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Explosions of Femtosecond Laser Irradiated Heteronuclear Clusters

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In recent years, there has been quite substantial progress in the understanding of explosions of atomic clusters subject to intense laser irradiation. It is now well understood that single species clusters of low Z materials (such as hydrogen or deuterium) expand by a Coulomb explosion if they are irradiated with enough intensity. In this case, if irradiated with a pulse of sufficiently fast rise time and sufficiently high intensity to eject all free electrons from the cluster, the ejected ion energies will be simply the potential energy of the ions after ionization at their equilibrium position in the cluster. The picture is not as simple if the cluster contains a mixture of species, as occurs in a heteronuclear cluster such as a CH_4 or CD_4 cluster. Last and Jortner have studied numerically the explosions of such heteronuclear clusters and find that a dynamic enhancement of the light ions can occur [*Phys. Rev. Lett.* **87**, 033401 (2001)]. We have experimentally studied this process by comparing the ion energies from laser irradiated methane and deuterated methane clusters. We find that the protons ejected from CH_4 clusters, irradiated by 35 fs pulses at intensity up to 10^{18} W/cm^2 exhibit a higher energy than deuterons ejected from otherwise identically sized CD_4 clusters. This is consistent with the theory of Last and Jortner and promises to impact laser driven exploding cluster fusion experiments in the future.