

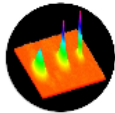
Forbidden atomic transitions
driven by an
intensity-modulated laser trap

2015/05/25

Kyeong Ock Chong

Forbidden atomic transitions driven by an intensity-modulated laser trap

Kaitlin R. Moore¹, Sarah E. Anderson¹ & Georg Raithel¹



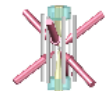
Bose-Einstein Condensation (David Anderson, Stephanie Miller)

A BEC consists of many atoms in the same quantum state. BECs are of interest because they are large objects that behave quantum mechanically. We intend to explore interactions between BECs and ions.



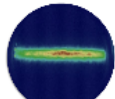
Ponderomotive Optical Lattice Trap (Kaitlin Moore, Yun-Jhih Chen, Andira Ramos)

We use the ponderomotive force to trap and study Rydberg atoms in optical lattices.



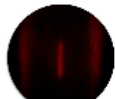
Cavity-Generated Optical Lattice Trap (Yun-Jhih Chen)

We use an in-vacuum near-concentric optical cavity to generate deep potentials to study Rydberg atoms.



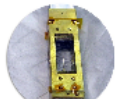
Strong Magnetic Field Atom and Plasma Trap (Eric Paradis)

A superconducting Ioffe magnet has been developed to confine cold atoms at ~3 Tesla, and is coupled to a Penning trap for plasmas. Exotic Rydberg atoms, strongly magnetized cold plasmas, and other systems.



Continuous-wave Atom Laser (Mallory Traxler)

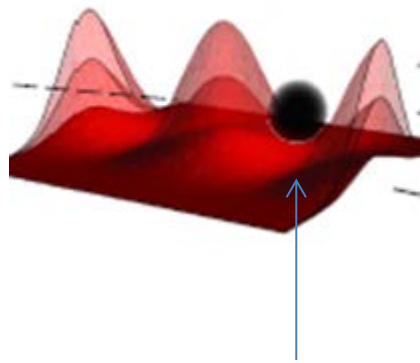
By mapping the evaporative cooling necessary to achieve BEC into space rather than time (as is conventionally done), it will be possible to realize a truly continuous BEC. By adding the correct output coupler...



Ion-imaging Tip (Andrew Schwarzkopf, Nithiwadee Thaicharoen)

We hope to probe the physical distributions of Rydberg atom systems and plasmas.

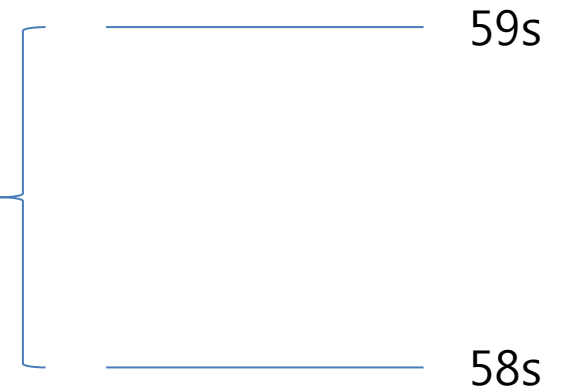
Main features of this paper



Intensity modulated lattice
($T=2\pi/\Omega$)

Rydberg atoms (^{85}Rb)

Target transition ($\Omega = 38.7685\text{GHz}$)



Main features of this paper

$$V_{int} = \frac{1}{2m_e} (2|e|\mathbf{A} \cdot \mathbf{p} + e^2 \mathbf{A} \cdot \mathbf{A})$$

Forbidden by selection rule
(electric-dipole transition)

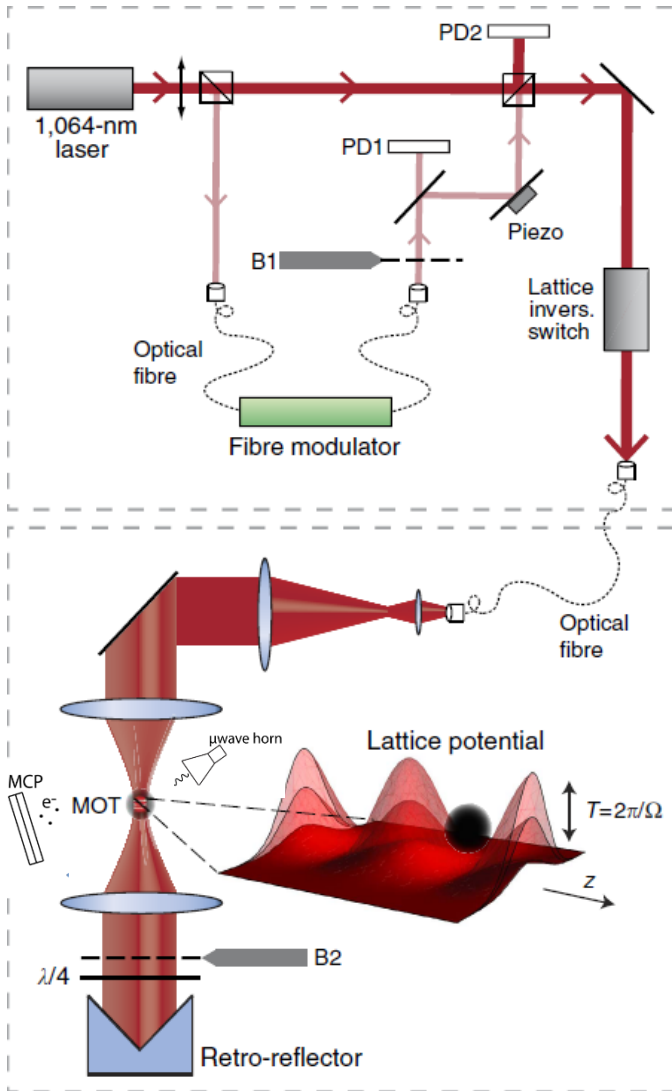
Drive transition by
ponderomotive term

Target transition (38.7685GHz)

59s

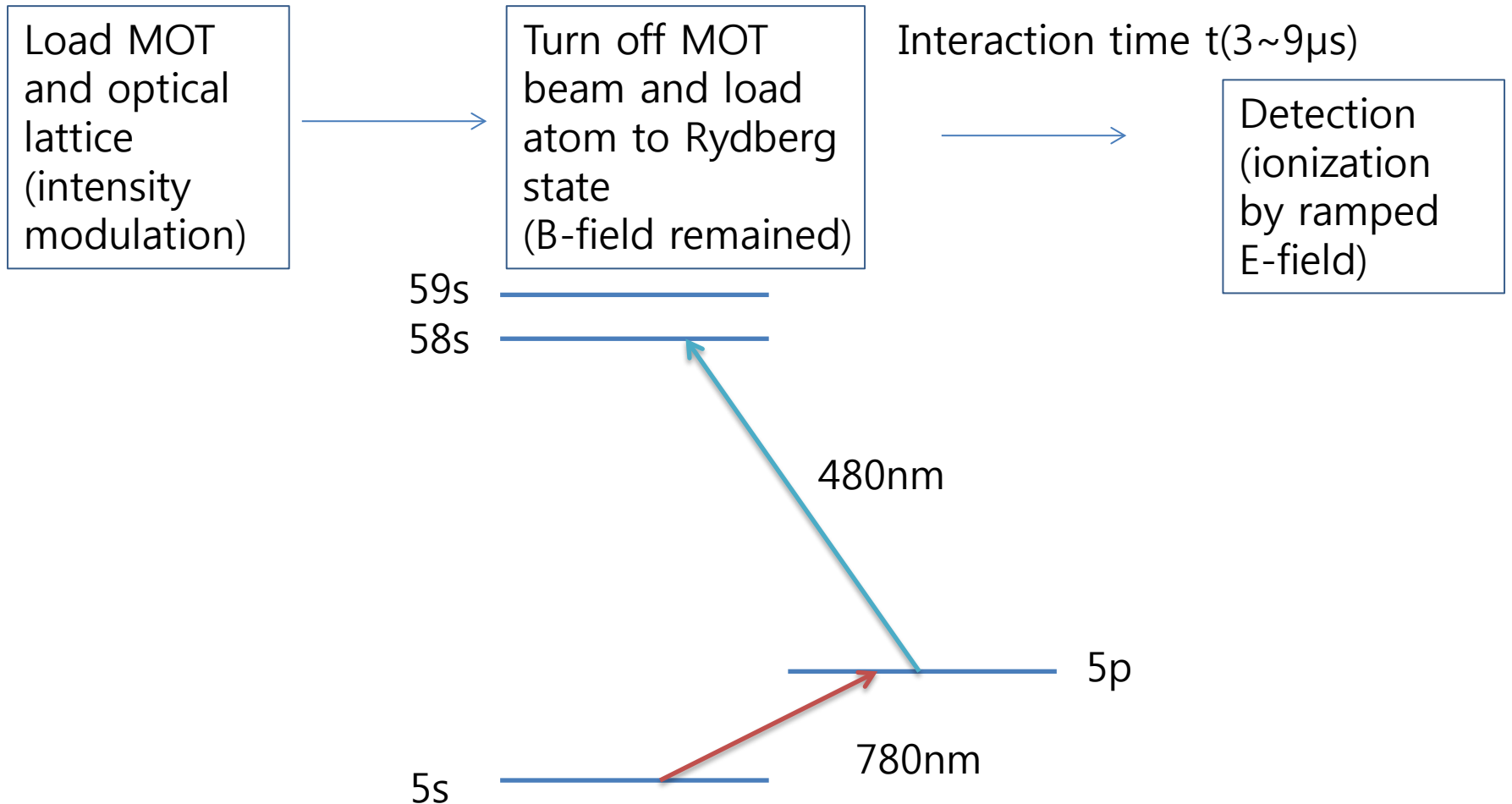
58s

setup

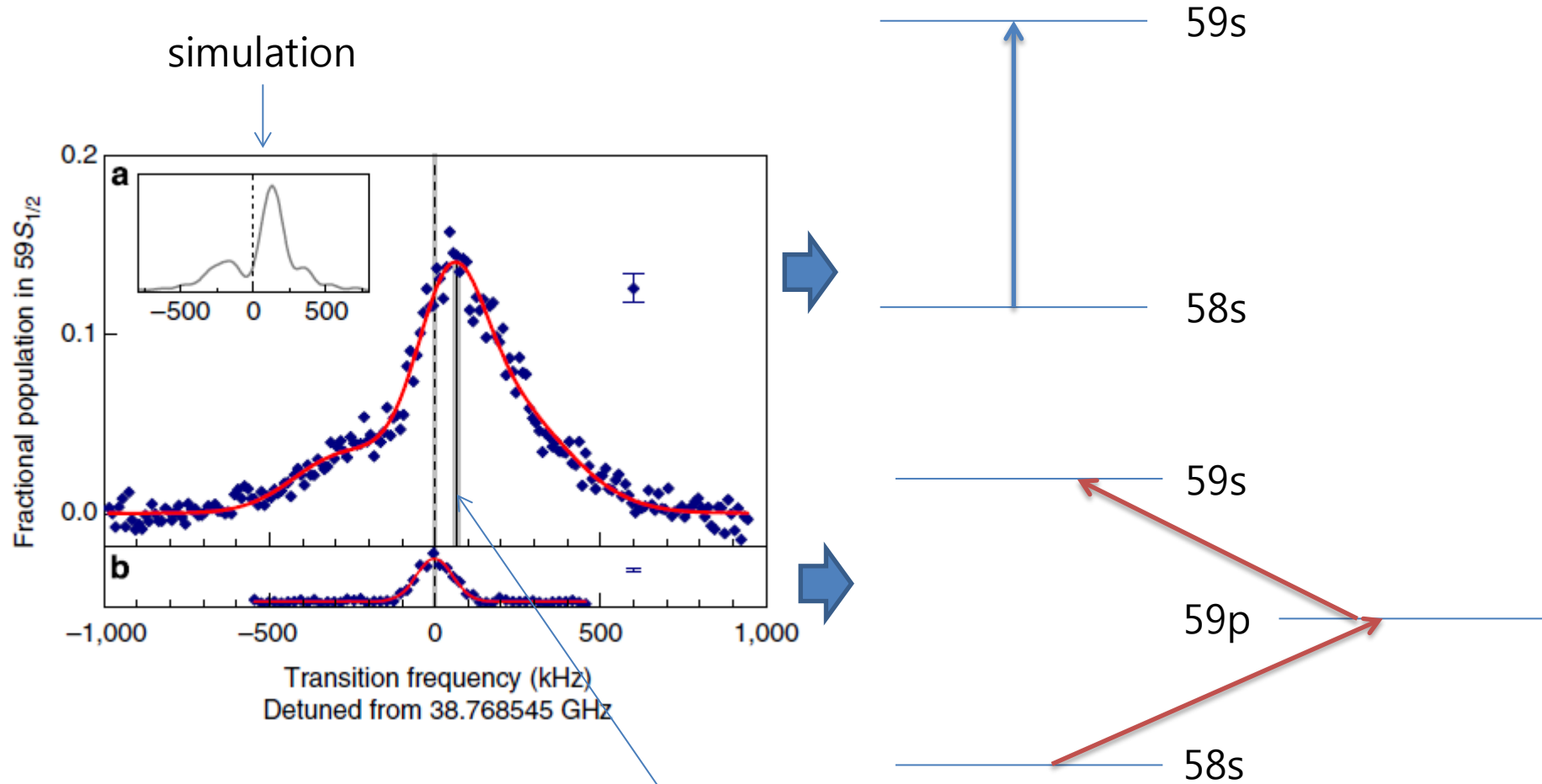


- MOT
- Optical Lattice
 - Unmodulated high power beam(3.9W)
 - Modulated low power beam(190mW)
 - Mach Zehnder-type interferometer
 - Coherent recombination
- PD1 for precise modulation
- PZT and PD2 for phase matching

Experiment scheme



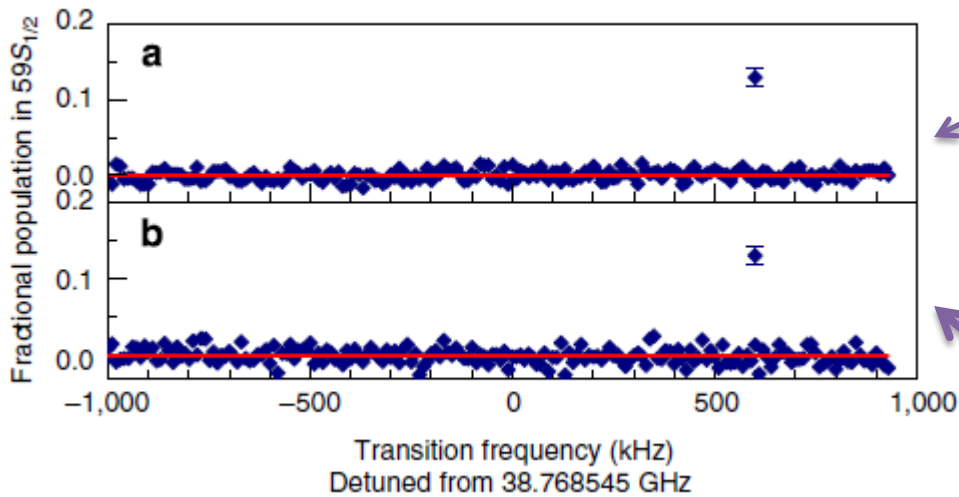
Results (spectroscopy signal)



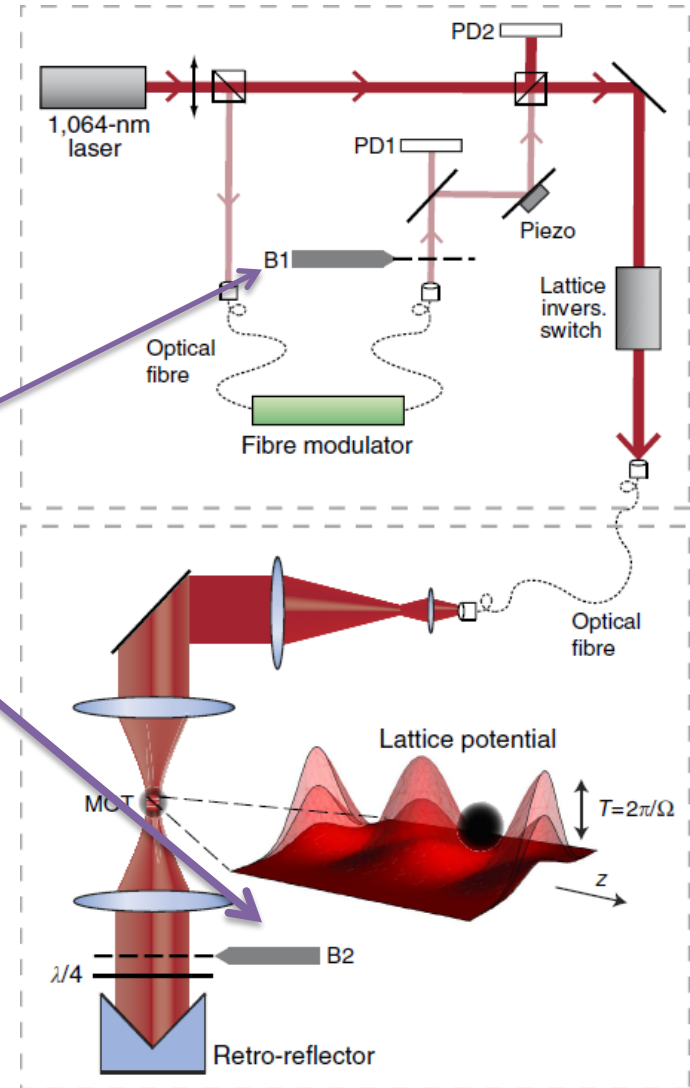
Due to light shift from optical lattice

Results (testing the results)

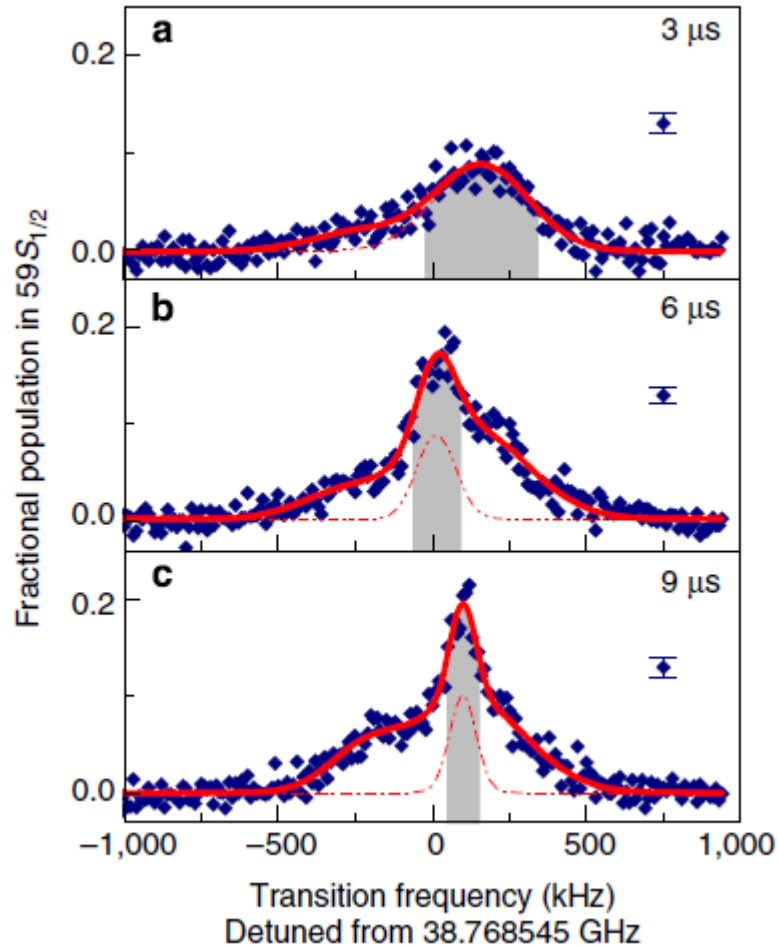
Testing microwave leakage



Testing two-step process
second ($\mathbf{A} \cdot \mathbf{p}$) coupling



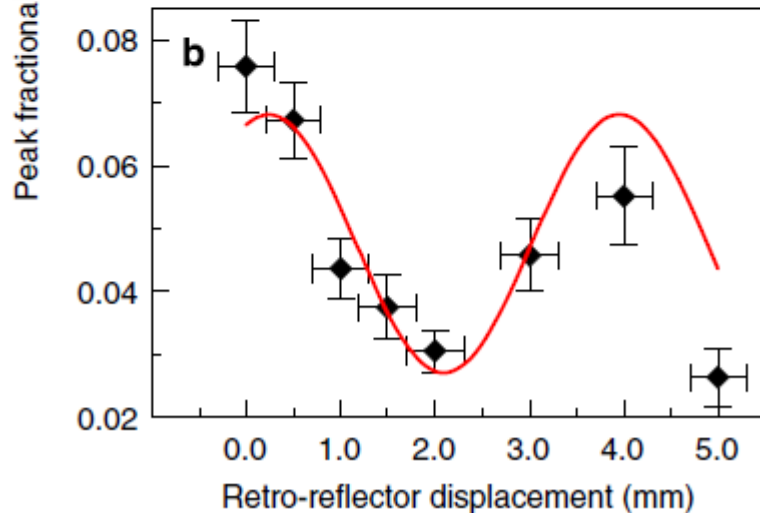
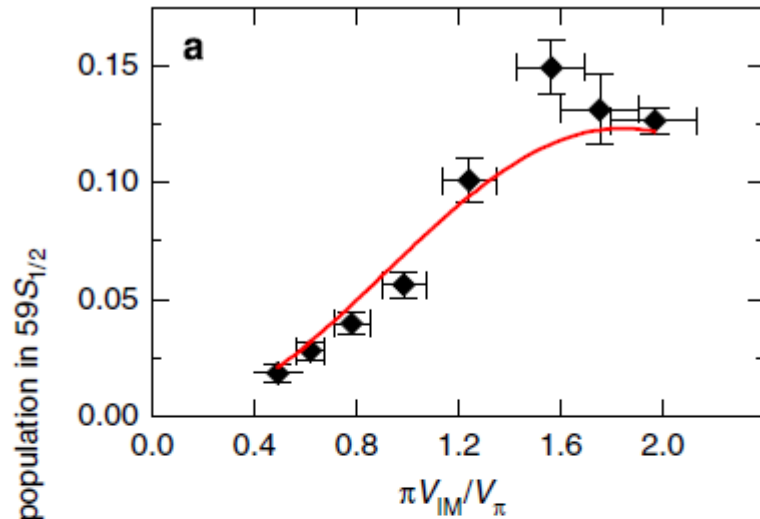
Results (interaction time)



as t_{int} increases, FWHM decreases and height increases.

50~100kHz of Rabi frequency estimated (theory : 100kHz)

Results (position, voltage)



$$\chi \approx \sqrt{\epsilon} \frac{e^2}{\hbar m_e c \epsilon_0 \omega^2} I_{0 \text{ inc}}^{\text{mod}} J_1 \left(\frac{\pi V_{IM}}{V_{\pi}} \right) \left[1 + \sqrt{\frac{2I_{0 \text{ inc}}^{\text{unmod}}}{I_{0 \text{ inc}}^{\text{mod}}}} \right] D_{n,l,m}^{n',l',m'}$$

$$(\chi t_{\text{int}})^2 \propto J_1^2(\pi \hat{V}_{IM}/V_{\pi})$$

χ : Rabi frequency

Time delay between reflected and incident pulse

→ Sinusoidal varying

Conclusion

- Demonstration of Rydberg spectroscopy
- Advantages
 - Flexible selection rule
 - High spatial addressability
 - Possibility of suppressing AC Stark shift
- Possible application
 - Quantum computing (single site addressability)
 - Precision measurement of atomic characteristics and physical constants
 - Rydberg constant (leading to proton size)

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LN86S-FC

LN66S-FC

FC/PC Connectors

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Part Number	Product Description
LN65S-FC	40 Gb/s Intensity Modulator with Polarizer, FC/PC Connectors
LN27S-FC	40 Gb/s Phase Modulator with Polarizer, FC/PC Connectors
LN66S-FC	40 Gb/s Phase Modulator without Polarizer, FC/PC Connectors

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40T26G40A

40 Watt CW, 26.5 - 40 GHz

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The Model 40T26G40A is a self contained, forced air cooled, broadband traveling wave tube (TWT) microwave amplifier designed for applications where wide instantaneous bandwidth, high gain and moderate power output are required. A reliable TWT provides a conservative 40 watts minimum at the amplifier output connector. Stated power specifications are at the fundamental frequency. The amplifier's front panel digital display shows forward and reflected output plus extensive system status information accessed through a series of menus via soft keys. Status indicators include power on, warm-up, standby, operate, faults, excess reflected power warning and remote. Standard features include a built-in IEEE-488 (GPIB) interface, 0dBm input, VSWR protection, gain control, RF output sample port, auto sleep, plus monitoring of TWT helix current, cathode voltage, collector voltage, heater current, heater voltage, baseplate temperature and cabinet temperature. Modular design of the power supply and RF components allow for easy access and repair. Use of a switching mode power supply results in significant weight reduction. Housed in a stylish contemporary cabinet, this unit is designed for benchtop use but can be removed from the cabinet for rack mounting. The Model 40T26G40A provides readily available RF power for a variety of applications in Test and Measurement, (including EMC RF susceptibility testing), Industrial and University Research and Development, and Service applications. These sub-octave amplifier features moderate harmonic content. The export classification for this equipment is EAR99. These