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Avalanche Ionization of a Frozen Rydberg Gas Embedded in an Ultracold Neutral Plasma, with Possibilities for Stronger Coupling
PATRICK MCQUILLEN, XINYUE ZHANG, TREVOR STRICKLER, THOMAS KILLIAN, Rice University Department of Physics and Astronomy — Ultracold neutral plasmas (UNPs) are well controlled, exotic plasmas with unusually low temperatures ($T_i \sim 1\text{K}-5\text{K}$ and $T_e \sim 20\text{K}-1000\text{K}$) that permit detailed study of strongly coupled dynamics. Frozen Rydberg gases are highly interactive quantum systems with dynamics dictated by their unusually large dipole moments. They exhibit many interesting effects, such as the Rydberg blockade, the suppression of subsequent Rydberg excitations within a blockade radius of the first. By combining the two systems, it seems that spatial correlations induced by the blockade could be used to lessen disorder induced heating (DIH), and extend UNPs into stronger coupling. To this goal, we added the capability of exciting Rydberg states to our apparatus. We studied the dynamics of spontaneous ionization in strontium frozen Rydberg gases, in both space and time, with and without a collocated UNP. We have observed that ionization rates of a solitary Rydberg gas follow the expected dependence on density and interatomic potentials. We see rapid avalanche ionization with a “seed” UNP and show its utility in counting Rydberg excitations. We will discuss optical imaging of the Rydberg core, similar to Sr UNP imaging, but complicated by l-mixing collisions and autoionization concerns.

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