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Study of the electron temperature in an ultra-cold Rydberg plasma[1] DUNCAN TATE, GABRIEL FOREST, YIN LI, EDWIN WARD, Colby College, ANNE GOODSELL, Middlebury College — We report a systematic experimental and numerical study of the electron temperature in ultra-cold Rydberg plasmas. Specifically, we have measured the asymptotic expansion velocities of ultracold neutral plasmas (UNPs) which evolve from cold, dense samples of Rydberg rubidium atoms using ion time-of-flight spectroscopy. We have also simulated numerically the interaction of UNPs with a large reservoir of Rydberg atoms to obtain data to compare with our experimental results. We find that for Rydberg atom densities in the range $10^7 - 10^9$ cm^{-3}, for $n > 40$, the initial electron temperature in the Rydberg plasma is insensitive of the ionization mechanism which seeds the plasma. Instead, it is determined principally by the plasma environment when the UNP decouples from the Rydberg atoms at the end of the avalanche regime. On the other hand, plasmas from Rydberg samples with $n \leq 40$ evolve with no significant additional ionization of the the remaining atoms once a threshold number of ions has been established. The dominant interaction between the plasma electrons and the Rydberg atoms is one in which the atoms are de-excited, a process that competes with adiabatic cooling so that the UNPs have a low Coulomb coupling parameter for electrons, $\Gamma_e \sim 0.01$.

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