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Using Rydberg atoms to increase electron coupling strength in ultracold neutral plasmas[1] DUNCAN TATE, YIN LI, ETHAN CROCKETT, RYAN NEWELL, Colby College — We have experimentally demonstrated heating and cooling of electrons in an ultracold neutral plasma (UNP) with an initial electron temperature $T_{e,i}$ (determined by the frequency of the ionizing laser) by embedding Rydberg atoms in them in the first 20 ns of their evolution [2]. We have quantified the crossover initial electron temperature, $T_{e,i} = T_{CO}$, for a plasma that is neither heated nor cooled when N_R Rydberg atoms with binding energy E_b are added to a plasma with initial ion number N_{ion}. This condition is $k_B T_{CO} \approx 2.7 \times |E_b|$ when $N_R \approx 0.2 \times N_{ion}$. Additionally, we have measured the change in the plasma expansion velocity when E_b does not satisfy the crossover condition for a range of N_R/N_{ion} values. These results are in good agreement with Monte-Carlo calculations. We are also pursuing similar studies, both experimental and numerical, in the regime where $N_R \gg N_{ion}$ to see if the plasma electrons can be cooled sufficiently to increase their coupling to $\Gamma_e \sim 0.5$ in the first 5 μs of plasma evolution, as predicted by by Pohl *et al.* [3].

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[2]Crockett *et al.*, *Phys. Rev. A*, **98**, 043431 (2018)
[3]T. Pohl *et al.*, *Eur. Phys. J. D*, **40**, 45 (2006)

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