Master thesis project

Transversal cooling for K atoms

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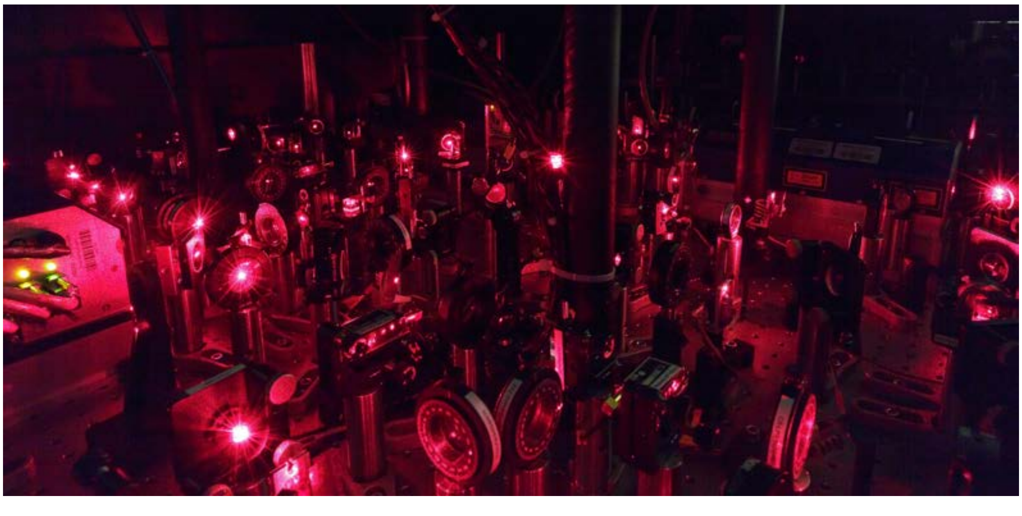
Scientific background: We work with an ultracold mixture of fermionic lithium (^{6}Li) and fermionic or bosonic potassium (^{40}K, ^{41}K) atoms, which opens up many exciting new avenues in quantum-gas research. In the early times of this experiment, we investigated the intriguing scattering properties of a mass-imbalanced Fermi-Fermi mixture. Amongst other things, we investigated the repulsive and the attractive Fermi polaron - for different interaction strengths - where the ^{40}K atoms acted as an impurity. After this, we switched to the bosonic isotope ^{41}K and are now exploring the behavior of these two species in the vicinity of a Feshbach resonance.

Why do we need transversal cooling? In our experiment we work with quantum-degenerate samples of Li and K. The first steps in producing such a mixture are to cool down the atoms and at the same time, load as much as possible of them in the trap. Unfortunately, the natural abundancy of the fermionic ^{40}K and the bosonic ^{41}K are very low (0.012% and 6.7%) which prevents us from having big samples of quantum-degenerate potassium clouds. Therefore, we want to install a transversal cooling stage at the beginning of the cooling sequence, before the Zeeman-slower stage in order to make more atoms join the hot atomic beam, feeding the magneto-optical trap (MOT). With this method, we will increase our final atom number significantly.

The Master thesis project: In this project, you build the transversal-cooling stage by using a commercially available TOPTICA diode-laser system operating at a wavelength of 767 nm. The project consists of three steps. First, you design and build the laser system to collimate the atoms to increase their flux already before the Zeeman-slower stage. Second, you implement the set up into the existing experiment. As a last step, you test the functionality of your design on our K atoms, and measure, using absorption imaging, the increase of atoms loaded into the MOT

What you get out: This project will provide excellent training in modern laser technologies, and it is directly connected to a state-of-the-art research project. You will learn how to work with lasers, how to cool and confine atoms and how to image atomic clouds.



Example of one of the laser systems at a wavelength of 671 nm used in the FeLi(Bo)Kx experiment.