heat the cluster ions further. In practice this limits the maximum efficiency of cluster ion production to less than 10%.

Due to these restrictions of direct photoionization of the cold neutral clusters, we have examined the possibilities of producing the cluster ions directly in the supersonic nozzle -- allowing the supersonic expansion to cool the cluster ions prior to forming the cluster beam. Although this seems straightforward, this turns out to be not quite as trivial a problem as it initially appears.

First there is the problem of space charge. In order to produce a cluster ion beam of sufficient intensity after the supersonic expansion, it is necessary to produce greater than 10^6 cluster ions per cm^3 back in the nozzle. Without some counteracting negative ions, the space charge of such a dense array of positive ions would push most cluster ions off axis far before the end of the supersonic expansion, and collisions of these space-charge accelerated ions with the helium in the jet would actually heat the clusters, not cool them.

Second, there is the problem of stray electrostatic and magnetic fields in the apparatus. Even if the cold positive cluster ions beam could be produced, it would only be moving at the terminal velocity of a helium supersonic expansion : 1.9×10^5 cm/sec. For cluster ions in the 100-1000 amu range, this corresponds to an ion beam of only a few eV translational energy, and such low energy ion beams are terribly sensitive to small stray fields along the beam path. Stray electric fields of only a couple volts/cm would be sufficient to produce extensive beam deflection, and such small fields are extremely difficult to