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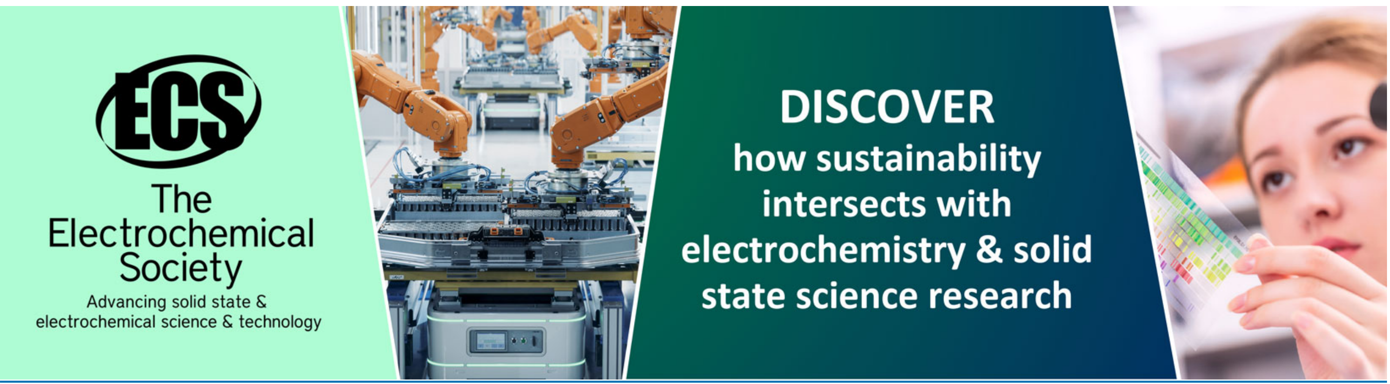

Experimental measurement of Interatomic Coulombic Decay rates in Argon dimers

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Synopsis We present a method by which the internuclear distance-dependent decay width Γ(r) of Interatomic Coulombic Decay can be obtained using a measured energy distributions and a classical nuclear dynamics model.

Interatomic Coulombic Decay (ICD) is a fundamental decay process, which can occur in weakly bound systems such as the Argon dimer after excitation. It was predicted in 1997 by L. S. Cederbaum *et al* [1] and confirmed experimentally in 2004 [2].

The decay widths of ICD depend strongly on the internuclear distance of the two atoms involved in the decay. Here we present a method employing a classical nuclear dynamics model in order to extract the decay width Γ(r) from measured experimental data.

As an experimental setup we used a Cold Target Recoil Ion Momentum Spectroscopy (COLTRIMS) [3] apparatus located at the Advanced Light Source (ALS) in Berkeley, a 3rd gen. synchrotron, to populate a singly ionized and excited Argon dimer state. As ICD takes place the system breaks up into the three fragments $Ar^+ + Ar^+ + e_{ICD}$. These fragments and the emitted photoelectron are measured in coincidence. From the measured momenta the state excited prior to ICD can be determined, as shown in Figure 1.

Since the different initial states can be analyzed individually and the potential curves of the ground state and excited states are known, the nuclear dynamics occurring during the decay can be modelled in order to deduce a decay time and internuclear distance from the measured kinetic energy release (KER).

Figure 2 depicts the decay width in dependence of the internuclear distance of the $(^1D)4d(^2S)$ state marked in Fig. 1.

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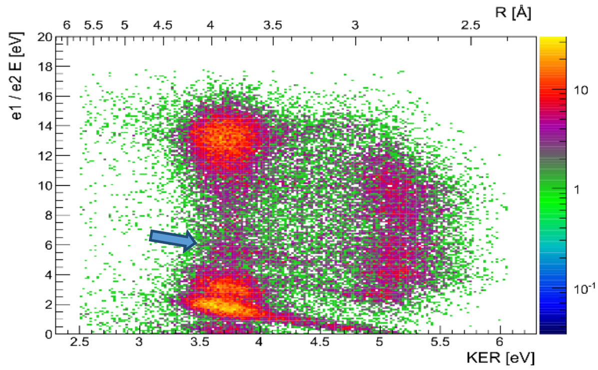

Figure 1. Electron energy distribution in dependence of the recoil kinetic energy release in Argon dimers.

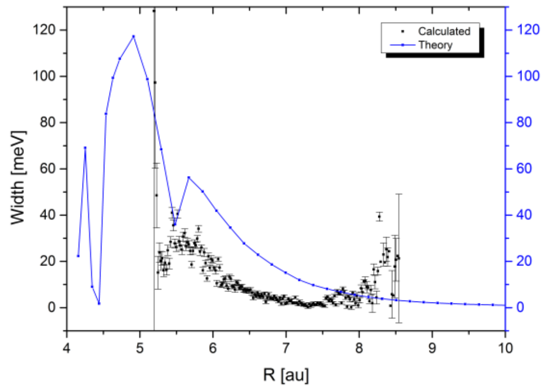

Figure 2. Calculated Γ(r) (dots) compared with the theory [4] (line) for the $(^1D)4d(^2S)$ state.

Comparing the values obtained from the experiment to theoretical predictions yields good qualitative agreement for internuclear distances greater than 5.5 *au*.

References

[1] L. Cederbaum *et al* 1997 *Phys. Rev. Lett.* **79** 4778
[2] T. Jahnke *et al* 2004 *Phys. Rev. Lett.* **93** 163401
[3] R. Dörner *et al* 2000 *Phys. Rep.* **330** 95-192
[4] Private Communication. (P. Kolorence)