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Atom trap loss, elastic collisions, and technology[1]

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The study of collisions and scattering has been one of the most productive approaches for modern physics, illuminating the fundamental structure of crystals, surfaces, atoms, and sub-atomic particles. In the field of cold atoms, this is no less true: studies of cold atom collisions were essential to the production of quantum degenerate matter, the formation of cold molecules, and so on. Over the past few years it has been my delight to investigate elastic collisions between cold atoms trapped in either a magneto-optical trap (MOT) or a magnetic trap with hot, background gas in the vacuum environment through the measurement of the loss of atoms from the trap. Motivated by the goal of creating cold atom-based technology, we are deciphering what the trapped atoms are communicating about their environment through the observed loss rate. These measurements have the advantages of being straightforward to implement and they provide information about the underlying, fundamental inter-atomic processes. In this talk I will present some of our recent work, including the observation of the trap depth dependence on loss rate for argon-rubidium collisions. The data follow the computed loss rate curve based on the long-range Van der Waals interaction between the two species. The implications of these findings are exciting: trap depths can be determined from the trap loss measurement under controlled background density conditions; observation of trap loss rate in comparison to models for elastic, inelastic, and chemical processes can lead to improved understanding and characterization of these fundamental interactions; finally the marriage of cold atoms with collision modeling offers the promise of creating a novel pressure sensor and pressure standard for the high and ultra-high vacuum regime.

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