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Experimental Realization of an Exactly Solvable Plasma Expansion PRIYA GUPTA, SAMPAD LAHA, CLAYTON SIMIEN, THOMAS KILLIAN, Rice University — We study the expansion of ultracold neutral plasmas into a surrounding vacuum from the early acceleration phase until the approach to a terminal velocity. Ultracold neutral plasma is created by photoionizing laser-cooled and trapped neutral Sr^{88} atoms. A fraction of the electrons, which have been heated and perhaps accelerated by the photoionizing laser, leave the plasma and enter the surrounding vacuum, creating a strong ambipolar electric field that accelerates the ions outward. The initial density distribution of the plasma is Gaussian and it remains Gaussian as it expands. Using absorption imaging techniques, we can observe the evolution of the ion and electron kinetic energy in the plasma. Measurements of the ion kinetic energy show that the expansion is described well by an analytical solution of the Vlasov equations. The behavior is closely related to the dynamics of plasmas produced by laser irradiation of solids, clusters, and gases with fast-pulse lasers.

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