

# UNIVERSITÀ DI BARI

DIPARTIMENTO DI FISICA

Via Amendola, 173  
I-70126 Bari. Italy  
Tel. +39 080 5443462  
Fax +39 080 5442470/5442434  
Email: saverio.pascazio@ba.infn.it

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**Object:** Diploma Thesis of Bc. Daniel Štěrba

The thesis work of Bc. Daniel Štěrba deals with the phenomenon of synchronization in open quantum systems, in the approximation of Markovian evolution.

The thesis consists of five chapters. The first two chapters are introductory and focus on the basic concepts and ideas. After reviewing the fundamentals of the theory of quantum dynamical semigroups, the discussion is focused on the key ideas at the basis of synchronization and phase-locking. Historical as well as research topics, recent developments and literature are well integrated and summarized. Focus is on the quantum mechanical aspects of the problem, where the main ideas are expressed with clarity and conciseness.

Chapters 3-5 represent the main part of the investigation and the most original contribution of the thesis. The third chapter is a thorough analysis of a system of two qubits and contains a number of original elements. One finds a nice a discussion of the synchronizing maps of two qubits, complete synchronization and attractor space.

In the fourth chapter the results obtained for two qubits are extended to qubit networks ( $n$ -qubit systems with bipartite couplings). The main problem here is to understand how the synchronization mechanisms apply to more complex systems. This is clearly an intricate subject, that involves, among others, issues related to network topologies and graph theory.

The fifth and last chapter is a discussion of the (physical and mathematical) features of two-qubit synchronizing maps. A number of factors are elucidated, from the role of the initial state, to symmetries and entanglement.

Three appendices complete the exposition.

The thesis work combines rigorous techniques with a discussion of the properties and validity of the models investigated, and a critical analysis of future research avenues. Among them, one finds non-normal Lindblad operators, evolutions beyond the Markovian approximation, systems whose structure (subsystems) is not trivial. Bc. Daniel Štěrba's thesis is well organized and pleasant to read. The candidate masters the subject and understands the mathematical and physical subtleties of the topics investigated.

In conclusion, this thesis convincingly shows that the phenomenon of synchro-

nization is of great interest in quantum mechanical applications. I am very satisfied with the analysis, contribution and overall vision of the candidate. My overall impression is that this is excellent work (A), and I am happy to give Bc. Daniel Štěrba a very positive evaluation.

Sincerely

Saverio Pascazio

Dipartimento di Fisica  
Università di Bari  
Via Amendola 173  
70126 Bari  
Italy