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Ion induced fragmentation of diatomic molecular clusters

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Synopsis Weakly bound atomic or molecular clusters are of growing interest in the fields of atmospheric science, hadron-therapy or astrophysics. We will present our recent experimental results on the fragmentation of diatomic molecular dimers after irradiation by highly charged ions. For $(N_2)_2$ dimers, the measured KER spectrum is very similar to the one of the N_2 monomers but is globally shifted towards higher energies. Moreover, sequential dissociation of the $(CO)_2$ dimers has been observed when metastable states of the CO^{2+} dications are populated.

Diatomic molecular dimers such as $(N_2)_2$ and $(CO)_2$ are model systems containing both covalent intramolecular bonds and van der Waals intermolecular bonds. Following multiple electron capture, both intramolecular and intermolecular fragmentation may occur. We will focus on some particular 3-body dissociation channels where only one of the constitutive molecule breaks while the other cation remains in a non-dissociative state. For such channels, the influence of a second spectator ion on the molecular dissociation has been investigated.

We use a COLTRIMS setup (COLd Target Recoil Ion Momentum Spectroscopy) to perform cross beam collisions between molecular dimers produced by a supersonic gas jet and highly charged ions delivered by the low energy beam line of the GANIL/ARIBE facility. The charged fragments produced in the collision are measured in coincidence and their three-dimension momentum vectors are computed thanks to their position and time-of-flight on a position sensitive detector. A clean data selection is then achieved by imposing momentum conservation laws. The kinetic energy of each fragment as well as the KER (Kinetic Energy Release) are deduced from

the momentum vectors and m/q identification of the fragments. Finally, a comparison between events originating from monomer or dimer targets is performed from a single experiment.

In the case of $(N_2)_2$ dimers, the measured KER spectra are globally shifted towards higher energies in comparison to the fragmentation of the N_2 monomer. The value of the energy shift is fairly well reproduced by accounting for the additional Coulomb potential energy due to presence of the neighbor ion [1]. This indicates that the presence of the second molecule has a weak influence on both electron capture and molecular fragmentation dynamics. For $(CO)_2$ dimers, similar results are observed but concerted and sequential fragmentation of the dimer have also been identified. These two processes are respectively associated to the population of either short or long lived excited states of the CO dication. As a consequence, molecular fragmentation within such dimers can be used as a tool to distinguish between short lived and metastable states of the monomer cations.

References

[1] Méry A *et al* 2017 *Phys. Rev. Lett.* **118** 233402

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