(Dataset) Measured hyperfine frequencies of ^{85}Rb and ^{87}Rb in inert buffer gases

B. H. McGuyer

Department of Physics, Princeton University, Princeton, New Jersey 08544

(Dated: 20 November 2020.)

This dataset provides measurements of the microwave resonant frequencies of the 0–0 hyperfine transitions of ground-state ^{85}Rb and ^{87}Rb atoms as a function of Ar, He, Kr, Ne, N_2, Xe, or ^{136}Xe buffer-gas pressure.

The microwave resonant frequencies of ground-state Rb atoms have a nonlinear dependence on the pressure of certain inert buffer gases, presumably because of short-lived van der Waals molecules. This dataset consists of measurements taken during 2010–2011 to research nonlinear pressure shifts as part of the author's PhD dissertation.[1] For experimental details, please see Chapter 4 of Ref. 1. The ^{87}Rb data was published in Ref. 2.

The spreadsheet "Rb-hyperfine-frequencies-2012-TableOfContents.xlsx" is an overview of the individual datasets and their experimental conditions. Each row corresponds to a separate dataset with a unique identification number as labeled. Note that anomalous frequency shifts are present in some of the data below about 1 Torr as described in Ref. 2 and on p. 102 of Ref. 1. Additional datasets with known technical issues were excluded.

Each file "Rb-hyperfine-frequencies-2012-Dataset_#.csv" gives the dataset with identification number #. Each row is a data point with the following columns:

VdW_Cfreq_#: Measured 0–0 "clock" frequency (Hz). This is the average of captured frequency counter data. Unfortunately, the zero-pressure intercepts were not controlled enough to guarantee that frequency data from different # datasets can be combined.

VdW_CfreqError_#: Uncertainty of Cfreq data (Hz). This is the sample standard deviation of the frequency counter data.

VdW_QBPressure_#: Corrected buffer-gas pressure (Torr). This is BPressure processed to remove pressure-gauge nonlinearity as described in Section 4.4.1 of Ref. 1.

VdW_QBPresError_#: Uncertainty for QBPressure and BPressure data (Torr). This is the sample standard deviation of raw pressure-gauge readings.

VdW_BPressure_#: Buffer-gas pressure (Torr). This is the average of raw pressure-gauge readings processed to subtract a zero-pressure offset. This data includes a systematic error from pressure-gauge nonlinearity that is removed in QBPressure.

This work was supported by the Air Force Office of Scientific Research, the Department of Defense, and the Department of Energy.

REFERENCES

[1]B. H. McGuyer, "Atomic physics with vapor-cell clocks," Ph.D. dissertation, Princeton University (June 2012): Chapter 4. Available online: http://arks.princeton.edu/ark:/88435/dsp01ng451h53d

[2]B. H. McGuyer, T. Xia, Y.-Y. Jau, and W. Happer, "Hyperfine frequencies of ^{87}Rb and ^{133}Cs atoms in Xe gas," Phys. Rev. A **84**, 030501(R) (2011). DOI: https://doi.org/10.1103/PhysRevA.84.030501