

A pressure standard for Ultra-High-Vacuum based on laser-cooled atoms

Eite Tiesinga

*Joint Quantum Institute and National Institute of Standards and Technology Gaithersburg,
Maryland 20899, USA*

At the National Institute of Standards and Technology we are building a Cold Atom Vacuum Standard (CAVS) device that will operate as a primary standard for the Ultra-High-Vacuum and Extreme-High-Vacuum regimes. Current pressure sensors do not operate reliably at these pressures. The CAVS device operates by relating loss of microkelvin lithium atoms from a shallow conservative trap by collisions with ambient, room-temperature atoms and molecules to the background density and thus pressure through the ideal gas law. The predominant background constituent at ultra-low pressures is molecular hydrogen.

After giving an introduction into pressure sensing technologies, I will describe our theoretical characterization of the lithium with hydrogendimer collision processes. Specifically, we computed the relevant Born-Oppenheimer potential energy surface, paying special attention to its uncertainty. Coupled-channels calculations were then used to obtain total rate coefficients, which include momentum-changing elastic and inelastic processes, with a 2% relative uncertainty. We also showed that inelastic rotational quenching of the hydrogen dimer is negligible near room temperature.