Mrs Catharine Werner

Grants manager for AQDJJ network,
ESF

Dear Mrs Werner,

I represent the final report for my ESF exchange grant. The duration of the visit
was 11 weeks starting from 23-th February 2005 and ending at 11-th May 2005
(11 weeks). The host Professor and organization are:
Professor F.V.Kusmartsev,
Physics Department, Loughborough University,
Loughborough, Leicestershire LE11 3TU, UK
+44(0) 1509 228409, e-mail: F.Kusmartsev@lboro.ac.ru

The real travel cost, including forward and return flights, trains and taxi, can be
estimated approximately as 470 EUR (all tickets and receipts are sent by post). The
final report is attached to this file.

Sincerely yours

S.A. Bulgadaev

Landau Institute for Theoretical Physics
Chernogolovka, Moscow Region,
142432, Russian Federation
E-mail: bulgad@itp.ac.ru

ESF-Exchange Grant-Application

ESF ACTIVITY: Arrays of Quantum Dots and Josephson Junctions (AQDJJ)

FINAL REPORT

1. The purpose of the visit.

The visit was directed on the investigation in the framework of the proposed project of some problems connected with such fundamental physical phenomena as dissipation, symmetries, magnetic field and topological quantization on the transport properties of various classical and quantum systems, having (or having) a wide range of applications in the contemporary solid state physics and high technology. The aims of the visit were: 1) to develop a theory of joint action of a dissipation and a topology on the tunnelling properties of different quantum contacts; 2) to study the influence of a magnetic field on the transport properties of strongly inhomogeneous two-dimensional or layered systems.

2. Description of the work carried out during this visit.

Since these two problems have many similar properties (nontrivial antisymmetrical part connected with a topological term and dual symmetries), the main efforts during this visit were concentrated on the more simple second problem: the influence of a magnetic field on the transport properties of strongly inhomogeneous two-dimensional or layered systems. At the same time, the quantum properties of the long Josephson junctions with periodic boundary values (a ring) and small contacts were considered.

3. Description of the main results obtained.

The main results obtained during this visit:
1) Using the exact "magnetic" dual transformation, constructed in the paper [1] and connecting the effective conductivities of self-dual systems with and without magnetic field, the explicit expressions for the magnetoresistance and the Hall resistivity are obtained for three two-phase systems with the different structure of inhomogeneities.
2) It is shown that all of them give the large linear magnetoresistance (LLMR) effect at high magnetic fields for strongly inhomogeneous systems, but the dependence on phase concentrations is different for various models.

3) It is shown that the most convenient for the practical usage of the LLMR effect inhomogeneity structure is the striped structure of the "random parquet" model type, i.e. with finite, randomly oriented, stripes.
4) It is shown that the sharp Hall transition between partial Hall constants takes place in these systems simultaneously with the LLMR effect and there is strong correlation between these two effects.
5) In the framework of the effective action approach the renormalization of the effective action of small quantum contacts, describing them at the simultaneous presence of a dissipation and a topological term, is considered. It is shown that topological term gives a nontrivial contribution into renormalization group (RG) equations.
6) It is established that the bound states of kinks (the breathers) can give an essential contribution in the dynamical properties of the ring Josephson junctions.

4. Future collaboration with the host university.

The obtained results form a good basis for a future collaboration in the investigation of the problems from the proposed project. They can find a numerous applications in the modern high technology. I hope to continue the investigation of these problems together with Prof. F.Kusmartsev from the host organization.

5. Projected publications/articles resulting or to result from my grant.

The obtained results will be published in some forthcoming papers and will be presented at the International Conferences. One paper is already accepted for publication in Physics Letters A [2].

References:

1. S.A.Bulgadaev, F.V.Kusmartsev, Duality and exact results for conductivity of 2D two-phase isotropic systems in magnetic field, Phys.Lett. A336 (2005) 223.
2. S.A.Bulgadaev, F.V.Kusmartsev, "Large linear magnetoresistivity in strongly inhomogeneous planar and layered systems ", Phys.Lett. A (2005), to be published; cond-mat/0505163.