The aim of this project is to conduct precise spectroscopic measurements on mercury atoms that are co-trapped with rubidium atoms. Mercury, being an element with two valence electrons, exhibits extremely narrow optical transitions connecting its ground state and triplet states. These transitions play a crucial role in optical atomic clocks, which are renowned for their exceptional stability and accuracy. Not only are these clocks used for timekeeping, but they also find applications in quantum simulations and the detection of gravitational waves.

By conducting accurate spectroscopy on narrow optical transitions, we can explore the invariance of fundamental physical constants. Additionally, measuring the precise frequencies of these transitions in different isotopes of mercury allows us to investigate fundamental interactions and search for potential new interactions beyond what the Standard Model predicts.

Optical atomic clocks rely on the stability of ultra-narrow optical transitions. However, their precision can be affected by various external factors that disturb the energy states of the atoms. To enhance the precision of these clocks, we aim to trap atoms with highly sensitive optical transitions together with the reference atoms. By studying the effects of external disturbances on the secondary species, we can gain a better understanding of these perturbing factors and improve the overall precision of the clocks. Nevertheless, this approach introduces collisions between atoms of different elements, which can cause shifts in energy levels and broadening of the spectral lines.

Our research primarily focuses on measuring how collisions with rubidium atoms affect the optical transitions in mercury atoms when they are co-trapped. The findings of this study will contribute to the development of two-species optical atomic clock systems. Additionally, comparison of our experimental results with theoretical calculations, enabling us to gain deeper insights into the interactions between colliding particles. By combining theoretical predictions with experimental data, we strive to advance our knowledge of these intricate atomic systems and their potential applications in high-precision timekeeping and fundamental physics research.