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

Action number: CA21126

Grantee name: Dogan Erbahar

Details of the STSM

Title: Catalytic formation of molecules on the surface of cosmic dust grains: A carbon + water + UV case

Start and end date: 26/06/2023 to 30/06/2023

Description of the work carried out during the STSM

A seminar was given to the Laboratory Astrophysics Group of the Max Planck Institute for Astronomy at the Friedrich Schiller University Jena, Germany (LAG) presenting the latest studies carried out on carbon nanostructures in the computational nanomaterials group of Dogus University (DU).

The planned experiments were performed on three samples (amorphous carbon, amorphous carbon free of fullerenes and pure fullerenes) received from Actinium Chemical Research srl, Italy (ACR). The powder samples were dissolved and then deposited on the substrates.

[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.



Figure 1 Deposited samples on the substrates

The samples were then investigated in INterStellar Ice-Dust Experiment (INSIDE) setup[1] of LAG. Each of the samples were cooled to 15 K temperature, and then they were covered by H_2O ice and irradiated by UV radiation for about 6-7 hours while taking IR spectra of the samples every half an hour. The data were evaluated to calculate the accumulated CO_2 formation. The results are presented in Figure 2.

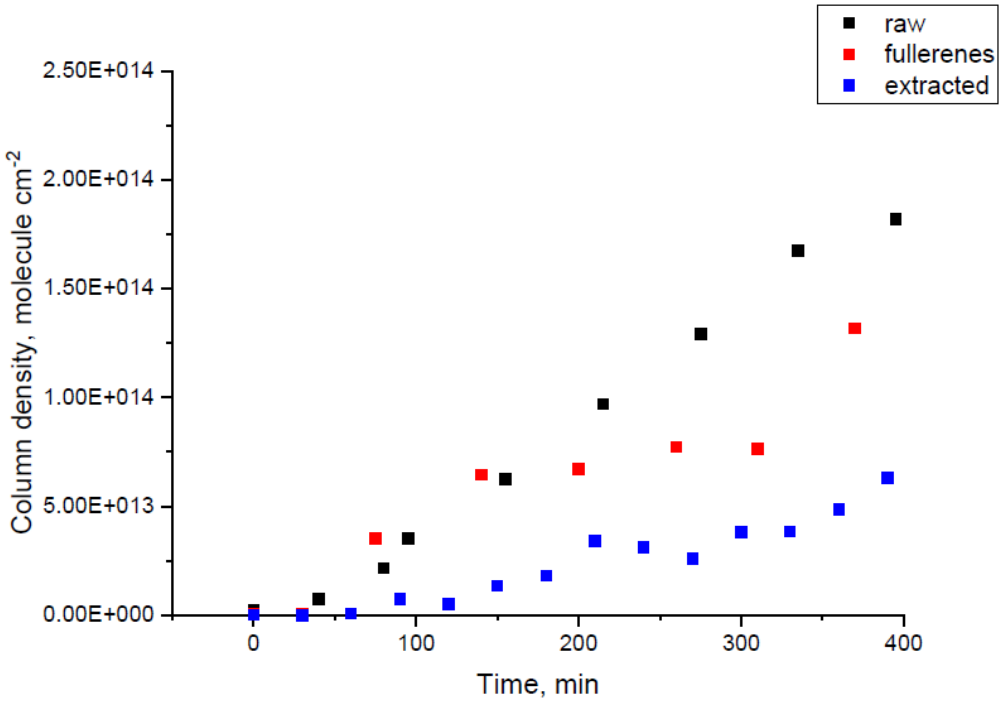


Figure 2 Accumulated CO_2 production of three samples over the experiment time.

[1] Alexey Potapov *et al* 2019 *ApJ* 880 12

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

STSM was quite fruitful in the sense that planned activities have been fully accomplished; besides, solid foundations of collaboration between LAG and DU have been laid via the scientific discussions and mutual understandings developed throughout the week. The interpretation and modelling of the results obtained in the experiments have been discussed and initiated.

The main issue regarding the interpretation of the results of the experiments is identified as the apparent diversity of the coverage areas of the deposited samples as can be seen from Figure 1. The fact that the fullerene sample was able to produce comparable amount of CO_2 besides having a significantly lower coverage area than the other samples is interpreted as a preliminary result of a real potential of fullerenes acting as the catalyst in the studied reaction.

It was agreed to continue the research in the following directions in parallel:

- Further experiments have been planned on the same samples and with pure fullerenes to get some statistics on the results.
- The coverage areas of the samples are planned to be measured with an image processing script to meaningfully compare the results.
- The structures of the samples were decided to be investigated under electron microscopy to get a better understanding of the structures.
- Various models have been discussed to best simulate the experimental conditions and computational studies were planned to interpret the results.

The study was directly within the scope of working group 1 as the subject involved various carbon nano species in space. It also directly addressed the questions studied in working group 2 in an extensive way where catalytic activity was studied by laboratory observations. Since some of the reactions involved in the study are hypothesized to be important in the formation of life it also is in the scope of working group 3.