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Charge, density and electron temperature in a molecular ultracold plasma[1]

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The double-resonant laser excitation of nitric oxide, cooled to 1 K in a seeded supersonic molecular beam, yields a gas of $\approx 10^{12}$ molecules cm^{-3} in a single selected Ryberg state. This population evolves to produce prompt free electrons and a durable cold quasineutral plasma of electrons and intact NO^{+} ions. This system shows some properties of a correlated electron fluid. For example, the plasma expands at a small but measurable rate that accords with the Vlasov equations for an initial electron temperature of $T_e \approx 7$ K. The laser-prepared population of Rydberg molecules releases electrons as it evolves to form an ultracold plasma. The size of this prompt signal, compared with one extracted from the plasma by the subsequent application of a pulsed electric field, determines the absolute magnitude of the plasma charge. This information, combined with the number-density of ions, supports a simple thermochemical model that explains the evolution of the plasma to an ultracold electron temperature.

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