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

Action number: CA18212

Grantee name: Or Licht

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| **Details of the STSM**  **Details of the STSM**  Title: **Homochirality and peptide bond formation in serine clusters.**  Start and end date: 10/07/2023 to 15/07/2023 |
| **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.  Our research during the STSM focused on exploring the behaviour of three distinct amino acids: serine, valine, and glycine. The work carried out during the mission can be categorized into three sections, with particular attention given to the glycine, which yielded the most notable results.  Initially, our aim was to observe serine clusters and fragments resulting from collisions with both alpha and protonated helium particles. However, we encountered a notable challenge during this phase, as the serine caused the cluster source to clog frequently, and was difficult to work with. Despite this setback, we managed to accumulate data on serine clusters and fragments. Preliminary analysis indicates that that only a few small clusters are formed but a clear peak is seen for a mass corresponding to the serine dipeptide suggesting peptide bond formation.  For the investigation of valine, we conducted experiments involving collisions with alpha particles. We observed the formation of large, protonated clusters. Preliminary analysis shows no sign of peptide bond foration but interesting results from coincidence analysis.  The most remarkable and unexpected findings emerged from our exploration of the glycine amino acid. Though glycine was not originally part of our proposed research plan, we decided to study it further to gain insights into peptide bond formation. Our experiments with glycine provided compelling evidence of peptide bond formation following collisions with alpha particles. The meticulous time of flight measurements reveals many peaks whose mass corresponds to peptide bond formation. The yield of some of these fragments is even larger than that of neighboring protonated glycine clusters. These results suggests high specificity in peptide bond formation, and in particular that glycine is remarkable in its tendency to form peptide bonds in the gas phase.  Unfortunately, we did not have enough time to study mixed clusters and study chiral effects. We hope to do so in the near future. |
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| **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.  The STSM has yielded significant achievements in understanding the formation of peptide bonds through high-energy collision-induced dissociation, particularly in glycine clusters. Unlike previous experiments focusing on intra-cluster bond formation with alpha particles, our observations revealed that the most dominant fragment yield is the peptide bond itself, surpassing even the protonated clusters of glycine. Additionally, the data from the valine experiments have provided intriguing insights into cluster physics, allowing us to distinguish some of the parent clusters of smaller protonated clusters.  Building upon these groundbreaking findings, we plan to conduct further activities in this field. The discovery of a dominant peptide bond pathway in glycine clusters opens up the opportunity to study mixed clusters with it in GANIL. This exploration may lead to the observation of new peptide bonds previously unidentified, as seen in the case of valine, or enhance the yield of an already-observed peptide bond channel, as observed in the case of beta-alanine.  To expand our investigations, we are planning a new experiment on glycine using a different excitation method, specifically irradiation in the VUV spectra (electronic excitation). This approach holds the potential to provide deeper insights into peptide bond formation dynamics in glycine clusters.  For serine clusters, we have a future plan to design a new oven for the cluster source at GANIL, which will streamline the process of studying serine, making it more convenient and efficient.  Furthermore, in November, we scheduled a mixed amino acid cluster experiment at the SOLEIL synchrotron in France. In this experiment, we aim to explore the original homochiral preference proposal, but with a unique approach of colliding the cluster using photons in the VUV range. This experiment is anticipated to shed light on the intricate interactions between mixed amino acid clusters and photon-induced processes.  Despite encountering some deviations from our initial working plan, the STSM yielded valuable insights into the behaviour of serine, valine, and glycine amino acids under various collision conditions. The results obtained during this mission significantly contribute to our understanding of cluster dynamics and the fascinating process of peptide bond formation. Moreover, these discoveries make a way for further research in the field of intra-cluster bond formation in amino acids, peptide bond formation, and cluster dynamics. |



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. [↑](#footnote-ref-1)