

Classical and Quantum Nonlinear Dynamics, Frühjahrssemester 2025

Preliminary outline

I. Flows on the line

- I.1 Introduction: A geometric way of thinking
- I.2 Linear stability analysis
- I.3 Existence and uniqueness of solutions
- I.4 Bifurcations
- I.5 Flows on the circle (self reading)

II. Two-dimensional flows

- II.1 Linear systems
- II.2 Phase plane; linearization
- II.3 Index theory (self reading)
- II.4 Limit cycles
- II.5 Bifurcations revisited

III. Chaos

- III.1 Lorenz equations
- III.2 One-dimensional maps

IV. Synchronization

- IV.1 Basic concepts
- IV.2 Locking of one oscillator to an external harmonic signal
- IV.3 Mutual synchronization of two oscillators
- IV.4 Many oscillators: The Kuramoto model

V. Parametrically-pumped oscillators

- V.1 Mathieu equation; Floquet theory
- V.2 The nonlinear parametric resonator
- V.3 Coupled parametric resonators

VI. Quantum nonlinear dynamics

- VI.1 From closed to open quantum systems
- VI.2 The quantum parametric oscillator
- VI.3 Quantum synchronization
- VI.4 Quantum chaos