Abstract Submitted
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Heating and cooling of an ultra-cold neutral plasma by Rydberg atoms[1] DUNCAN TATE, ETHAN CROCKETT, RYAN NEWELL, Colby College — We have experimentally demonstrated a mechanism for controlling the expansion rate of an ultra-cold neutral plasma (UNP) so that it is different from the value determined by the photo-ionizing laser frequency. We achieved this by adding Rydberg atoms to the UNP 10 - 20 ns after its creation. Specifically, we added $nd_{5/2}$ state atoms with $n = 24 - 60$ to UNPs with initial electron temperatures, $T_{e,0}$, in the range 10 - 250 K. The evidence is both indirect, from the change in the electron evaporation rate from the UNP, and direct, from the change in the asymptotic plasma expansion velocity, v_0, measured using the time-of-flight spectrum of Rb^+ ions. In addition, the results strongly support the existence of a "bottleneck" in the state distribution of Rydberg atoms formed by three body recombination (TBR) where the binding energy of the bottleneck state is $E_b \approx 2.3 \times k_B T_{e,0}$. Finally, we show that the amount of heating or cooling is linear in the number density of Rydberg atoms added to the UNP for small Rydberg densities, but saturates at higher densities to a value that is determined solely by the Rydberg binding energy. These results are in good general agreement with Monte-Carlo calculations.

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Duncan Tate
Colby College

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