

Contents

The Problem of Quantum Chaos <i>Boris V Chirikov</i>	1
1. Introduction: The Theory of Dynamical Systems and Statistical Physics	1
2. Asymptotic Statistical Properties of Classical Dynamical Chaos	9
3. The Correspondence Principle and Quantum Chaos	17
4. The Uncertainty Principle and the Time Scales of Quantum Dynamics	20
5. Finite-Time Statistical Relaxation in Discrete Spectrum	26
6. The Quantum Steady State	32
7. Asymptotic Statistical Properties of Quantum Chaos	40
8. Conclusion: The Quantum Chaos and Traditional Statistical Mechanics	49
 Semi-Classical Quantization of Chaotic Billiards <i>Uzy Smilansky</i>	 57
I Introduction	58
II Classical Billiards	62
III Quantization – The Semi-Quantal Secular Equation	67
III.a Quantization of Convex Billiards	68
III.b Quantization of Billiards with Arbitrary Shapes	70
III.c Properties of the Semi-Quantal Secular Equation	75
IV The Semi-Classical Secular Function	80
V Spectral Densities	90
V.a The Averaged Spectral Density	91
V.b The Gutzwiller Trace Formulae for the Spectral Density	95

VI	Spectral Correlations	98
VI.a	S Matrix Spectral Correlations	100
VI.b	Energy Spectral Correlations	104
VI.c	Composite Billiards	106
VII	Conclusions	112
	Appendix A	115
	Stochastic Scattering Theory or Random-Matrix Models for Fluctuations in Microscopic and Mesoscopic Systems <i>Hans A Weidenmüller</i>	121
1.	Motivation : The Phenomena	122
1.1	Microwave Scattering in Cavities	124
1.2	Compound-Nucleus Scattering in the Domains of Isolated and of Overlapping Resonances	126
1.3	Chaotic Motion in Molecules	128
1.4	Passage of Light Through a Medium with a Spatially Randomly Varying Index of Refraction	130
1.5	Universal Conductance Fluctuations	130
2.	Stochastic Modelling	133
2.1	Chaotic and Compound-Nucleus Scattering	134
2.2	Conductance Fluctuations	135
3.	Methods of Averaging	137
3.1	Monte-Carlo Simulation	137
3.2	Disorder Perturbation Theory	138
3.3	The Generating Functional	139
4.	Chaotic Scattering and Compound-Nucleus Reactions	141
5.	Universal Conductance Fluctuations	151
6.	Persistent Currents in Mesoscopic Rings	159
7.	Conclusions	164

**Atomic and Molecular Physics Experiments in Quantum
Chaology**
Peter M Koch

		167
1.	Introduction	168
1.1	The Diamagnetic Kepler Problem	170
1.2	Spectroscopy of Highly Excited Polyatomic Molecules	171
1.3	The Helium Atom	172
1.4	Swift Ions Traversing Foils	173
1.5	What This Paper Covers and Does Not Cover	174
2.	Apparatus and Experimental Method	176
2.1	Apparatus	176
2.2	Experimental Methods	179
3.	The Hamiltonian and Scaled Variables	182
4.	Regimes of Behavior	187
4.1	"Ionization" Curves	187
5.	Static Field Ionization	190
6.	Regime-I : The Dynamic Tunneling Regime	191
7.	Regime-II : The Low Frequency Regime	194
8.	Regime-III : The Semiclassical Regime	196
8.1	Classical Kepler Maps for 1d Motion	199
9.	Regime-IV : The Transition Regime	203
9.1	Nonclassical Local Stability and "Scars"	206
10.	Regime-V : The High Frequency Regime	212
11.	Conclusions	215

Topics in Quantum Chaos	225
<i>R E Prange</i>	
I. Introduction	225
A. Philosophy	225
B. Time Scales	227
C. The Quasiclassical Approximation	228
D. Pseudorandom Matrix Theory	229
E. Types of Chaotic Systems	230
F. Summary and Outline	232
II. Quantum Longtime Behavior and Localization	233
A. The Kicked Rotor	233
B. Tunneling and KAM Torii	234
C. Dynamic Localization	237
D. Connection of Anderson Localization to Quantum Chaos	241
E. Pseudorandomness of T_n	242
F. An Aside on Liouville Numbers	242
G. Comparison of Pseudorandom and Truly Random Cases	243
H. Numerical Solutions	243
I. Relationship of the Localization Length to Classical Diffusion	244
III. Transitions to Chaos	244
A. Introduction	244
B. The Logistics Map	244
C. Period Doubling Sequence	246
D. Hamiltonian Maps	252
E. Last KAM Torus	252
F. Other Relevant Variables	254
G. Planck's Constant as a Relevant Variable	254

H.	Consequences of Scaling	256
I.	Tunnelling Through KAM Barriers	258
IV.	Validity of the Semiclassical Approximation in Quantum Chaos	258
A.	Introduction	258
B.	Quantum Maps	260
C.	Periodic Point Expansions	262
D.	Propagation of Geometry	263
E.	Validity of the Assumption of Periodic Point Dominance	265
F.	Generic Chaos	268
G.	Breakdown of the Semiclassical Approximation	269
H.	Conclusions and Acknowledgements	270
	Dynamic Localization in Open Quantum Systems	
	<i>Robert Graham</i>	273
1.	Introduction	273
2.	Dissipative Quantum Dynamics	279
a.	Model Systems	279
b.	Wigner-Weisskopf Theory and Quantum Measurements	281
c.	Quantum Langevin Equation	284
d.	Master Equation	286
e.	Influence Functional Method	288
3.	Dynamical Localization in the Dissipative Kick-Rotor Model	295
a.	Quantum Map	295
b.	Semi-Classical Limit, Quantum Noise	295
c.	Dynamical Localization and Weak Dissipation	299

4.	Dynamically Localized Electromagnetic Field in a High-Q Cavity	305
5.	Rydberg Atoms in a Noisy Wave-Guide	308
a.	Basic Effects and Ideas for an Experiment	308
b.	Theory	309
c.	Experiment	314
6.	Dynamical Localization in the Periodically Driven Pendulum	314
a.	Classical Pendulum	315
b.	Quantized System	318
c.	Coupling to the Environment	322
d.	Experimental Realization by the Deflection of an Atomic Beam in a Modulated Standing Light Wave	323
e.	Dynamical Localization in Josephson Junctions	325