Scientific Report of the short visit grant

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Coherent and non-Markovian effects in Full Counting Statistics

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Purpose of the visit

The proposed project is the fruit of the discussions between the applicant and Christian Flindt in occasion of the conference SCEN06 helded in June of this year in Pisa. In those days the applicant thought extremely interesting to apply the recent developed approach [1], for the calculation of the Full Counting Statistics (FCS) in systems with non-Markovian dynamics, to systems where the coherence play a crucial role.

The experience developed by the applicant during the preparation of the work [1], done in collaboration with Prof. J. König and Prof. R. Fazio, and the knowledge of Prof. A. P. Jauho group, in the contest of coherent systems [2], appeared the important ingredients to be joined to begin a successful project in the study the current cumulants and the FCS of coherent systems in presence of a dissipative environment.

The arrays of Josephson junctions, in particular regimes, and many of the different proposals of quantum computation schemes are some of the typical examples where we think our theory can be applied.

We hope also that our predictions on the current cumulants could also stimulate the experimental community to develop a better measurements of them developing the nowadays technology. In particular during the recent year the array of quantum dots appear to play a crucial role in the measurements of the high order current cumulants and we think our work should be extremely interesting also in this perspective.

In conclusion we hope our approach give us the opportunity to get new insights in the problem of the quantum dissipation in coherent systems using the FCS and the current cumulants as investigation tool.

Description of the work carried out during the visit

The first tests on the feasibility of the program was done during the last days of June. They was successful but the distance between the authors limited the possibility to do the following step. So it appeared extremely important to do a meeting between the authors where the project could be planned. The possibility to the collaborators to meet was found but, due previous appointments and summer conferences, was possible to do the meeting only during 3 days from 13th to 15th of July in the MIC - Department of Micro and Nanotechnology of the Technical University of Denmark, Kongens Lyngby in Copenhagen, Denmark. Here is reported mainly the work done during the visit.

In the morning of *first day* the applicant presented, to Prof. A.-P. Jauho and his collaborators the detail of the techniques [1] recently developed to calculate the FCS in non-Markovian systems mainly showing the possible ex-

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tensions and connections to the approach [2] used by C. Flindt, T. Novotny and A.-P Jauho. In the afternoon the applicant also gave a talk in the institute to exchange the recent development with the broader audience. In the late afternoon C. Flindt and T. Novotny presented to the guest what are the main assumption in their approach and how one can apply them to calculate the transport properties of a system with coherent dynamics.

The *second day* was completely devolved to identify some test cases and verify the correctness of the calculation of the current cumulants using the new hybrid approach. As test case was considered a coherent system with a Markovian dynamics where the current cumulants was known before. After the tracing out of coherencies degrees of freedom we ended in a "effective" non-Markovian dynamics where the *new* approach was necessary. The consistency between the two method give us a strong support on the correctness of the new theory.

The *third day* we studied with more attention what are the possible application of the new theory and we define a non-trivial example where we expect new and interesting results. The idea was to study the non-Markovian effects induced on the coherent dynamics of a two level system by the dissipation induced on the system with the coupling with a dissipative environment. The current cumulants and, in general, the FCS for this system should be able to extract information on the dissipation opening new and interesting possibility in the study of coherent systems. In last part of the day the different role of the authors in the work was discussed and in particular a first schedule of the work was planned.

In conclusion during the three day visit the collaboration between the two group was fully established and we hope in the next months to be able to develop a complete work.

Description of the main results obtained

Before of the beginning of August the main results are:

- A natural and expected extension of the theory of the FCS in non-Markovian system for system with coherent dynamics was obtained.

- Simple test cases demonstrate the essential structure of the theory and the easy and general applicability.

- Coherent systems in presence of dissipation can be analyzed with the new theory opening a new path to study the of the dissipative systems.

- A first draft was prepared with the working title *Full counting statistics in coherent systems beyond the Markovian limit.*

Future collaboration with host institution

The applicant hopes to open a long-time collaboration with the host institution especially in view of the interesting and new results that the actual research is producing. In particular there is the hope to develop a more strict collaboration between the italian group and the danish group looking for some future common research projects.

Bibliography

[1] A. Braggio, J. König and R. Fazio, Phys. Rev. Lett. **96**, 026805 (2006).
[2] C. Flindt, T. Novotný and A.-P. Jauho, Europhys. Lett. **69**, 475 (2005).