



# CONTENTS

<i>Contributors</i>	<i>ix</i>
<i>Preface</i>	<i>xi</i>
<b>1. Ultracold Few-Body Systems</b>	<b>1</b>
Yujun Wang, Jose P. D’Incao, and Brett D. Esry	
1. Introduction	2
2. Interactions in Ultracold Gases	6
3. Efimov Physics in Ultracold Quantum Gases	18
4. Beyond the Efimov Scenario	43
5. Other Three-Body Systems Relevant for Cold Atom Physics	94
6. Outlook	99
Acknowledgments	100
References	100
<b>2. Shortcuts to Adiabaticity</b>	<b>117</b>
Erik Torrontegui, Sara Ibáñez, Sofia Martínez-Garaot, Michele Modugno, Adolfo del Campo, David Guéry-Odelin, Andreas Ruschhaupt, Xi Chen, and Juan Gonzalo Muga	
1. Introduction	118
2. General Formalisms	120
3. Expansions of Trapped Particles	131
4. Transport	145
5. Internal State Engineering	150
6. Wavepacket Splitting	158
7. Discussion	160
Acknowledgments	161
References	161

<b>3. Excitons and Cavity Polaritons for Optical Lattice Ultracold Atoms</b>	<b>171</b>
Hashem Zoubi and Helmut Ritsch	
1. Introduction	172
2. Ultracold Atoms in an Optical Lattice as Artificial Crystals	178
3. Excitons in Optical Lattices	181
4. Cavity QED with Excitons: Polaritons	196
5. Optical Lattices with Defects: Beyond the Mott Insulator State	214
6. Conclusions	224
Acknowledgments	226
References	226
<b>4. Quantum Science and Metrology with Mixed-Species Ion Chains</b>	<b>231</b>
Jonathon P. Home	
1. Introduction	232
2. Normal Modes of Mixed-Species Chains	233
3. Sympathetic Cooling	247
4. Re-Ordering Ions of Different Mass	251
5. Quantum Logic Readout	255
6. Quantum Computation	261
7. Quantum State Engineering	265
8. Molecular Cooling and Control	269
9. Outlook	272
Acknowledgments	273
References	273
<b>5. Limits to Resolution of CW STED Microscopy</b>	<b>279</b>
Alexei S. Trifonov, Jean-Christophe Jaskula, Claire Teulon, David R. Glenn, Nir Bar-Gill, and Ronald L. Walsworth	
1. Introduction	280
2. Theory	281

---

3. Experiment Setup	289
4. Results	292
5. Summary and Outlook	297
Appendices	297
Acknowledgments	301
References	301
<b>6. Ultrafast High Power and Stabilized Semiconductor Diode Lasers—Physics, Techniques, and Applications in Coherent Signal Processing</b>	<b>303</b>
Peter J. Delfyett	
1. Introduction	304
2. Background Physics	306
3. Experimental Configurations for Mode-Locked Semiconductor Diode Lasers	320
4. Applications	338
5. Summary, Concluding Remarks, and Future Directions	377
Acknowledgments	378
References	378
<i>Index</i>	383
<i>Contents of Volumes in this Serial</i>	391