Jacek Wojtkiewicz
Department for Mathematical Methods in Physics
Hoża 74, 00-682 Warsaw, Poland
e-mail: wjacek@fuw.edu.pl

REPORT
on the short visit within the RDSES programme
on K.U. Leuven, 16-23.01.2005

1. *Purpose of the visit.* The aim of my visit in the Institute for Theoretical Physics, Katholieke Universiteit Leuven, was discussion with Prof. Christian Maes on the Mott-Hubbard transition in the Falicov-Kimball model (FKM), and on possible strategies of investigation of these phenomenon.

2. *Description of the work carried out during the visit.* In the course of the visit, I discussed with Prof. Maes the following subjects:

   - I presented some results concerning the *static* quantities in the FKM (orderings present in the ground state and at low temperatures and phase diagrams). There were both "general knowledge" as well as my original contributions. Prof. Maes noticed that two subjects would be very interesting: *i)* elaborate the Large Deviation Principle for FKM; *ii)* check if the low-temperature properties of segregated FKM (out of half-filling) could be described by Wulff construction. To my best knowledge, both of them are open problems.
   - I discussed two of a few existing methods to calculate the conductivity in the system of itinerant particles and to distinguish between metal and insulator. One of them is based on properties of *density of states*, whereas second one uses *the Kubo-Greenwood formula*. Prof. Maes suggested an alternative approach, in which one examines the system consisting of the finite-size Falicov-Kimball system coupled to two reservoirs with different chemical potentials, and looks for the stationary states of such

a system. Such an approach could also be applied to other models (Hubbard model). It would be very interesting to compare these three approaches. The FKM seems to be good candidate to make such comparison.

- Moreover, (apart from the main aim of the visit) I discussed also the problem of proving the Bose-Einstein Condensation with Prof. A. Verbeure. He is author of numerous important contributions to this field, and I have obtained many information about his approach to this problem.
- I also discussed with Prof. M. Fannes some of my results, concerning the Heisenberg model within the Resonating Valence Bond theory. Prof. Fannes worked with this class of models in the past, and I benefitted much from discussion with him.

3. *Description of the main results obtained.* The results are clear posing of problems to be solved: *i)* elaborate the Large Deviation Principle for FKM; *ii)* Wulff construction for the low-temperature segregated FKM (out of half-filling); *iii)* alternative approach to the conductivity problem in the FKM.
   Moreover, I have done some partial calculations related to the metal-insulator transition in the FKM (calculations for density of states in the half-filled FKM).

4. *Future collaboration with the institution.* I hope such collaboration will be possible; I would like to visit K.U.L. again after progress achieved (I hope it would be possible) in the solving (some of) problems listed above.

5. *Projected publications/articles to result from this grant.* I expect that at least one paper will appear. I plan to collect there the results of calculations of "dynamic" quantities (related to conductivity) in the case of half-filled Falicov-Kimball model. Perhaps, also another results (solutions of problems listed above in p. 3.) could be possible to obtain and further publish, but it can also turn out that they are too difficult – it is difficult to make definite predictions now.