Thermal attenuation noise of optical power from a 420nm light source in hot ^{85,87}Rb vapor.

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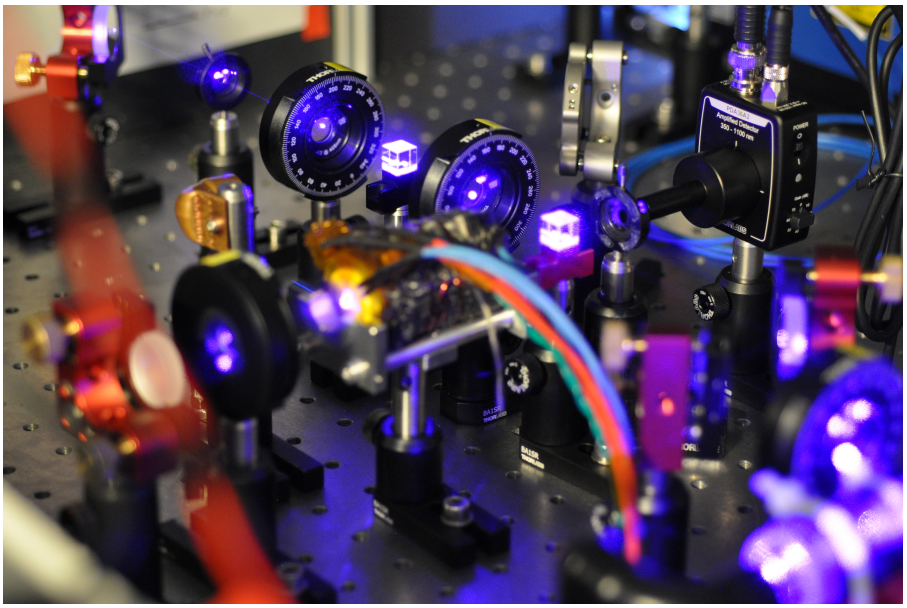
Datum: 13. Mai 2019



Rough project description The aim of this project is to use an existing laser system build for doppler free absorption spectroscopy to create optical power attenuation due to hot Rubidium vapor. The hot Rb vapor is produced in a vapor-gas cell and can be heated up to 160 C. It is expected to acquire gaussian distributed white-noise which can be measured and evaluated.

Experimental procedure The base consists of a Gallium nitride semiconductorlaser in an extended cavity diode laser design. This minimizes any spurious noise from the laser source itself since the linewidth is approx. $< 100\,\text{kHz}$ and therefore around 5 magnitudes smaller than the expected doppler broadening. The laser is stabilized and run non-resonant in a two way fashion with a $\lambda/4$ plate, through the heated cell which in turn attenuates the power signal.
From previous experiments it is known that the cell reaches enough temperature to increase the optical density below the full absorption limit. Therefore it must be run below that which gives an acceptable range of $40 - 90$ degrees.

Evaluation Let the hypothesis of gaussian distributed white noise be true, then we can simply acquire uniform distributed values betwenn $[0, 1)$ with simply putting the inverse of the Box-Mueller transform

$$Z_1 = \sqrt{-2 \log U_1} \cos(2\pi U_2) \tag{1}$$

$$Z_2 = \sqrt{-2 \log U_1} \sin(2\pi U_2) \tag{2}$$

which can be done numerically of in a case-by-case symbolic inversion.
Should this be successfull, the result can be tested against known random-quality tests (perhaps provided by a different group?)

Timeframe Since the experiment is already build up and running, it can be expected to get first results the first time it is free to do such a task. (I would say in the next two weeks at least once).

References

1. Scott, D. W. Box Muller transformation. *Wiley Interdisciplinary Reviews: Computational Statistics* **3**, 177 179. issn: 1939-0068 (2011).

2. Toptica Photonics, *Handsheet for DL pro HP 420*, **029183** (2018)