulting dissipation will then feed back into the equation of motion governing the interface dynamics. In principle we can also study the effect on non-ideal textures and textural defects on either side of the interface. We can compare this with existing experimental data. We will also apply these ideas to calculate the velocity of a freely moving interface. This secondary objective is important as the free interface moves so fast in our experiments that we have only been able to put a lower limit on its speed owing to limitations in our measurement technique. Knowing the velocity impacts on assessing the stability of the moving interface and therefore on the likelihood of leaving topological textural defects in its wake.
Technical description of work performed: (250 words max)	In our experimental arrangement the texture of both the A and B phase order parameters is influenced by the interface, and bends by 90 degrees from its direction in bulk. As the interface moves, the texture of the surrounding A and B phases must bend and realign to accommodate it. Previous attempts by Leggett and Yip, and Kopnin, to model the friction on a moving interface did not include effects of the bending texture, and therefore ignored orbital viscosity, leading to estimates of dissipation that are much lower than what we measured experimentally. We have modelled the moving interface and the concomitant bending of the texture. We have applied ideas of orbital viscosity to calculate the subsequent dissipation, and hence the friction on the moving interface. We have compared the model calculations to the existing measurements of the anomalous drag on an oscillating interface. We have used this model to make estimates of the speed of a freely moving interface limited by friction.
Project achievements (and difficulties encountered):[5] (250 words max)	In order to explain the dissipation associated with the periodic movement of the interface, as measured at Lancaster, this time we started to consider an extra relaxation mechanism at the AB interface due to the rearrangement of the order parameter texture on the B phase side. The idea is that the magnetic field produces a small axial distortion of the energy gap, so that the quasiparticle distribution has to relax to equilibrium when the gap structure bends in the texture. Due to the finite quasiparticle scattering time, a net viscous force develops. We had a breakthough in finding a functional form

	for a frequency dependent damping coefficient that allowed us to make qualitative fits to the measured data for the first time. Quantitative estimations also appear to be of the right order of magnitude. At the moment, the relaxation time of quasiparticles to equilibrium needed to fit the experimental data is bigger than the estimation from the time that a quasiparticle reaches the container wall. There is also a high frequency mechanism presented in the dissipation process that seems to be independent of the orbital viscosity one. We have modelled it as an extra term, but its physical origin is under discussion.
Expected publications and dates:	After some further measurements and data analysis, we plan to publish our preliminary findings in the next few months or so.
Submission date of user group questionnaire:	25 Sep, 2013

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

SEVENTH FRAMEWORK PROGRAMME

Please complete and sign the form and send it by email or fax to the MICROKELVIN Management Office (leena.meilahti@tkk.fi, Fax No.: +358 9 4512969)

CERTIFICATION OF VISIT

at MICROKELVIN Transnational Access Site

I herewith confirm that the following project was carried out at our Transnational Access Site

University of Lancaster

in the context of MICROKELVIN Transnational Access:

The superfluid 3He AB interface; friction and orbital viscosity

The amount of access[1] delivered to the project group (project users) is as follows:

	Participant name	Duration of stay (start – end date)	Amount of access[2]
Project leader:	Dr Manuel Arrayás	13/8/13 – 6/9/13	25
Project user 1:			
Project user 2:			
Project user …:[3]			
Total amount of access delivered to project group:			25

LANCASTER 6/9/13

Location and date

Signature of access provider
Prof. Shaun Fisher

LANCASTER 6/9/13

Location and date

Signature of project leader
Dr Manuel Arrayás

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(sari.laitila@aalto.fi, fax: +358 9 47022969)

[1] TKK Helsinki, CNRS Crenoble, or Lancaster University

[2] The amount of access is defined as the time, in days, spent by the user at the infrastructure for this project, including weekends and public holidays (e.g., a scientist who spent 5 days at the infrastructure must indicate '5'). The total amount of access of the project group is the sum of access days of each project user.

[3] Please, expand if necessary