Warszawa, 20.02.06

Report on the visit of J. Dereziński in the Physics Department, K.U. Leuven, 11-18.02.06

1. **Purpose of the visit:**

   - Collaboration with W. De Roeck on joint papers [1] and [2] concerning then stochastic limit of the Friedrichs model and of the Pauli-Fierz Hamiltonian.
   - Presentation of the results obtained together with V.Jakšić and C.A.Pillet in a talk "Return to equilibrium".
   - Discussions with Belgian physicists (C. Maes, A. Verbeure, M. Fannes and others)

2. **Description of the work carried out and results obtained during the visit:** The visit was an occasion to discuss the final form of the papers [1] and [2].

   [1] is devoted to a simple model of stochastic limit for a self-adjoint Hamiltonian acting on the Hilbert space decomposed into two parts – a finite dimensional "small space", and the "large space". The Hamiltonian consists af a diagonal part and an interaction multiplied by a small parameter λ. After rescaling of the time as t/λ^2 and rescaling the energy in the "large space" we obtain convergence to a unitary group, which is the unitary dilation (in the sense of Foias and Nagy) of the semigroup acting on the "small space".

   [1] can be viewed as a toy model, a pedagogical introduction to a physically more relevant and mathematically more complicated case of the Pauli-Fierz Hamiltonian, describing a small quantum system interacting with a Bosonic field, studied in [2]. We prove that, under rather weak assumptions, the unitary evolution, after appropriate rescaling of time and of the reservoir dynamics converges to a unitary dilation of a semigroup acting on the subsystem Hilbert space. If we apply our result to the framework of the Heisenberg picture and look at the

reduced dynamics, we obtain a completely positive semigroup coinciding with the semigroup obtained by Davies in [4]. On the level of the asymptotic reservoir, the asymptotic dynamics resembles strongly the formalism used often in quantum optics to describe the measurement processes [6].

Our work is a related to the ideas of [3], our results are however valid under much weaker assumptions. Our proof uses partly the ideas of [5].

3. **Future collaborations with host institution:**

   I plan to continue to work with W. De Roeck of K.U. Leuven in order to finish the papers [1] and [2]. Perhaps, we will start a new project about applying the results of [2] to study fluctuations of open quantum systems.

4. **Projected articles to result from the visit;**

   [1] J. Dereziński, W. De Roeck: Stochastic limit in the Friedrichs model, in preparation

   [2] J. Dereziński, W. De Roeck: Stochastic limit for Pauli-Fierz Hamiltonians, in preparation

5. **Other comments:** The hosts were very hospitable and the scientific atmosphere in the Physics Department KUL was very stimulating.

6. **Additional literature:**

   [3] L. Accardi, A. Frigerio, Y.G. Lu, Weak coupling limit as a quantum functional central limit theorem, Springer

   [4] E. B. Davies, Markovian master equations, Commun. Math. Phys. 39, 91 (1974).

   [5] R. Dümcke, Convergence of multitime correlation functions in the weak and singular coupling limits, J. Math. Phys. 24, 311–315, (1983)

   [6] H.J. Charmichael, An Open Systems Approach to Quantum Optics, (Springer-Verlag, Berlin, 1993)