Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**Lancaster07**	
Project Title:	**The superfluid 3He AB interface; analogue cosmological brane**	
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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	E-mail:	manuel.arrayas@urjc.es
	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.	
	Five most recent publications:	
	1. Motion of charged particles in a knotted electromagnetic field M. Arrayás and J.L. Trueba. J. Phys. A: Math. Theor. 43, 235401 (2010).	
	2. Contour dynamics model for electric discharges. M. Arrayás, M. A. Fontelos and C. Jiménez. Phys. Rev. E 81, 035401 (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'.

	3. 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).		
	4. 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).		
	5. Fluctuation charge effects in ionization fronts. M. Arrayás, J.P. Baltanás and J.L. Trueba. J. Phys. D: Appl. Phys. 41, 105204 pp 9 (2008).		
Other participating scientists:[3]	**Name:**	**Position:**	**New User:**[2]
	1-		
	2-		
	3-		

[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:**	**6/7/11**	**Completion date:**	**29/7/11**

Project description (12 lines max):

Experiments on superfluid helium-3 at Ultra Low Temperatures (ULT) can provide possible analogues for cosmological processes and thus enable the study of fundamental physical processes in the laboratory. In essence the symmetry-breaking phase transitions of the superfluid mimic those undergone by the evolving Universe after the Big Bang. One of the goals of the MICROKELVIN project is to investigate the properties of condensate-condensate phase boundaries as analogue branes. In helium-3 the interface between the superfluid A and B phases is a highly ordered 2D structure, and plays the role of a 2-brane that is embedded in a 3-brane comprising the underlying quantum vacuum states of the A and B condensates. At Lancaster, colliding 2 of these A-B branes together has been shown to create topological defects of lower dimension, in analogy with the creation of cosmological defects in the inflationary epoch of the Universe. Work is in progress to identify these defects, and to further elucidate the properties of the interface itself. Dr Arrayas has experience in studying and simulating the dynamics of interfaces and, in particular, has expertise in assessing the instability modes. These are of crucial importance for understanding the mechanisms of annihilation and defect creation.

Scientific objectives of the project (12 lines max):

The primary objective of the project is to further understand 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 A and B. This exploits the influence of a magnetic field on the phase transition between the two, 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. Dr Arrayas has been developing 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. Dr Arrayas' visit will coincide with ongoing experiments where the Lancaster ULT group plans to move the AB interface through an array of detectors and monitor its progress through the experimental cell; he will participate in these experiments and help to interpret the results using his previously developed simulation tools.

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

The experiment consists of a vertical cylinder of superfluid, 6cm long and 1.2cm in diameter. A superconducting solenoid provides a controllable magnetic field gradient, allowing for the stabilisation of the AB interface across the cylinder. Ramping the current to 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 project into the superfluid from the top, bottom, and sidewalls of the cylinder. These resonators are sensitive to the density of broken Cooper pair quasiparticle excitations, and are thus used to detect any changes as the interface is moved through the cell. Such changes could be due to several effects, for example simple heating, the presence of defects, or the underlying order parameter texture of the surrounding superfluid phase. The correct interpretation is of paramount importance. The resonators can also be driven to high velocities and break Cooper pairs themselves, providing a beam of quasiparticles that can be directed to interact with the surrounding phase and the interface. Dr Arrayas will collaborate with the Lancaster group to address several open issues relating to these measurements. For instance, can instabilities of the AB interface be identified using these methods, and do defects exist inside the interface that are detectable? How would such instabilities and defects influence the approach, interaction and subsequent annihilation of two AB interface analogue branes? Do such defects survive the annihilation and evolve afterwards into the defects that have been observed previously? Do the behaviour and properties of the interface allow for further insight into the defects that are created by annihilation?

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)