Observation of a Microwave Feshbach Resonance in Sodium

M Ballu[1], B Mirmand[1], Z Yao[1], T Badr[1], A Perrin[1], and H Perrin[1]

[1] *Laboratoire de Physique des Lasers, CNRS and Univ. Sorbonne Paris Nord, 99 av. JB Clément, Villetaneuse, France*

Contact Email: helene.perrin@univ-paris13.fr

Controlling the interactions in a quantum gas is a key tool to explore phase diagrams of quantum systems. In general, interactions are tuned through a magnetic Feshbach resonance. This however requires to confine the atoms in an optical trap in order to control independently the magnetic field and hence the interactions. Feshbach resonances also exist in the optical or in the microwave range, where an oscillating field is required to dress a molecular state near a molecular resonance. In this work, we investigate in a degenerate Bose gas of magnetically trapped sodium atoms a microwave Feshbach resonance predicted for alkali by Papoular, Dalibard and Shlyapnikov in 2010 [1].

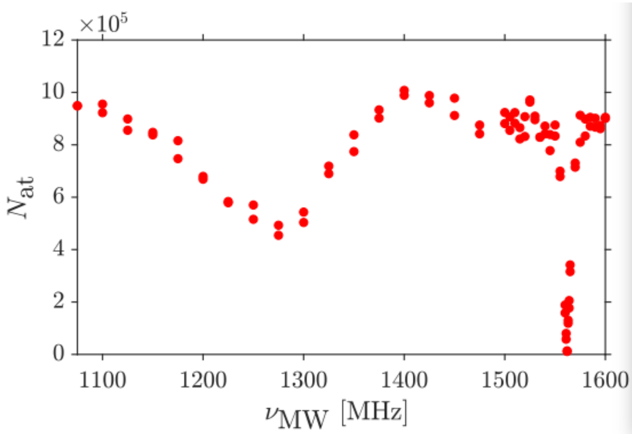

Figure 1: Molecular spectroscopy in the range 1.1–1.6 GHz, evidencing the narrow transitions around 1564 MHz as well as a broad molecular transition around 1280 MHz

A molecular resonance was predicted at a frequency near 1.6 GHz, corresponding to a molecular bound state situated approximately 200 MHz below the hyperfine atomic transition in the ground state of sodium. Previous studies in the optical domain located the molecular resonance at 1568 ± 10 MHz [2]. We excite a sodium quantum gas magnetically trapped under an atom chip with the high power microwave field produced by a microwave guide on the same chip. The large microwave amplitude (several gauss) allows us to locate the resonance easily around 1564 MHz, with a much better precision, of the order of 10 kHz. We also find a very broad resonance around 1280 MHz, which allows us to identify all relevant molecular transitions corresponding to different internal molecular spin states and model the molecular spectrum accurately, with one- or two-photon excitation. We record the two-body and three-body loss rates near the resonance, and discuss experimental protocols to evidence an effect of the microwave field on the atomic interactions.

References

[1] D J Papoular, G V Shlyapnikov and J Dalibard, Phys. Rev. A **81**, 041603 (2010)

[2] L E E de Araujo, J D Weinstein, S D Gensemer, F K Fatemi, K M Jones, P D Lett and E Tiesinga, J. Chem. Phys. **119**, 2062 (2003)