

# Proceedings of the XVIII International Conference on Atomic Physics

The Expanding Frontier of Atomic Physics



Cambridge, Massachusetts, USA

July 28 – August 2, 2002

*editors*

**H. R. Sadeghpour**

*ITAMP - Harvard-Smithsonian Center for Astrophysics,  
Cambridge, USA*

**E. J. Heller**

*CUA - Departments of Physics and Chemistry,  
Harvard University, Cambridge, USA*

**D. E. Pritchard**

*CUA - Department of Physics, MIT, Cambridge, USA*



**World Scientific**

*New Jersey • London • Singapore • Hong Kong*

## Contents

Preface	vii
<b>BEC Nobel Symposium</b>	
The Mystery of the Ramsey Fringe that Didn't Chirp <i>D. M. Harber, H. J. Lewandowski, J. M. McGuirk and E. A. Cornell</i>	3
The Bose-Einstein Condensate — A Superfluid Gas of Coherent Atoms <i>Wolfgang Ketterle</i>	11
Fermi-Bose and Bose-Bose K-Rb Quantum Degenerate Mixtures <i>Massimo Inguscio, Giovanni Modugno and Giacomo Roati</i>	19
<b>New BECs</b>	
All-Optical Atomic Bose-Einstein Condensates <i>M. D. Barrett, M.-S. Chang, C. Hamley, K. Fortier, J. A. Sauer and M. S. Chapman</i>	31
Ionization in a Bose-Einstein Condensate of Metastable Helium: A Quantitative Monitoring Tool <i>A. Aspect, O. Sirjean, S. Seidelin, J. Viana Gomes, D. Boiron and C. I. Westbrook</i>	39
Bose-Einstein Condensates in Magnetic Micro Traps <i>C. Zimmermann, J. Fortagh, H. Ott, S. Kraft and A. Günther</i>	47
<b>New Directions</b>	
Atom-Molecule Coherence Near a Feshbach Resonance in a Bose-Einstein Condensate <i>Sarah T. Thompson, Neil R. Claussen, Elizabeth A. Donley and Carl E. Wieman</i>	57
Single Atom Manipulation in a Microscopic Dipole Trap <i>Georges Reymond, Nicolas Schlosser and Philippe Grangier</i>	65
Ultracold Neutral Plasmas <i>S. L. Rolston and J. L. Roberts</i>	73

Photoassociation of Laser-Cooled Ytterbium Atoms <i>Y. Takahashi, Y. Takasu, K. Komori, K. Honda, M. Kumakura and T. Yabuzaki</i>	83
Cooling of Cesium Atoms by Collective Emission Inside an Optical Resonator <i>Adam T. Black, Hilton W. Chan and Vladan Vuletić</i>	91
<b>Degenerate Fermi Systems</b>	
Ultracold Fermi Gases: Towards BCS <i>G. V. Shlyapnikov</i>	101
Mixtures of Degenerate Fermi and Bose Gases <i>L. Khaykovich, J. Cubizolles, T. Bourdel, F. Schreck, G. Ferrari, L. Carr, Y. Castin and C. Salomon</i>	112
Ultracold Three-Body Recombination of Fermionic Atoms <i>B. D. Esry, H. Suno and C. H. Greene</i>	122
<b>Beyond AMO</b>	
Phase and Absorption Gratings for Electrons <i>Hong Gao, Glen Gronniger, Daniel Freimund, Alex Cronin and Herman Batelaan</i>	133
Quantum Optics with Quantum Dots <i>A. Imamoglu</i>	142
Single Molecule Studies of Biological Processes <i>Steven Chu</i>	149
Extra Dimensions, Scalar Fields and CPT: New Tests of Nature's Oldest Force <i>Blayne Heckel</i>	159
<b>BECs in Optical Lattices</b>	
Beyond Mean Field Physics with Bose-Einstein Condensates in Optical Lattices <i>M. Greiner, O. Mandel, A. Altmeyer, A. Widera, T. Rom, T. W. Hänsch and I. Bloch</i>	171

83	<b>Cold Molecules</b>	
	Buffer-Gas Loading and Magnetic Trapping of Molecules	183
91	<i>John M. Doyle</i>	
	Deceleration and Trapping of Polar Molecules	194
	<i>Gerard Meijer</i>	
	<b>Intense Fields</b>	
101	Characterization of Attosecond Pulse Trains from High-Harmonic Generation	209
112	<i>H. G. Muller, P. Agostini and Ph. Balcou</i>	
	Multiple Ionization in Strong Fields	219
	<i>J. Ullrich, R. Dörner, R. Moshhammer, H. Rottke and W. Sandner</i>	
122	<b>Slow Light and Quantum Control</b>	
	Toward Manipulating Quantum Information with Atomic Ensembles	231
133	<i>M. D. Lukin, A. André, M. D. Eisaman, M. Hohensee, D. F. Phillips, C. H. van der Wal, R. L. Walsworth and A. S. Zibrov</i>	
	Generation and Investigation of Number States of the Radiation Field	241
	<i>Herbert Walther</i>	
142	Precision Measurement of the Anomalous Magnetic Moment of the Muon	252
	<i>William Morse</i>	
149	<b>Quantum Information</b>	
159	Quantum Information Processing and Multiplexing with Trapped Ions	263
	<i>D. J. Wineland, D. Leibfried, B. DeMarco, V. Meyer, M. Rowe, A. Ben-Kish, M. Barrett, J. Britton, J. Hughes, W. M. Itano, B. M. Jelenković, C. Langer, D. Lucas and T. Rosenband</i>	
	Quantum Computing and Quantum Communication with Atoms	273
171	<i>L.-M. Duan, W. Dür, J. I. Cirac, D. Jaksch, G. Vidal and P. Zoller</i>	
	Quantum Communication and Memory with Entangled Atomic Ensembles	283
	<i>Eugene Polzik, Brian Julsgaard, Christian Schori and Jens Sørensen</i>	

---

Quantum Information Processing and Cavity QED Experiments with Trapped $\text{Ca}^+$ Ions	293
<i>S. Gulde, H. Häffner, M. Riebe, G. Lancaster, A. Mundt, A. Kreuter, C. Russo, C. Becher, J. Eschner, F. Schmidt-Kaler, I. L. Chuang and R. Blatt</i>	
<b>Fundamental Tests</b>	
Observations of Cold Antihydrogen	305
<i>Gerald Gabrielse</i>	
Limits on CP Violation from Electric Dipole Moments	317
<i>Michael V. Romalis</i>	
Status of Atomic PNC: Experiment/Theory	327
<i>W. R. Johnson</i>	
<b>Laser Frequency and Time</b>	
Laser Frequency and Time	341
<i>Theodor W. Hänsch</i>	
Control of Coherent Light and Its Broad Applications	350
<i>Jun Ye, R. J. Jones, K. Holman, S. Foreman, D. J. Jones, S. T. Cundiff, J. L. Hall, T. M. Fortier and A. Marian</i>	
Author Index	361