**Semester report**

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Ph.D. Thesis title: ***"Interaction of noble gas clasters with ultrashort laser pulses"***

## *Introduction*

High harmonic generation is not only a topic of interest for obtaining radiation sources in the ultraviolet, but it is a possible tool for investigating fast processes with femtosecond or attosecond resolution. High harmonics in clusters are not only – in some cases – more intense than those from gases, but they give insight into the structures of clusters in the same time. In recent works of the researchers of the Wigner FK [1,2] evidence was shown for the existence of nanoplasmas inside the clusters from the observation of a pressure-dependent red shift of the generated high-harmonics. However the necessary conditions for the existence of nanoplasmas was not cleared in full. My PhD work is therefore to carry out systematic investigations and demonstrating the nanoplasmas by alternative methods.

## *Description of research work carried out in current semester*

In the first semester I got acquainted with the Rayleigh scattering method which enables us to determine the sizes of the clusters generated by the pulsed gas jet source.

In the second semester I was again hindered by the pandemics, therefore the actual experimental work could only be started in the last month of the semester. In my studies the preparation of the synchronization was carried out. In this case synchronization of a single laser pulse must be carried out with the gas jet and the CCD detector. The laser has an intrinsic 10 Hz repeated. It serves a 10Hz output signal (the light does not come out because the Pockels cell in the amplifier is closed). A previously used **LABVIEW** program was modified for it. The measurement can be started with a mouse. After the mouse push the next laser signal must be caught. This is time equal to zero. A time synchronizing unit, Camtimer was used [3]. After the arrival of this signal it gives a delayed signal opening the laser Pockels cell for the next shot. It will come with 100 ms delay. Therefore the valve must be opened some ms (typically 3ms) before the arrival of the laser pulse (this timing must be checked and optimized experimentally). Then the laser will arrive into the cluster source. This delay serves

as modifying the cluster density [2]. Then the CCD camera is triggered after ~99ms which allows catching the laser pulse. The exposure time is set by a separate camera driver program.

The main subject of this task is the quantitative and qualitative study of the generation of XUV radiation and attosecond pulse with high harmonic generation technique in noble gas cluster. The first part where I was focused on to implemented the designing program to simulate and pulse generation. Finally these all lead to find the overall synchronized photon which is responsible for high harmonic generation phenomena by a means of nonlinear cluster gas jet in vacuum chamber. Now every part of the experimental work is set, therefore we hope that during the summer interaction experiments will be carried out. We aim to find the cluster size range where the spectral red shift of the harmonics can be observed, which is the region of appearing nanoplasmas. Then in case of we aim to investigate the dependence of harmonics on the incoming laser polarization especially in case of nanoplasmas which might give a further evidence for its existence. Note that previous experiments at limited range without nanoplasmas did not show an effect on polarization different from that of atomic gases [4].

**Studies in current semester:**

| Course code | Course name | Course credit |
|---|---|---|
| **FIZ/3/015E** | Carbon nano structure | 6 |
| **fotonikaf21sx** | Fundamental of photonics | 3 |
| **FIZ/KUT-S2** | Guided research semester-2 | 18 |

***References***


[1] Aladi, M. et al., *High harmonic generation and ionization effects in cluster targets;* High Power Laser Science and Engineering **2**, e32 (2014)
[2] Aladi, M., et al., *Cluster size distributions in gas jets for different nozzle*
[3] Camtimer
[4] B. Bódi, et al.: *High Harmonic generation on noble gas clusters*; Optics Express 27, No. 19, 26721 (2019)