

## Observation of interatomic Coulombic decay in Ne dimer above and below the Ne $2s^{-1}$ threshold

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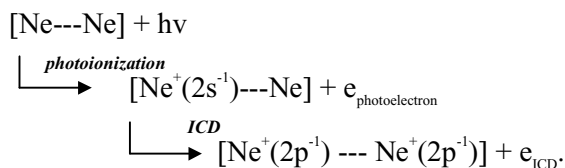
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### Introduction

It is well now that, in rare gas atoms, inner-shell core holes usually decay by emitting a secondary Auger electron. This pathway is forbidden in case of inner valence holes, for their binding energy lies below the lowest double ionization potential. Consequently, they can only experience a radiative decay. However, when the rare gas atom is a part of a weakly bound van der Waals cluster, an alternative interesting decay path is opened whereby the initially ionized atom transfers its energy to a neighboring atom. We have demonstrated that this process occur in Ar, Kr and Xe dimers [1]. The Ne dimer case is even more spectacular as the transferred energy is sufficient to ionize the neighboring atom. Such a decay process is called Inter-atomic Coulombic Decay (ICD) and was for the first time theoretically predicted by Cederbaum and co-workers [2,3] to be much faster than the competing intra-atomic radiative decay.

### Results and Discussion

Ne dimer is the most suitable species in order to investigate the ICD mechanism. The process can be schematically depicted in the following way: an inner-valence  $2s$  electron is photoionized from a Ne atom inside the Ne dimer ( $[\text{Ne}---\text{Ne}]$ ), the hole then decays by transferring its energy to the neighboring Ne atom and ejecting an outer-valence  $2p$  electron, that is:



The final state is thus a doubly charged Ne dimer that dissociates through charge separation. Recently, ICD was observed experimentally in  $2s$  ionized Ne dimer by detecting the two  $\text{Ne}^+$  fragments and the ICD electron in coincidence at an excitation energy 10eV above the  $2s$  ionization threshold [4].

In the present study, we used a very simple and sensitive experimental approach to investigate ICD process in Ne dimer, namely coincidence between the two receding energetic  $\text{Ne}^+$  ions. Experiment was

performed at undulator beamline BL16B. Ne dimers are produced in a supersonic expansion with a proper stagnation pressure in order not to produce large size clusters. The two fragment ions were detected in coincidence by two apparatus: a simple ion filter that rejects low energy or thermal ions and a hemispherical electrostatic analyzer [5] which allows the measurement of the kinetic energy distribution of energetic  $\text{Ne}^+$  ions. We confirmed the ICD occurrence by detecting two  $\text{Ne}^+$  ions simultaneously with the two detectors. The ICD cross section were measured as a function of the photon energy, which is strongly affected by resonances due to double excitations,  $[\text{Ne}^*(2p)^+(3s)(np)---\text{Ne}]$ , located just above the ionisation threshold of the  $[\text{Ne}^+(2s^{-1})---\text{Ne}]$  state. The  $\text{Ne}^+$  kinetic energy observed in the present study is in good agreement with the previous theoretical prediction [3] and experimental observation [4] and remains constant within a few eV above threshold. Surprisingly, we observed that ICD process is also present below the  $2s$  ionization threshold. Work is in progress to understand this phenomenon which we attribute to a spectator process upon excitation of a  $2s$  electron to a Rydberg orbital.

### References

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