welcome to the
European Microkelvin Collaboration

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:	Lancs07	
Project Title:	**The superfluid 3He AB interface: analogue cosmological brane**	
Lead scientist:[1]	**Title:**	Dr
	First name:	Manuel
	Last name:	Arrayás
	Home institution:	Universidad Rey Juan Carlos
Host scientist:[2]	**Title:**	Dr.
	First name:	Rich
	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]	Yes
	Scientific Field:	Low temperature plasma physics
	Home institution:	Universidad Rey Juan Carlos
	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)	The primary objective of the project is to provide further understanding on the properties of the A-B interface 2-brane. In the experiments a shaped magnetic field is used to stabilise and manipulate the phase boundary between the A and B phases. Here we exploit the influence of a magnetic field on the phase transition between the two phases, with the B phase being stable up to a critical field of 340 mT, whereupon there is a first-order transition to the A phase. A first-order transition has an energy cost associated with the surface tension between the two phases. This must be taken into account when assessing the equilibrium shape of the interface within the magnetic field profile, as well as the differences in wetting energy between the two phases and the container walls. I have developed numerical methods to find the equilibrium position for realistic field profiles and boundary conditions, to simulate the interface behaviour when subjected to perturbations, and to see how its properties may be modified by defects that can exist within it. My visit was planned to coincide with the ongoing experiments where the AB interface is moved through an array of detectors, by which the motion is monitored. I participated in these experiments and helped to interpret the results using my previously developed simulation tools.
Technical description of work performed: (250 words max)	The experiment consists of a vertical cylinder of superfluid, 6 cm long and 1.2 cm in diameter. A superconducting solenoid provides a controllable magnetic field gradient, allowing for the stabilisation of the AB interface across the cylinder. Sweeping the current in the solenoids changes the field gradient and moves the AB interface up and down the cylinder, converting B phase to A phase and vice versa. The passage of the AB interface was inferred from the behaviour of vibrating quartz tuning fork resonators that protrude into the superfluid from the sidewalls of the cylinder. These resonators are sensitive to the density of broken Cooper pair quasiparticle excitations, and are used to detect any changes as the interface is moved through the cell. It was seen that the interaction of the resonators with the interface was reproducible. Furthermore the signal depended on the relative orientation of the fork and the interface. New techniques were developed to move the interface more quickly through the cylinder, using temperature steps rather than magnetic field gradients. This was to investigate whether a fast-moving interface is more susceptible to instabilities. This remains an open question.
Project achievements (and difficulties encountered):[5] (250 words max)	For the analysis we have used a dynamical effective model proposed by Legget and Yip (see for example "He 3", edited by W.P Halperin and L. P Pitaevskii, Chapter 8). Initially, to calculate the equilibrium profile, the effective inertia term of the interface was neglected. Under that condition, the simulations suggest that the contact angle of the interface with the walls

	is not playing a fundamental role due to the dimensions of the interface at equilibrium. Also the slow movement of a perturbed interface has been simulated and preliminary results point to the damping of any transverse perturbation of the interface under cylindrical symmetry. A bubble equilibrium configuration also has been calculated. When the interface moves through the cylinder, on passing by the forks, we observed in the experiments that there is a kind of hysteresis behaviour on the response of the forks. The contact angle could be important then, but this is an open question at the moment. It is not clear whether the dynamical model used in the simulations can answer that. For a fast moving interface we have included now the inertia term. The linear approximation gives a driven Mathieu equation when the magnetic field is changed harmonically. It is a well-known fact that the Mathieu equation exhibits parametric resonance. There is some work on progress to explain a previous experiment by Bartkowiak et al.
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:	Madrid, February 5, 2012

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