Optical Isotope Separation of Rubidium

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Whether for medical applications, radiation protection, or the utilization in physical metrology – having access to a pure or enriched amount of a single isotope can be a huge advantage. Natural abundant rubidium is composed of ^{85}Rb and ^{87}Rb. Since these isotopes differ in their nuclear spin, the hyperfine groundstates are spectrally well separated and individually accessible.

Our experimental setup consists of two vapor cells which are interconnected by a capillary. Resonant high-power lasers are used to exert a light-induced drift on the individual rubidium isotopes [1]. Changes in isotope concentration in the cells are measured using absorption spectroscopy.

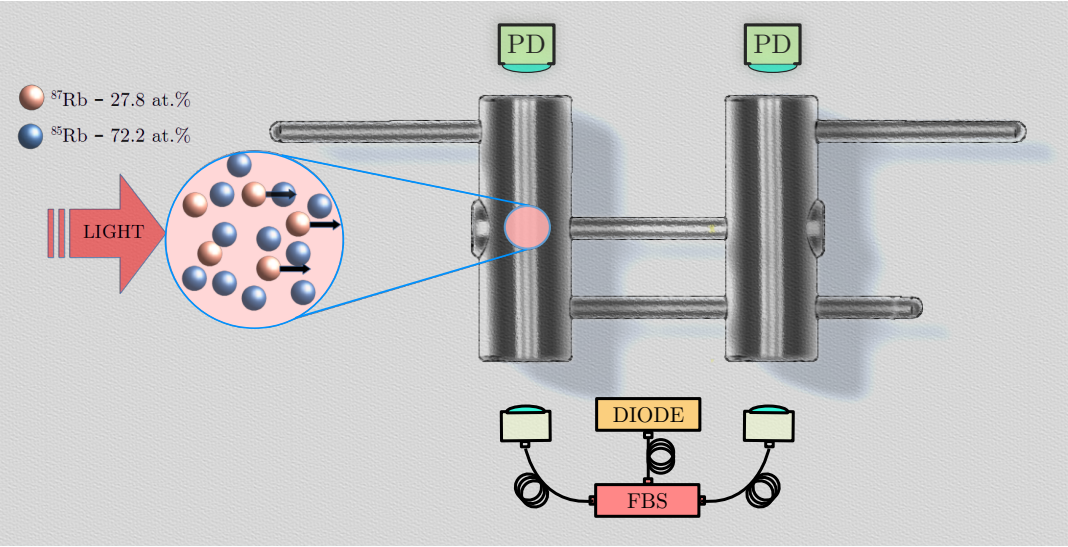

Figure 1. The basic working principle of the rubidium isotope separation. The abbreviations used here are: FBS ≡ Fiberbeamsplitter, PD ≡ Photodiode.

We report on the method and ability to enrich the ^{87}Rb–isotope. The enrichment factor of ^{87}Rb, which describes the ratio between the enriched and natural abundance of the desired isotope, is spectroscopically measured to be (1.58 ± 0.03).
In a time-resolved approach, where the isotope ratio is constantly monitored over time, the maximum enrichment factor is revealed by a exponential fit function to be (1.63 ± 0.01). That corresponds to an enrichment factor per neutron mass difference of (1.26 ± 0.01) (measured) and (1.28 ± 0.01) (fit). These enrichment factors exceed those from a single-stage gas centrifuge [2].

Such optics based separation methods are assumed to be promising candidates for producing highly enriched ^{87}Rb for the manufacturing of vapor cells in a multi-stage realization. This specific method also enables the possibility to investigate systems with different predefined isotope ratios.

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[1] Okamoto, M. *et al.* Observation of Light-Induced Drift Effect of Rubidium by Using Two Diode Lasers for Pumping and Re-Pumping. Materials Transactions. 49, 11 (2008), pp. 2632–2635.
[2] Wood, H. G. *et al.* "The gas centrifuge and nuclear weapons proliferation". Physics Today 61, 9 (2008), pp. 40–45.