

Building Single Molecules from Single Atoms

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ABSTRACT

Contents

o	INTRODUCTION	1
1	APPARATUS	2
1.1	Cooling and optical pumping beams	2
1.2	Tweezer and imaging	3
1.3	Molecular Raman frequency generation	3
2	COMPUTER CONTROL OF THE EXPERIMENT	4
2.1	Overall structure	4
2.2	Frontend	4
2.3	Backends	4
2.4	Automation of scan	5
3	RAMAN SIDEBAND COOLING	6
3.1	Theory	7
3.2	Setup	7
3.3	Challenge with large Lamb-Dicky parameter	7
3.4	Solution: High order sidebands	7
3.5	Solution: Simulation based optimization	7
3.6	Cooling performance	7
4	INTERACTION OF SINGLE ATOMS	8
4.1	Scattering length	8
4.2	Energy levels of two interacting atoms in an anisotropic trap	9
4.3	Interaction shift spectroscopy	9
5	PHOTOASSOCIATION OF SINGLE ATOMS	10
5.1	Energy levels	10
5.2	Effect of the trap	10
5.3	Photoassociation spectroscopy	11
6	TWO-PHOTON SPECTROSCOPY OF NACs GROUND STATE	12
7	COHERENT OPTICAL CREATION OF NACs MOLECULE	13

Acknowledgments

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Introduction

1

Apparatus

1.1 COOLING AND OPTICAL PUMPING BEAMS

(MOT, OP, fiber back reflection)

(Mention Na Raman beam to be covered in later chapter?)

1.2 TWEEZER AND IMAGING

1.3 MOLECULAR RAMAN FREQUENCY GENERATION

(beam path, calibration)

2

Computer control of the experiment

2.1 OVERALL STRUCTURE

2.2 FRONTEND

2.3 BACKENDS

(communication protocol)

2.3.1 FPGA BACKEND

2.3.2 NIDAQ BACKEND

2.3.3 USRP BACKEND

2.4 AUTOMATION OF SCAN

3

Raman sideband cooling

3.1 THEORY

3.2 SETUP

3.3 CHALLENGE WITH LARGE LAMB-DICKY PARAMETER

3.4 SOLUTION: HIGH ORDER SIDEBANDS

3.5 SOLUTION: SIMULATION BASED OPTIMIZATION

3.6 COOLING PERFORMANCE

4

Interaction of single atoms

4.1 SCATTERING LENGTH

(Importance/relation with binding energy etc.)

4.2 ENERGY LEVELS OF TWO INTERACTING ATOMS IN AN ANISOTROPIC TRAP

4.3 INTERACTION SHIFT SPECTROSCOPY

(motional sideband, scattering length result)

5

Photoassociation of single atoms

5.1 ENERGY LEVELS

5.2 EFFECT OF THE TRAP

(light shift, broadening)

5.3 PHOTOASSOCIATION SPECTROSCOPY

($v=0, 12, 14$, etc)

6

Two-photon spectroscopy of NaCs ground state

(N=2, different HF states)

7

Coherent optical creation of NaCs

molecule

8

Conclusion