2022 International Symposium on Nonlinear Theory and Its Applications,
NOLTA2022, Virtual, December 12-15, 2022

# Perturbations in cycle expansions

Yueheng Lan†, Huanyu Cao‡

†Faculty of School of Science, Beijing University of Posts and Telecommunications
10 Xitucheng Rd, Haidian DS, Beijing 100876, China
‡Doctoral Candidate of Systems Science, Beijing University of Posts and Telecommunications
10 Xitucheng Rd, Haidian DS, Beijing 100876, China
Email: lanyh@bupt.edu.cn, hycao@bupt.edu.cn

**Abstract**—An accurate evaluation of averages of observables is an essential task in the study of nonlinear dynamical systems, especially those with non-uniform hyperbolicity. By the famous Lambda Lemma, a chaotic attractor is covered densely with unstable periodic orbits. According to periodic orbit theory, short cycles may be used to compute dynamical averages in terms of cycle expansions, resulting in an exponential or super-exponential convergence if the system is hyperbolic. However, the convergence becomes slow or even fails if the hyperbolicity appears non-uniform or non-existent, just like in an intermittent system where chaotic and regular dynamics pop up alternatively. In the current research, a perturbation technique is developed to cope with this non-ideal case in which cycle expansions are used to treat the hyperbolic part while an analytic approximation is made to take care of the regular dynamics. In addition, based on the framework provided by cycle expansions, we are able to design a perturbation scheme in the presence of chaos, which could be used to compute averages over a continuous family of dynamical systems. For the details of part of this presentation, see our paper on the arXive (H. Cao, A. Gao, H. Zheng, Y. Lan, Wielding intermittency with cycle expansions, arXive 2206.00499).

**Acknowledgments**

The authors would like to thank NOLTA2022 organizing committee members for their fruitful suggestions and comments.

ORCID iDs Yueheng Lan: 0000-0002-2950-8022, Huanyu Cao: 0000-0002-1506-1805.