# Report on the outcomes of a Short-Term Scientific Mission[1]

**Action number: CA20129**

**Grantee name: SISOURAT Nicolas**

**Details of the STSM**

Title: Interatomic Coulombic Electron Capture

Start and end date: 30/03/2025 to 07/04/2025

**Description of the work carried out during the STSM**

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

The aim of the project is to provide the first experimental demonstration of Interatomic Coulombic Electron Capture (ICEC) and to shed new lights onto the dynamics taking place during this highly relevant process. To tackle this challenging task, we have investigated the collisions between $D^-$ and the ionized Van der Waals dimer $HeNe^{+\cdot}$ Noting that in the ground electronic state of the dimer the charge is located on the neon atom (i.e. He - $Ne^+$), the ICEC process should lead to the ionization of the He atom and to the dissociation of the dimer:

$D^- + HeNe^+ \rightarrow D + Ne + He^+ + e^-$

In this reaction , $D^-$ provides the attached electron and the excess energy is transferred to He which is thus ionized. By measuring in coincidence the $He^+$ ion and the neutral fragment, we hope to provide first experimental proof of ICEC.

These measurements have been done at the DESIREE ion rings facility in Stockholm. During the STSM, we have performed the above mentioned measurements. The experiments went as planned and thus we did not deviate from the initial working plan.

During the first two days, we have optimized the ion beams to obtain enough currents. This was especially difficult for the $NeHe^+$ beam. After agreeing on the optimal conditions, we have started the measurements at collision energy for which ICEC is allowed. We had some ion beam instabilities and thus the measurements took about two days. After these first measurements, we changed the collision energy to a value below the ICEC threshold. This is important to ensure that the signals we had measured so far comes from the collision between $D^-$ and $NeHe^+$ and not with residual gas. In the last days, we have investigated the collisions between $D^-$ and the larger cluster

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

$NeHe_2^+$. We hope to be able to see the effects of having more neighbours on the ICEC process.

**Description of the STSM main achievements and planned follow-up activities**

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

During the STSM, we have measured in coincidence the $He^+$ ion and the neutral fragments from the reactions between the anion $D^-$ and the ionized Van der Waals dimer $HeNe^+$, as well as the reactions between the anion $D^-$ and the trimer $He_2Ne^+$. The experiments went as planned. The data obtained during the STSM are currently analyzed and will be compared to the ab initio calculations performed by the applicant's group.

We hope that we have enough 3 particle events to conclude unambiguously on the first experimental observation of ICEC. The analysis is not a trivial task and will require some time. This is therefore too early to conclude on the final outcomes of the measurements done during the STSM. However, we have learned a lot on the preparation of ionized dimers as well as on 3 particle detection which will benefit to future measurements, relevant to the Action objective.

Furthermore, we might apply to the another DESIREE beamtime call to conduct follow-up measurements if the analysis indicates that more statistics is required and to investigate ICEC further.