welcome to the European Microkelvin Collaboration

CAPACITIES

Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**TKK 04**	
Project title:	**Magnetic Q ball**	
Project acronym:		
Lead scientist:[1]	**Title:**	Professor
	First name:	Yuriy
	Last name:	Bunkov
	Birth date:	29.08.1950
	Passport number:	
	Research status/Position:	Directeur de Recherches at CNRS
	New User:[2]	Yes
	Scientific Field:	NMR, vortices, and superfluid dynamics
	Home institution:	Institute Neél, CNRS, Grenoble, France
	Is your home institution MICROKELVIN partner?	Yes
	Business address:	Avenue des Martyrs
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	Curriculum vitae (18 lines max): Professor Yuriy Bunkov is a senior member of the permanent staff at the Institute of Louis Neél of the Grenoble branch of CNRS, France. He is a widely known expert of 3He superfluids who received the International London Award in 2008 for his pioneering work on magnetic spin transport and coherent spin dynamics in superfluid 3He. He is also well known from his work on fast superfluid transitions in 3He, initiated by thermal neutron capture reaction in liquid 3He.	
	Five most recent publications:	
	Yuriy M. Bunkov (Inst. Néel, Grenoble) "Helium-3; Cosmological and atomic physics experiments", Phil. Trans. R. Soc. A" **366**, 2821-2832, 2008.	
	T. Sato, T. Kunimatsu, K. Izumina, A. Matsubara, M. Kubota, T. Mizusaki, and Yu.M. Bunkov, "Coherent Precession of Magnetization in the Superfluid 3He *A*-Phase", Phys. Rev. Lett. **101**, 055301 (2008).	
	J. Elbs, Yu. M. Bunkov, E. Collin, H. Godfrin, and G. E. Volovik, "Strong Orientational Effect of Stretched Aerogel on the 3He Order Parameter ", Phys. Rev. Lett. **100**, 215304 (2008).	

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'.

	Yu.M. Bunkov and G.E. Volovik, “Magnon Condensation into a *Q* Ball in ^{3}He-B”, Phys. Rev. Lett. **98**, 265302 (2007).		
	Yu.M. Bunkov, “Spin Supercurrent and coherent spin precession”, London Prize lecture, J. Phys.:Condens. Matter **21**, 164201 (2009).		
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:	Low Temperature Laboratory, Helsinki University of Technology			
Access provider / Infrastructure Director:	**Name:** prof. Matti Krusius prof. Grigory Volovik		**E-mail address:** mkrusius@neuro.hut.fi volovik@boojum.hut.fi	
	Prof. Mikko Paalanen		paalanen@neuro.hut.fi	
Planned project dates:	**Start date:**	1.12.2009	**Completion date:**	21.12.2009

Project description (12 lines max):

MEASUREMENT OF VORTICES IN $T \rightarrow 0$ LIMIT

The dynamics of quantized vortices at the lowest temperatures is currently one of the centres of attention in the research of isotropic bulk superfluids. Rapid progress is expected. On the experimental side uniform rotation combined with NMR measurement have been central tools [1]. For superfluid ^{3}He-B the usual NMR technique is to monitor the vortex-free flow velocity via its influence on the order parameter texture when changes in the number of vortices occur. This signal decreases rapidly at the lowest temperatures below 0.3 T_C owing to the diminishing density of the normal component. New detection methods therefore need to be developed. One suggestion is to make use of a collective coherent spin precession mode, the persistent induction mode (PIM). This mode was discovered in the early nineties by professor Yuriy Bunkov and his co-workers [2]. Only recently the first measurements in rotation were undertaken to examine the influence of vortices and vortex-free macroscopic counterflow in this non-local collective resonance mode. It is this effort which should be continued and reactivated with this visit.

Scientific objectives of the project (12 lines max):

PERSISTENT INDUCTION MODE IN SUPERFLUID ^{3}He-B

The Persistent Induction Mode develops from the collective spin wave resonances which can be excited in a potential well formed by a slowly changing distribution of order parameter orientations in the centre of the axially symmetric flare-out texture of a cylindrical sample. These spin wave excitations are a standard part of the continuous wave NMR spectrum at the lowest temperatures, *eg.* in the vicinity of one of the flat end plates of the cylinder. At carefully adjusted low excitation level in a precision magnetic field sweep the spin wave mode can be enhanced and expanded to dominate the NMR absorption. The phenomenon can be studied as a quantum oscillator where both the axial and the transverse strengths of the potential well can be externally tuned [3]. For instance, the distribution of vortices and vortex-free counterflow changes the flare-out order parameter texture and thereby the potential well of spin waves. This appears to be a competitive method for the detection of vortices in certain applications. For better comparison with the standard measuring methods based on an analysis of the NMR absorption line shape a more detailed evaluation has to be carried out below 0.2 T_C.

References:

[1] ***Quantum turbulence in a propagating superfluid vortex front;*** V.B. Eltsov, A.I. Golov, R. de Graaf, R. Hänninen, M. Krusius, V.S. L'vov, and R.E. Solntsev, Phys. Rev. Lett. **99**, 265301 (2007).

[2] ***Persistent spin precession in ^{3}B in the regime of vanishing quasiparticle density;*** Yu.M. Bunkov, S.N. Fisher, A.M, Guenault, and G.R. Pickett, Phys. Rev. Lett. **69**, 3092 (1992).

[3] ***Magnon BEC and spin superfluidity: a 3He primer;*** Yu. M. Bunkov and G.E. Volovik, Contem. Phys. April 2009, p. 1-14.

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

A two to three week visit is planned for (1) completing the analysis of earlier measurements, (2) to discuss these results, and (3) to perform supplementary measurements. Two reports on the measurements and their interpretation are under reparation and will be finished as a direct result from this visit.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure? **Yes** X **No** ☐
If yes, please specify: 1) Study of quantum turbulence in zero temperature limit 2) Study of coherent dynamic order parameter states

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

The completed Application Form should be submitted to MICROKELVIN Management Office (**leena.meilahti@tkk.fi**, fax +358-9-4512969)