

# Contents

<b>1. Introduction</b> .....	1
<b>2. Classical Maps</b> .....	7
2.1 Definition and Examples .....	7
2.2 Classical Chaos .....	9
2.3 Ensemble Description .....	11
2.3.1 The Frobenius–Perron Propagator .....	11
2.3.2 Different Types of Classical Maps .....	12
2.3.3 Ergodic Measure .....	15
2.3.4 Unitarity of Classical Dynamics .....	16
2.3.5 Spectral Properties of the Frobenius–Perron Operator .....	17
2.4 Summary .....	18
<b>3. Unitary Quantum Maps</b> .....	21
3.1 What is a Unitary Quantum Map? .....	21
3.2 A Kicked Top .....	22
3.3 Quantum Chaos for Unitary Maps .....	24
3.4 Semiclassical Treatment of Quantum Maps .....	27
3.4.1 The Van Vleck Propagator .....	27
3.4.2 Gutzwiller’s Trace Formula .....	28
3.5 Summary .....	29
<b>4. Dissipation in Quantum Mechanics</b> .....	31
4.1 Generalities .....	31
4.2 Superradiance Damping in Quantum Optics .....	33
4.2.1 The Physics of Superradiance .....	33
4.2.2 Modeling Superradiance .....	34
4.2.3 Classical Behavior .....	36
4.3 The Short-Time Propagator .....	37
4.4 The Semiclassical Propagator .....	40
4.4.1 Finite-Difference Equation .....	40
4.4.2 WKB Ansatz .....	40
4.4.3 Hamiltonian Dynamics .....	41
4.4.4 Solution of the Hamilton–Jacobi Equation .....	42

4.4.5	WKB Prefactor	43
4.4.6	The Dissipative Van Vleck Propagator	44
4.4.7	Propagation of Coherences	45
4.4.8	General Properties of the Action $R$	47
4.4.9	Numerical Verification	47
4.4.10	Limitations of the Approach	48
4.5	Summary	49
<b>5.</b>	<b>Decoherence</b>	<b>51</b>
5.1	What is Decoherence?	51
5.2	Symmetry and Longevity: Decoherence-Free Subspaces	53
5.3	Decoherence in Superradiance	55
5.3.1	Angular-Momentum Coherent States	55
5.3.2	Schrödinger Cat States	56
5.3.3	Initial Decoherence Rate	56
5.3.4	Antipodal Cat States	57
5.3.5	General Result at Finite Times	57
5.3.6	Preparation and Measurement	58
5.3.7	General Decoherence-Free Subspaces	60
5.4	Summary	62
<b>6.</b>	<b>Dissipative Quantum Maps</b>	<b>63</b>
6.1	Definition and General Properties	63
6.1.1	Type of Maps Considered	65
6.2	A Dissipative Kicked Top	65
6.2.1	Classical Behavior	66
6.2.2	Quantum Mechanical Behavior	68
6.3	Ginibre's Ensemble	71
6.4	Summary	73
<b>7.</b>	<b>Semiclassical Analysis of Dissipative Quantum Maps</b>	<b>75</b>
7.1	Semiclassical Approximation for the Total Propagator	75
7.2	Spectral Properties	78
7.2.1	The Trace Formula	78
7.2.2	Numerical Verification	85
7.2.3	Leading Eigenvalues	88
7.2.4	Comparison with RMT Predictions	95
7.3	The Wigner Function and its Propagator	100
7.4	Consequences	106
7.4.1	The Trace Formula Revisited	106
7.4.2	The Invariant State	106
7.4.3	Expectation Values	108
7.4.4	Correlation Functions	108
7.5	Trace Formulae for Expectation Values and Correlation Functions	111

7.5.1	The General Strategy .....	111
7.5.2	Cycle Expansion .....	112
7.5.3	Newton Formulae for Expectation Values .....	114
7.6	Summary .....	116
<b>A.</b>	<b>Saddle-Point Method for a Complex Function of Several Arguments .....</b>	<b>119</b>
<b>B.</b>	<b>The Determinant of a Tridiagonal, Periodically Continued Matrix .....</b>	<b>121</b>
<b>C.</b>	<b>Partial Classical Maps and Stability Matrices for the Dissipative Kicked Top .....</b>	<b>123</b>
C.1	Rotation by an Angle $\beta$ About the $y$ Axis .....	123
C.2	Torsion About the $z$ Axis .....	124
C.3	Dissipation .....	124
	<b>References .....</b>	<b>125</b>
	<b>Index .....</b>	<b>131</b>