



Optimal Convergence Rate in the Quantum Zeno Effect for Open Quantum Systems in Infinite Dimensions

T. Möbus¹, C. Rouzé².

Keywords: Quantum Zeno Effect, Optimal Convergence Rate, Chernoff \sqrt{n} Lemma

MSC2010 codes: 81S22, 81Q12, 81Q15, 46N50

Abstract

In open quantum systems, the quantum Zeno effect consists in frequent applications of a given quantum operation, e.g. a measurement, used to restrict the time evolution (due e.g. to decoherence) to states that are invariant under the quantum operation. In an abstract setting, the Zeno sequence is an alternating concatenation of a contraction operator (quantum operation) and a C_0 -contraction semigroup (time evolution) on a Banach space. In this paper, we prove the optimal convergence rate $\mathcal{O}(\frac{1}{n})$ of the Zeno sequence by proving explicit error bounds. For that, we derive a new Chernoff-type \sqrt{n} -lemma, which additionally proves the optimal convergence rate of Trotter's product formula for C_0 -semigroups in the strong topology. Moreover, we generalize the Zeno effect in two directions: We weaken the assumptions on the generator, which induce a Zeno dynamics generated by an unbounded generator and we improve the convergence of one result to the uniform topology. Finally, we provide a richer class of examples arising from our assumptions.

¹Technical University Munich, Department of Mathematical Physics, Germany, Munich. Munich Center for Quantum Science and Technology (MCQST), München, Germany. Email: tim.moebus@tum.de

²Technical University Munich, Department of Mathematical Physics, Germany, Munich. Munich Center for Quantum Science and Technology (MCQST), München, Germany. Email: rouzecambyse@gmail.com