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Nonlinear pressure shifts of alkali-metal atoms in xenon[1] BART MCGUYER, TIAN XIA[2], YUAN-YU JAU[3], WILLIAM HAPPER, Princeton University — Compact, portable atomic frequency standards are based on the microwave resonance frequencies of alkali-metal atoms in inert buffer gases. The frequency shift of these resonances due to collisions with the buffer gas is known as the pressure shift. We demonstrate that the microwave resonance frequencies of ground-state ^{87}Rb and ^{133}Cs atoms have a nonlinear dependence on the pressure of the buffer gas Xe. Previous work has demonstrated a nonlinear dependence in Ar and Kr, but not He and N_2, which is thought to be due to the loosely-bound van der Waals molecules that are known to form between alkali-metal and buffer-gas atoms in Ar, Kr, and Xe, but not He and N_2. Surprisingly, we find that the nonlinearities in Xe are of the opposite sign to those in Ar and Kr, even though the overall shifts for each of these gases are negative. This discrepancy suggests that though the shifts due to the molecules in Ar and Kr are positive, the shifts due to the molecules in Xe are negative. No nonlinearities were observed in the buffer gas Ne to within our experimental accuracy, which suggests that molecules do not form in Ne. Additionally, we present improved measurements of the shifts of Rb and Cs in He and N_2 and of Rb in Ar and Kr.

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[2]Present address: University of Wisconsin.
[3]Present address: Sandia National Laboratories.

Bart McGuyer
Princeton University

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