Adiabatic expansion of an electron gas.

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A specially constructed experiment is described that shows the near perfect adiabatic expansion of an ideal electron gas resulting in the measurement of a polytropic index greater than 1.4, approaching the adiabatic value of 5/3. The measurements were made on electrons in an argon plasma expanding in a magnetic nozzle where the potential of the expanding plasma was forced to be zero by externally setting the potential of the source plasma to be zero resulting in an electric current in the system. By changing the magnitude of the current, the plasma potential can be changed and either an isothermal or adiabatic expansion can be achieved. In all cases, the collision length of all processes is greater than the scale length of the expansion meaning the system cannot be in thermodynamic equilibrium, yet thermodynamic concepts can be used, with caution, in explaining the results. A Lorenz force, created by inhomogeneities in the radial plasma density, does work on the expanding magnetic field reducing the internal energy of the electron gas.