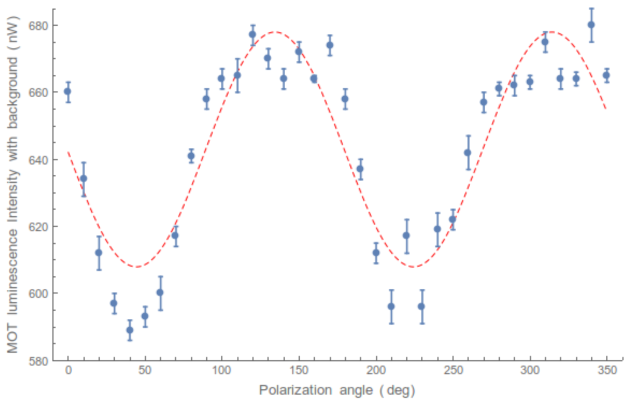

Figure 1: MOT luminescence intensity with background as a function of the polarization angle before the first MOT pass-through of one beam.

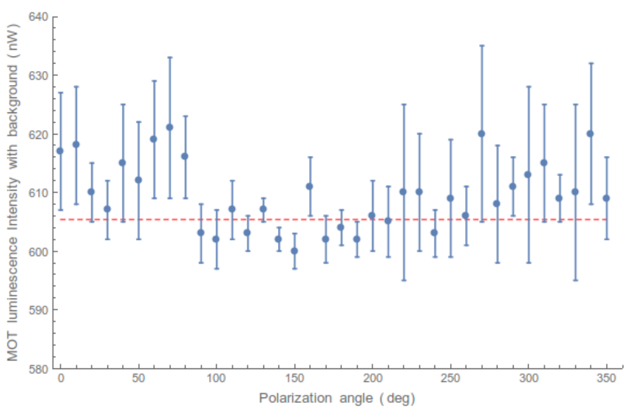

Figure 2: MOT luminescence intensity with background as a function of the polarization angle before the second MOT pass-through of one beam.

1 new things

1.1 Polarization direction dependence

As it is visible on Figure 1, the MOT luminosity changes periodically, following a π periodic dependence; the fitted function

$$f(x) = A\cos\left(\frac{\pi x}{180^\circ} - \varphi\right) + B$$

serves the purpose of confirming the periodicity, as the fitting is otherwise distorted by the abundance of near-maximum points compared to those near the minimum. Figure 2 shows the unadjusted luminosity as a function of the polarization angle of the beam changed before the second passing through the sample. Here, the strong fluctuations make it impossible to notice fine angle-dependent changes. The underlying function is likely a constant function, shown as the red dashed fitted line.

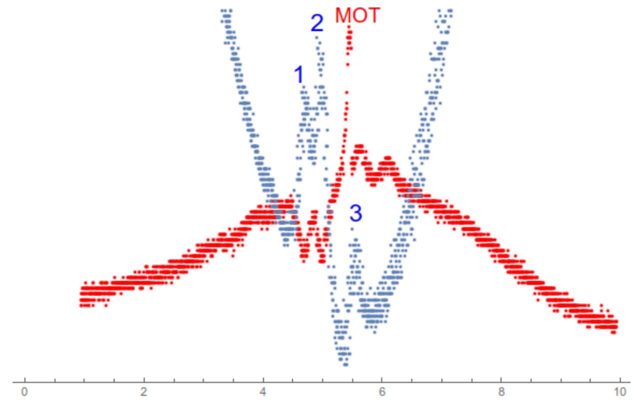

Figure 3: MOT luminescence intensity with background as a function of the polarization angle before the second MOT pass-through of one beam.

1.2 Detuning of the cooling laser

To quantify the ideal detuning of the cooling laser, we used a slow periodic signal to scan through the spectrum slow enough that the changes in the MOT can be recorded on an oscilloscope. The detected peaks (F $\rightarrow$ F1 and MOT fluorescence peak):

$$\begin{aligned}
3 \rightarrow 2,\, 4 &: \quad (4.708 \pm 0.024)\,\mathrm{s} \\
3 \rightarrow 3,\, 4 &: \quad (4.956 \pm 0.024)\,\mathrm{s} \\
3 \rightarrow 4 \quad &: \quad (5.556 \pm 0.016)\,\mathrm{s} \\
MOT \quad &: \quad (5.456 \pm 0.008)\,\mathrm{s}
\end{aligned}$$

By matching the difference of peaks 1, 2 and peaks 2, 3 with the frequencies of the transitions, averaging the results yields a frequency scale of

$$C = (114.161 \pm 11.163)\,\frac{\mathrm{MHz}}{\mathrm{s}}$$

The optimal detuning is the difference between the MOT and the $3 \rightarrow 4$ peaks:

$$\Delta = C \cdot (0.100 \pm 0.008)\,\mathrm{s} = (11.4161 \pm 1.4423)\,\mathrm{MHz}$$

References

[1] Unspecified Author, *FP Experiment: Rubidium MOT* (University of Bonn, 2014).