COLD CLUSTER ION BEAM PRODUCTION

Aside from the neutral cluster reaction studies, by far the most intense efforts related to this DOE contract have been associated with the study of metal cluster ions. The principal advantage here is, of course, that an initial mass selection of the clusters allows the properties of these clusters to be studied by sensitive techniques without worrying about interference from other cluster species originally produced in the laser-vaporization cluster source. It is critical, however, that these cluster ions be produced cold, and in high intensity.

Our original plan here was to produce the cluster ions by near-threshold direct one-photon ionization after the neutral clusters had been cooled in the supersonic expansion and skimmed to form a collisionless beam. Until a month ago, this was the procedure we actually used, and it worked rather well in the cases we tried. However, in principal we know that this direct photoionization technique is not a generally effective procedure for producing cold cluster ions. In some (perhaps even most) metal cluster species there will be a substantial difference in the geometry of the cluster ion as compared with the neutral, and in these cases the ionization cross-section is vanishingly small at the adiabatic threshold and direct (vertical) photoionization will produce a cluster ion with substantial vibrational excitation. In addition, even in the cases where the ionization threshold is sharp, the photoionization laser pulse must be kept weak enough to avoid absorption of a second photon which would