Towards a cold ^{6}Li - beam

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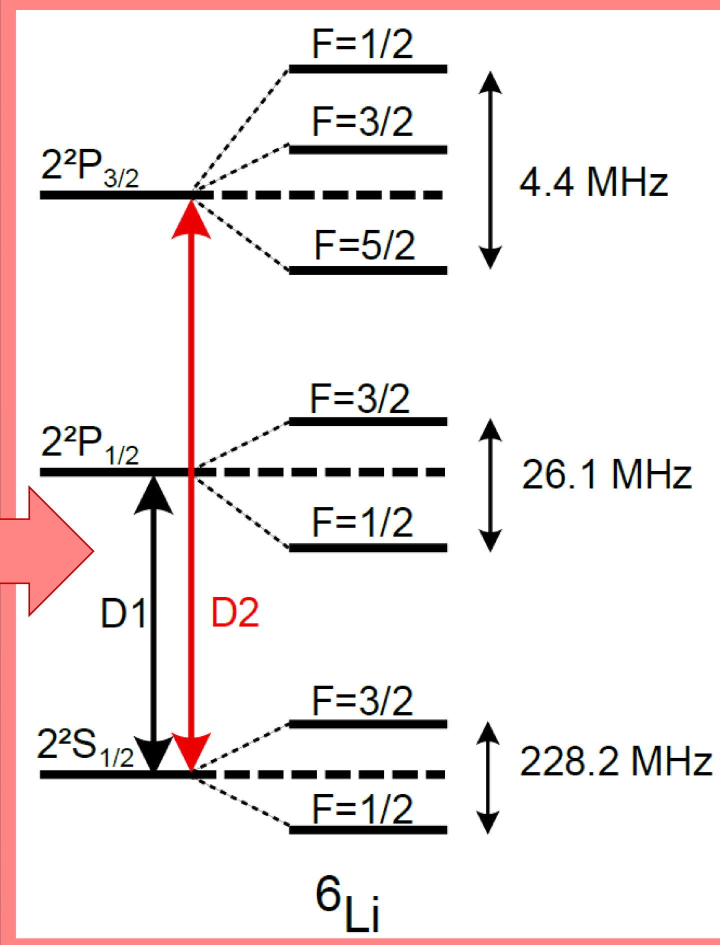
Basic Idea

1. Use 2-dimensional MOT loaded via hot effusive ^{6}Li - oven to provide initial atoms for a cold atomic beam.
2. Implement additional laser along unconfined axis (orthogonal to the 2D-trapping plane) to push trapped Li out of the MOT.

→ Cold atomic ^{6}Li-beam

Level scheme ^{6}Li – used transitions D2 lines.



For a more detailed view into the setup of the experiment look at Benedikt Tscharn's contribution *Towards building and loading a Ioffe trap using a 2D MOT, contribution number A112.*

Source model for hot effusive Li^6-oven, loading the 2D MOT

$$\theta_s = n_s \bar{v} A \frac{\Omega_C}{4\pi} \text{ [1]},$$

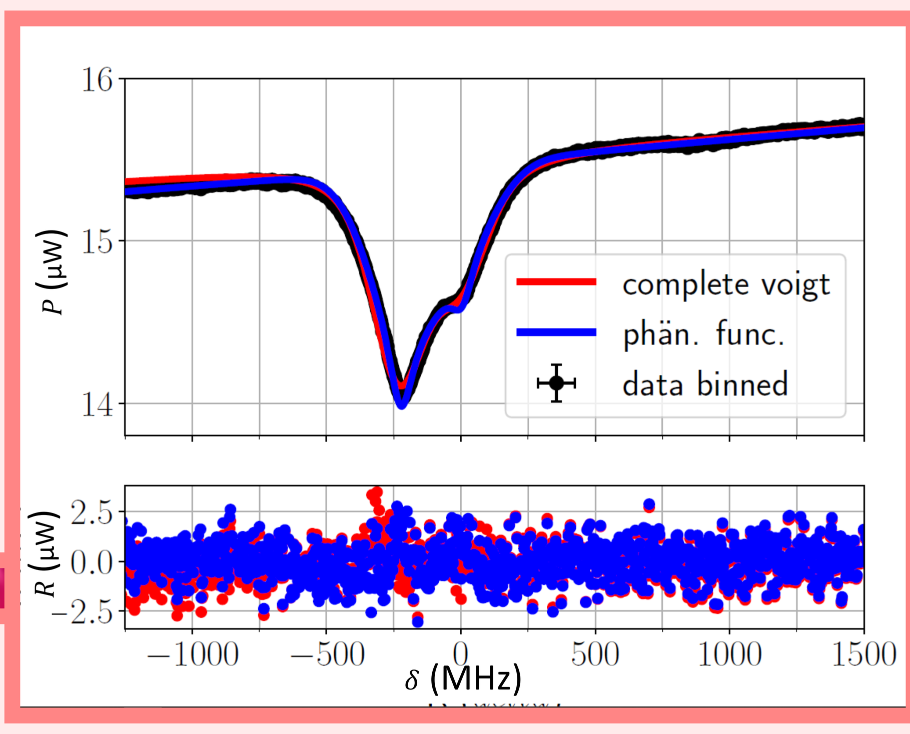
where θ_s total emitted atomic flux into area of capture Ω_C, A opening area of ^{6}Li-reservoir, $\bar{\boldsymbol{v}}$ mean thermal velocity of Li-atoms and n_s density of ^{6}Li-gas in reservoir.

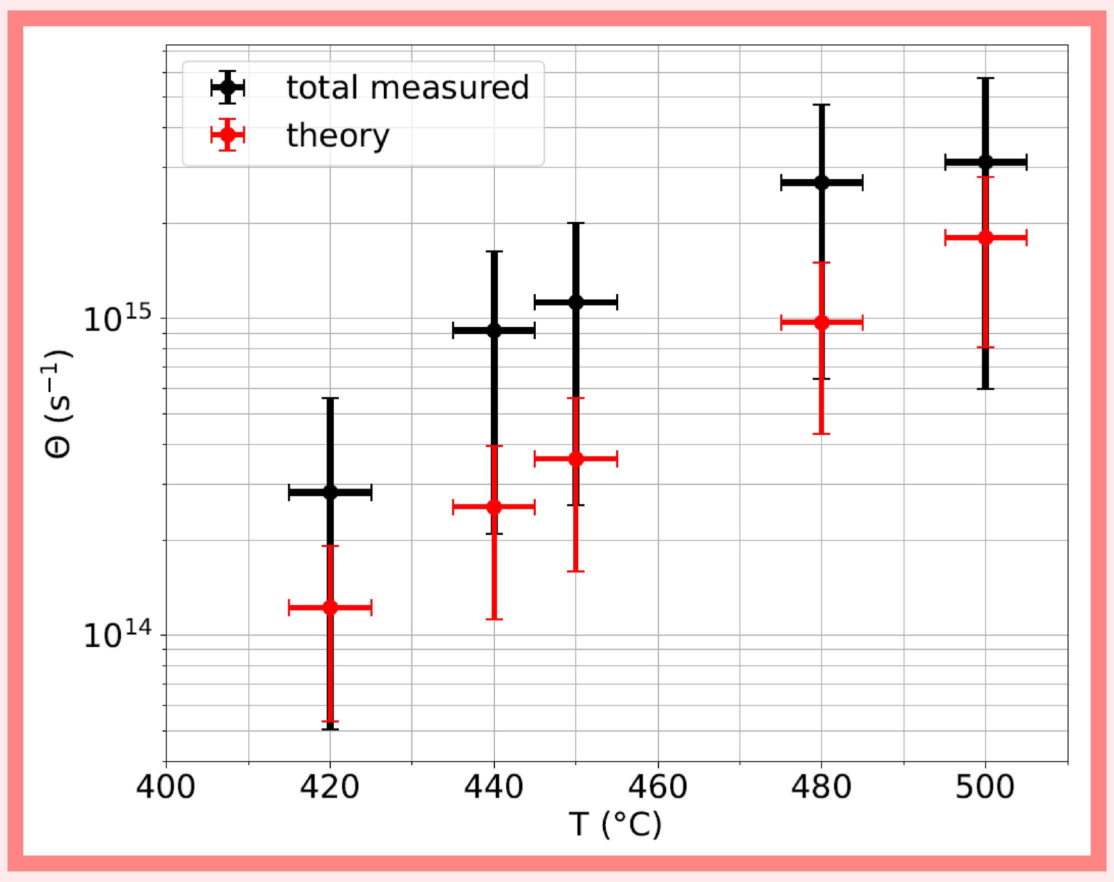
- $\theta_s \approx 10^{15}\ s^{-1}$, measured via transversal atomic beam absorption spectroscopy [2].

Discovered unusal lineshape via unphysical results due to

- finite oven size
- intermediate flow regime.

We were able to phenomeno-logically adapt lineshape model to match data:

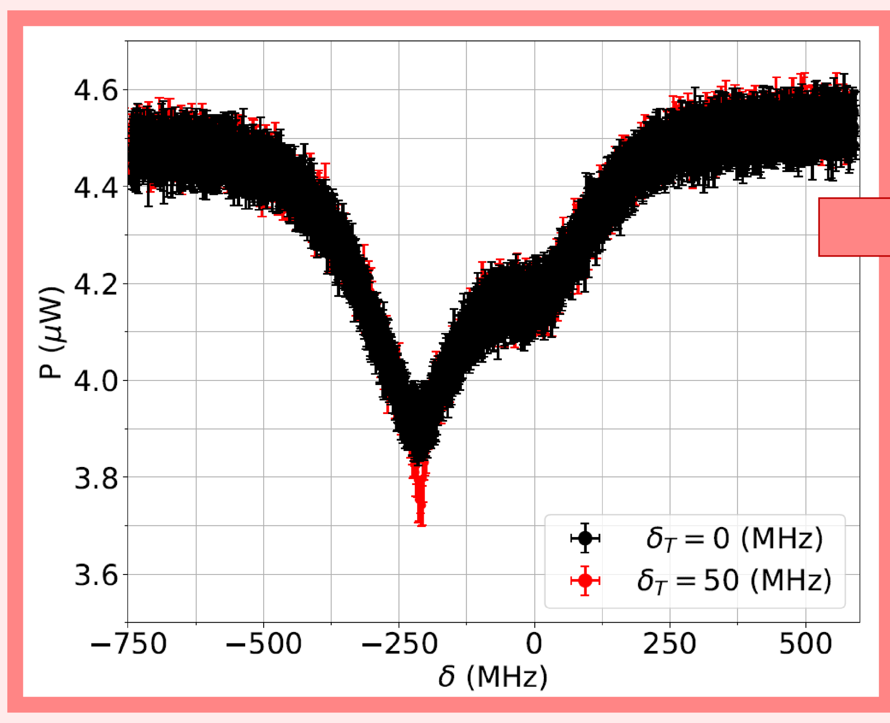


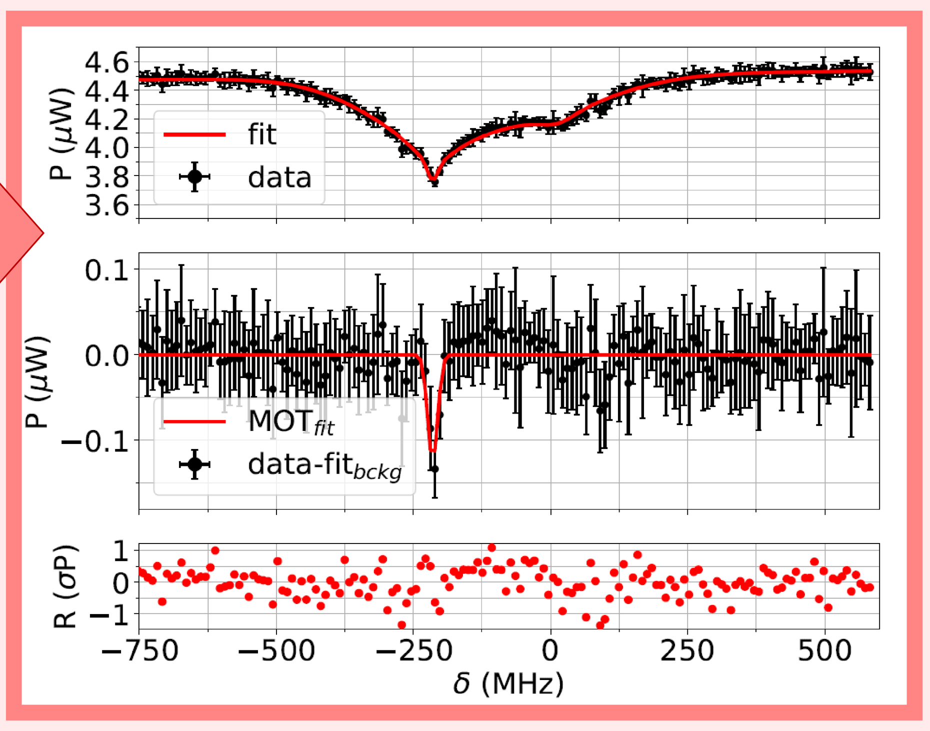


We phenomenologically understand the hot effusive ^{6}Li- oven!
next: create analytical model

Performance of 2D MOT [2]

Absorption of hot bckg. + captured atoms measured

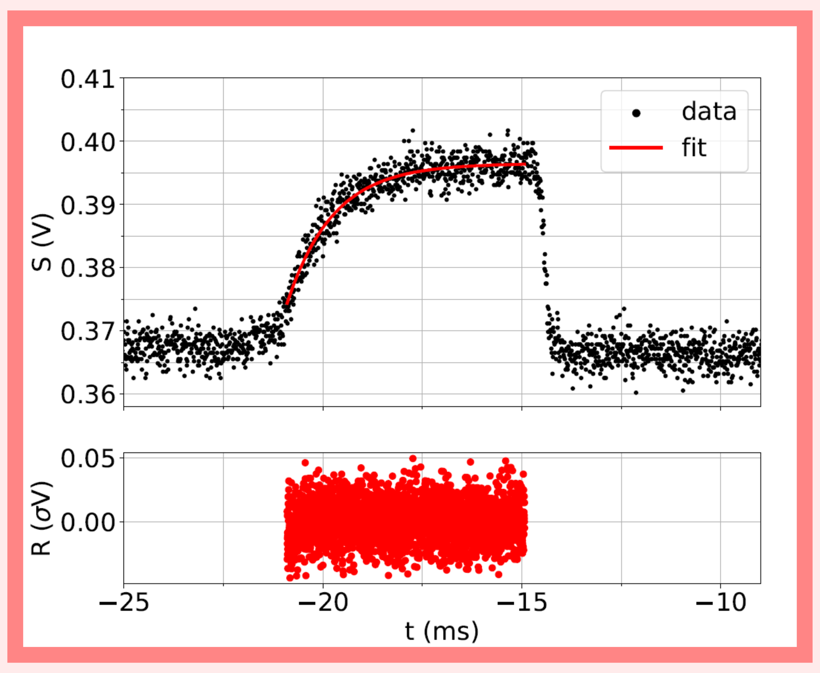




substract predic-ted bckg. (source model) from complete signal

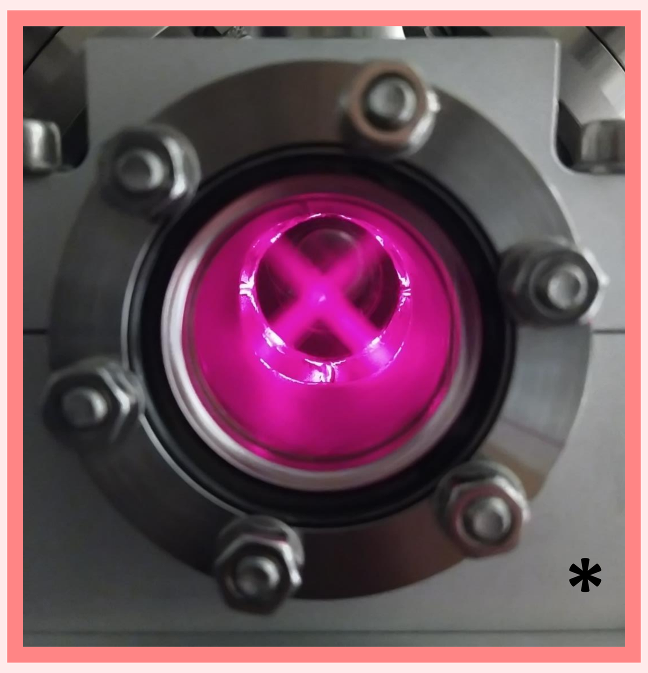
→ absorption spec-trum of trapped atoms

Typical loading curve for 2D MOT



Measurements resulted in:

- **^{6}Li- density MOT:** $n_z = 1.6(3) \cdot 10^5$ **cm^{-2}**
- **Temperature:** $T = 33.2(7)$ **mK**
- **Loading time:** $\tau_{load} = 2.7(2)$ **ms**



* both picture show typical fluorescence signasl of 2D-MOT

Current Status

- Push beam implemented
- Cold beam can be detected
- Atoms roughly 50 ms^{-1} fast

Future Plans

- Detailed analysis of cold beam
- Build magnetic trap to capture cold atoms [3]
- Integrate into further experiments [4]

For more information about projects in AG Pohl and a download of all posters of the group

Sources
[1] T.G. Tiecke et al. "A high-flux 2D MOT source for cold lithium atoms" in *Phys. Rev. A* Vol. 80. No.1 (2009).
[2] H.-L. Schumacher "Two-dimensional magneto-optical Trap for Lithium Atoms". Master thesis JGU Mainz (2023).
[3] J. Tollet et al. "Permanent magnet trap for cold atoms" in *Phs. Rev. A* Vol. 51. No. 1 (1995).
[4] S. Schmidt et al. "The next generation of laser spectroscopy experiments using light muonic atoms" in *J. Phys.: Conf. Ser.* pp 012010 (2018).