An atomic microwave spectrum analyzer based on MEMS ^{87}Rb atomic vapor cell

Yongqi Shi[1], Sylvain Karlen[2], Jacques Haesler[2] and Philipp Treutlein[1]

[1] University of Basel, Klingelbergstrasse 82, 4056 Basel, Switzerland
[2] CSEM SA, Jaquet-Droz 1, 2002 Neuchâtel, Switzerland

Spectrum analyzers are essential instruments in electronic test and measurement, the primary use of which is to measure the frequency of an unknown signal. A traditional spectrum analyzer operates either in a sweep-tuned mode or in FFT spectrum mode to detect the electronic signal of interest. Here we demonstrate an atomic microwave spectrum analyzer based on ^{87}Rb atomic vapor in an ultra-thin MEMS cell. The presence of buffer gas (nitrogen) slows down the movement of the ^{87}Rb atoms, effectively localizing them to obtain high spatial resolution within the cell. We apply a static magnetic field gradient across the cell, which generates different ^{87}Rb ground state energy level splittings in different positions of the cell [1].

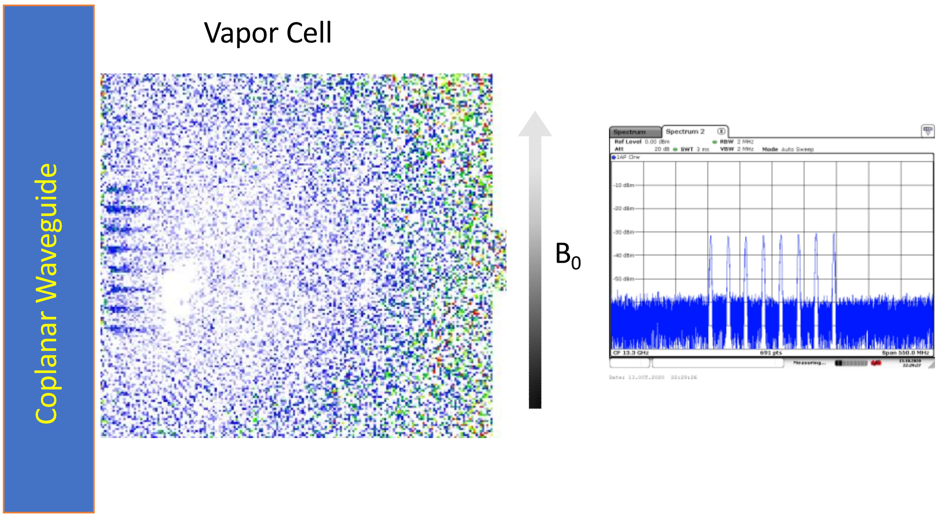

Figure 1. Fringes in different positions of the cell show frequency components of the microwave test signal. The right plot shows the signal measured with a conventional spectrum analyzer.

A pump-microwave-probe measurement sequence is used to generate a ***fringe*** at a specific position on a CMOS camera, which is directly related to the ***frequency*** information of the unknown signal. We use a Coplanar Waveguide (CPW) to transmit a multi-carrier microwave test signal into the vapor cell, and several fringes are observed simultaneously in the cell region, corresponding to all the frequency components of the signal (Fig.1). The observed frequency span over the whole cell is ~500 MHz at 13.33 GHz.

References

[1] A. Horsley, and P. Treutlein. Applied Physics Letters 108.21 (2016): 211102.