ESF ACTIVITY:Arrays of Quantum Dots and Josephson Junctions (AQDJJ)
HOST INSTITUTE: Professor Feodor Kusmartsev, Loughborough Uni, United Kingdom

Intrinsic Josephson effect and plasmon-polariton excitations in the stack-array of Josephson junctions made in multilayer high-T_c superconductors probed by infrared and Raman Spectroscopy

The purpose of the visit was to carry out test Raman-scattering experiments on the trilayer single crystal superconductor Bi2223 using the HR LabRam spectrometer in the Department of Physics at Loughborough University, UK. In theory we projected to explore the Josephson plasmon - photon coupling in the intrinsic stack-array of Josephson junctions.

During the visit a series of two talks entitled "Critical behaviour induced spectral weight transfer in complex oxides with strong electron correlations" was given (http://www.lboro.ac.uk/departments/ph/events/seminars.html). The departmental seminar was followed by extended discussions. Much attention was given to the plasmon-photon coupling problem in multiplayer high-T_c superconductors. The polariton branch of the 550 cm^{-1} A_1 (TO) optical plasmon in the trilayer Bi2223 superconductor is predicted. Experimentally, the plasmon polariton can be excited and probed with intense optical pulses using nonlinear optical processes like difference-frequency mixing and stimulated Raman scattering.

During the visit the setup of the first experiments using the HR LabRam Raman spectrometer was established. The test measurements of resonant Raman scattering done on the Bi2223 single crystal with T_c = 107 K reproduce the results of the previous measurements on the same sample with a conventional DILOR XY triple spectrometer [1]. We have found that the HR LabRam system gives one order of magnitude better signal-to-noise performance than the DILOR XY triple spectrometer. Moreover the instrument permits to measure the Raman spectrum as a function of the micrometer-sized focal laser spot position on the sample surface. By means of this option the (ac) plane mapping of the Bi2223 sample has been carried out. The data confirm that the crystal contains more than 90% of Bi2223 with only a minor fraction of layer-intercalated Bi2212 [2]. The preliminary results are encouraging future prospects of the stimulated Raman amplifier experiments to study the polariton branch of the A_1 optical plasmon in the trilayer Bi2223 superconductor.

Future projected collaboration is promising.

[1] N.N. Kovaleva *et al.* , Phys. Rev. B **69**, 054511 (2004).

[2] A.V. Boris *et al.* , Phys. Rev. Lett. **89**, 277001 (2002).