Semester III report

by **Habte Jambo Gebre** (habtejambo@gmail.com)

PhD Program: .Statistical Physics

Supervisor(s): Dr.István Földes..

Ph.D. Topic: ***"Interaction of noble gas clusters 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 last summer we have already investigated the Rayleigh scattering signals of Argon gas which enables us to determine the sizes of the clusters generated by the pulsed gas jet source. In the third semester, in my studies the preparation of the synchronization was modified again. 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 the computer simply by pressing the mouse. After the mouse push synchronizing signal of the next laser pulse must be caught. This is time equal to zero. Note that this time the pockels cell is closed, and therefore no light pulse is emitted. 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 pulse will arrive into the cluster source. This delay serves for modifying the cluster density [2]. Then the CCD camera is triggered just before the arrival

of the laser pulse which allows catching the laser pulse. The exposure time is set by a separate camera driver program.

Now every part of the experimental work was set, but unfortunately I was infected with **covid-19**. Owing to the case I have been in the quarantine for ten days. Hence after we hope that after a couple of weeks the main part of the experiments will be carried out. 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].

Study in the current semester

Subject code	**Subject name**	**credit**
Fiz/3/010E	Sensory bio physics	6
Fiz/2/022	Astrophysics,astrochemistry and origin of life	6
Fiz/3/094	X-ray and XUV physics and spectroscopy	6
Fotonika2f21sx	Fundamentals of photonics	3
Fiz/kut-s_3	Guided research work	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] Faithfull, N. T. "Economical heating programmer for a tungsten filament atomizer." *Laboratory Practice* 32.6 (1983): 86-87.
[4] B. Bódi, et al.: *High Harmonic generation on noble gas clusters*; Optics Express 27, No. 19, 26721 (2019)