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A Primary Cold-Atom Based Vacuum Pressure Standard

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Laser cooling and trapping of atoms has created a revolution in physics and technology. For example, the GPS network used for global navigation relies on cold atoms for time keeping. This poster will review the recent advances of our research program which is aimed at creating a cold-atom based primary pressure standard for the high-, and ultra-high vacuum regimes. Cold, trapped atoms can act as very sensitive flux detectors owing to the fact that they form an ensemble of non-interacting particles whose momenta, positions, and quantum states are well-controlled. A particle in the vacuum environment which passes through the cold atom's collision cross-section imparts momentum to the trapped particle. The collision is detected when the momentum gain is large enough to eject the cold atom from the trap, observed as a decrease in the light scattered from the trapped ensemble. The loss rate of trapped particles, detected optically, transduces the particle flux (pressure) into a timing signal. The loss rate is sensitive to both the type of collision and collision partner, as well as to the state of the trapped atom and the trap depth in which it is confined [1]. Thus, this provides an opportunity to study collisions and collisions physics in different types of traps, their dependence on trapped atom electronic state, and the spectroscopy of trap loss as a function of trap depth, all while working towards a new standard. The advantages of a cold atom standard include the fact the sensor relies on immutable, long-range interaction properties of atomic matter and that it will be a primary pressure standard, tied directly to the base SI unit of the second. [1] D. Fagnan, J. Wang, C. Zhu, P. Djuricanin, B. G. Klappauf, J. L. Booth and K. W. Madison, Phys. Rev. A 80, 022712, 2009.

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