

# Contents

<b>Introduction</b>	<b>3</b>
<b>Outline of the thesis</b>	<b>8</b>
<b>1. Open quantum systems, semiclassical methods and the emergence of classicality</b>	<b>11</b>
1.1. Closed systems	11
1.1.1. Amplitudes and the van Vleck-Gutzwiller propagator	11
1.1.2. Density matrix approach	16
1.2. Open systems	19
1.2.1. Spin environment and decoherence	20
1.2.2. The Caldeira-Leggett model	25
1.2.3. Semiclassical approximation to the Caldeira-Leggett model	30
1.3. Summary	36
<b>2. Strong coupling and non-Markovian effects in the statistical notion of temperature</b>	<b>37</b>
2.1. Introduction	37
2.2. The statistical emergence of temperature from a saddle-point condition	39
2.3. Finite-coupling regime	42
2.4. Microcanonical thermodynamic relations and ensemble equivalence	48
2.5. Summary	50
<b>3. Semiclassical treatment of decoherence in chaotic systems</b>	<b>51</b>
3.1. Classical chaos and Sieber-Richter orbit pairs	51
3.1.1. Action difference and density of trajectories	54
3.2. Interplay between coherent and incoherent effects in chaotic systems	58
3.2.1. Decoherence in the Caldeira-Leggett model	59
3.2.2. Particle in a chaotic cavity and quantum survival probability	61
3.2.3. Semiclassical treatment	62
3.3. Summary	70
<b>4. Semiclassical analysis of an open Bose-Hubbard model</b>	<b>73</b>
4.1. Amplitude: boundary conditions, and time-reversal invariance	74
4.2. Density matrix and dissipative equations of motion	76
4.3. System coupled to a microcanonical environment	80
4.4. Summary	83

*Contents*

<b>5. Semiclassical analysis of work statistics</b>	<b>85</b>
5.1. Classical relations . . . . .	85
5.2. Quantum relations . . . . .	90
5.3. Path integral and quantum work . . . . .	95
5.4. Semiclassical analysis of the characteristic function of work . . . . .	96
5.5. Path integral quantum work of a system coupled to an environment . . . . .	98
5.6. Summary . . . . .	103
<b>Summary and outlook</b>	<b>105</b>
<b>A. Equations of motion based on the influence functional symmetries</b>	<b>109</b>
<b>B. Environment autocorrelation function for complex arguments</b>	<b>111</b>
<b>Bibliography</b>	<b>115</b>
<b>Acknowledgments</b>	<b>125</b>