welcome to the European Microkelvin Collaboration

Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**Lancs14**	
Project Title:	**The superfluid 3He AB interface; dynamics and instability modes**	
Lead scientist:[1]	**Title:**	Dr
	First name:	Manuel
	Last name:	Arrayás
	Birth date:	21/07/1972
	Passport number:	AC899408
	Research status/Position:	Reader
	New User:[2]	No
	Scientific Field:	Low temperature plasma physics
	Home institution:	Universidad Rey Juan Carlos
	Is your home institution MICROKELVIN partner?	No
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	Curriculum vitae (18 lines max): 1. Teaching Assistant, Lancaster University (UK), 1998-1999. 2. Postdoc, Instituut-Lorentz, Universiteit Leiden (NL), 1999-2001. 3. Researcher, Centrum voor Wiskunde en Informatica (NL), 1999-2001. 4. Prof. Asociado Tipo 2, Universidad Rey Juan Carlos, 2001-2002., Prof. Asociado Tipo 3, Universidad Rey Juan Carlos, 2002-2003. Prof. Contratado Doctor, Universidad Rey Juan Carlos, 2003-2009. RESEARCH VISITS: • Faculty of Mathematics, Physics and Natural Sciences, Università di Pisa, Italy, 4 weeks, 1999. Institut für Physik, Universität Potsdam, Germany, 2 weeks, 2004. Engineering Faculty, University of Ljubljana, Slovenia, 2 weeks, 2004. Low temperature Lab, Helsinki University of Technology, Finland, 2 weeks, 2008. Innsbrucker Experimentelle Plasmaphysikgruppe, Innsbruck, Austria, 1 week, 2008. Department of Physics and Astronomy, University of British Columbia, Canada, 4 weeks, 2008. Physics Department, Lancaster University, U.K. 6 weeks, 2010.	

[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'.

	Five most recent publications:		
	1. Onset of treelike patterns in negative streamers. M. Arrayás, M. A. Fontelos and U. Kindelán. Phys. Rev. E **86**, 066407 (2012).		
	2. Quantum Brownian motion in a periodic potential: The path integral for a super-Ohmic bath. M. Arrayás. FNL **11**, 124006 (2012).		
	3.Exchange of helicity in a knotted electromagnetic field. M. Arrayás and J.L. Trueba. Ann. Phys. (Berlin), (2011).		
	4. Motion of charged particles in a knotted electromagnetic field M. Arrayás and J.L. Trueba. J. Phys. A: Math. Theor. **43**, 235401 (2010).		
	5. Contour dynamics model for electric discharges. M. Arrayás, M. A. Fontelos and C. Jiménez. Phys. Rev. E **81**, 035401 (2010).		
	6. Vorticity field, helicity integral and persistence of entanglement in reaction-diffusion systems. J.L. Trueba, M. Arrayás. J. Phys. A: Math. Theor. **42**, 282001 (2009).		
	7. Comment on Mechanism of Branching in Negative Ionization Fronts - Reply. M. Arrayás, M. A. Fontelos and J.L. Trueba. Phys. Rev. Lett. **101**, 139502 (2008).		
Other participating scientists:[3]	**Name:**	**Position:**	**New User:**[2]
	1-		

[3] Please list all participating user group members. Expand the table, if necessary.

2. Project Information

Name of host infrastructure:	Ultra Low Temperature Laboratory, University of Lancaster, Lancaster, United Kingdom			
Access provider / Infrastructure Director:	**Name:** Prof. S.N. Fisher Prof. G.R. Pickett		**E-mail address:** s.fisher@lancaster.ac.uk g.pickett@lancaster.ac.uk	
Planned project dates:	**Start date:**	**6/7/13**	**Completion date:**	**29/7/13**

Project description (12 lines max):

The analogues between the superfluid helium-3 order parameter and those describing other fundamental systems makes laboratory studies of such processes possible. For instance the symmetry-breaking phase transitions of the superfluid provide a test-bed for those undergone by the quantum vacuum state of the evolving Early Universe. One of the MICROKELVIN goals is to investigate the properties of condensate-condensate phase boundaries as analogue m-branes, where m denotes the dimension of the space. The order parameters of the superfluid A and B condensates are analogous to quantum vacuum states existing in 3 dimensions as a 3-brane. The highly ordered 2D interface between the A and B phases is then a 2-brane. In experiments at Lancaster the annihilation of 2 of these A-B branes has been shown to create topological defects, in analogy with the creation of cosmological defects in the inflationary epoch of the Universe. Now experimental work is in progress to measure the properties of the interface itself, with one focus being its dynamical behaviour. Dr Arrayas is experienced in studying and simulating the dynamics of interfaces and, in particular, has expertise in assessing the instability modes. Post-annihilation the receding AB interface moves very quickly and some of the defect creation is likely due to instability in this motion.

Scientific objectives of the project (12 lines max):

The primary objective is to elucidate the dynamical properties of the A-B interface 2-brane. The boundary between the A and B phases is controlled experimentally using shaped magnetic fields. In previous work Dr Arrayas first calculated the equilibrium profiles of the interface for various field and experimental cell configurations, as well as looking at the shape of a B phase “bubble” that is completely surrounded by A phase. Turning to the dynamics, Dr Arrayas has been attempting to account for the dissipation that has been measured for an oscillating interface, but remains unexplained. It seems that dissipation at low frequency and amplitude may be described well by a model due to Yip and Leggett, but it does not fit the behaviour of high frequency and high velocity measurements quantitatively, or even qualitatively. Our next step, and main objective of this visit, is to test whether the anomalous drag can be linked to a lag in the textural realignment that must take place within the A and B order parameters close to the interface as it moves. Understanding this “friction” is crucial for assessing the growth of instability modes for a moving interface.

Technical description of work to be performed (20 lines max):

In the current experiments the superfluid AB interface is stabilised and moved using a controllable magnetic field gradient provided by a stack of superconducting solenoids placed outside the containing vessel, which is a vertical cylinder 6 cm long and 1.2 cm in diameter. Ramping the current in the solenoids then ramps the field gradient and moves the AB interface up and down the cylinder, converting B phase to A phase and vice versa. The motion and properties of the interface are inferred from the behaviour of vibrating wire and quartz tuning fork resonators that protrude into the superfluid from the top, bottom, and sidewalls of the cylinder. Dr Arrayas has simulated the equilibrium interface profiles, and the quasi-equilibrium properties of an interface that is moved slowly through the cell and past the detectors. He is currently analysing measurements from a previous experimental cell, with a different solenoid stack, where we were able to oscillate the interface. Together we developed an experimental technique for much faster motion of the interface in the new cell by using heating and cooling steps to adjust the position of the temperature-dependent critical AB transition field, rather than ramping the whole magnetic field profile. This will hopefully allow us to test new models of dissipation and friction that Dr Arrayas will be developing during this visit. Further, Dr Arrayas will use his knowledge of the AB interface properties to contribute to the design of a

new solenoid stack that we are building to stabilise a bubble of B phase inside A phase. We need to know how much the interface surface tension will contribute to the equilibrium position of the interface, and how stable the bubble will be to motion through the surrounding A phase.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**No**
If yes, please specify:	

Is this proposal submitted to any funding programmes?	**No**
If yes, please specify:	

The completed Application Form should be submitted to MICROKELVIN Management Office (**laitila@neuro.hut.fi**, fax +358-9-47022969)