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High Resolution Density Sculpting of Ultracold Neutral Plasmas to Excite Collective Modes[1] PATRICK MCQUILLEN, JOSE CASTRO, THOMAS KILLIAN, Rice University & Rice Quantum Institute — Ultracold Neutral Plasmas (UNPs) are created by photoionizing laser cooled atoms near the ionization threshold. They provide extremely clean and controllable experimental conditions and a means of studying strongly coupled plasmas in the laboratory. By virtue of their extremely cold temperatures ($\sim$1K), the Coulombic potential energy can dominate thermal kinetic energies and lead to interesting collective effects. A recent advance in creation techniques allows the production of UNPs with controllable initial density distributions. This technique has allowed us to excite and measure dispersion of the low frequency Ion Acoustic Wave (IAW) as well as produce streaming plasmas with tunable velocities. With recent upgrades to our ionizing and imaging system we will continue these studies at much shorter length scales, those comparable to Debye shielding lengths and approaching average interatomic spacing. In this regime, where concepts of Debye shielding break down along with many fundamental plasma approximations, we can test predictions of deviations from classical plasma behavior.

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