# Semester Report 2018/2019 fall


## By Tariq Hailat (hailat@caesar.elte.hu)

## Doctoral School of Physics-ELTE

**Supervisor**: Balázs Madas, Radiation Biophysics Group, MTA Centre for Energy Research, Budapest, Hungary


**Ph.D Thesis topic**: Modeling of adaptive responses to ionizing radiation at different levels of biological organization

**Place of research**: MTA Centre for Energy Research, Budapest, Hungary

## *Introduction*

Radioactive sources are a known quantity of a radionuclide which emits ionizing radiation; typically one or more of the radiation types such as alpha particles, beta particles, gamma rays and neutron radiation. Ionizing radiation emitted during the radioactive decay can induce a variety of cytogenetic effects that can be biologically damaging and result in an increased risk of carcinogenesis (Robertson et al., 2013). Most of researchers perform their experiments in radiation biology to estimate the relationship between some biological effects like DNA double-strand breaks (DSBs) or cell survival and radiation dose. In order to determine the risks associated with these doses.

The objective of the research in this semester is to do a simulation model using Python program in order to calculate some important things which have related to the blood cell such as the probability of hitting nuclei which decaying from radioactive source with blood cell, the absorbed energy by blood cell and the radiation dose.

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

In this semester, my supervisor gave me several of different preparatory tasks, which are preliminary research steps for a deep understanding. One of these tasks is to calculate the average of alpha particles that hitting blood cell with known radius and a certain distance from a radioactive source such as radium 223 which has a known radioactivity. The research was carried out in two ways:

The first way is analytical in that it uses mathematical formulas and illustrative figures to obtain a solution for tasks.

The second way for investigating the research relies on creating a simulation model using Python software in that I have watched many videos and I read some books related to the basics of Python. I enjoyed it and gained a good knowledge about writing programs by Python and executing operations on it.

Having had the ability to write a python codes, quadratic equation was formed which represents the relationship between area of the spherical blood cell and the directions of nuclei which decaying from radioactive source. The solutions of this equation represent the condition for hitting the alpha particles with the blood cell. Then a Python code was written that included several operations such as calculating the number and the probability of alpha particles that hit the blood cell by taking a random number of decaying nuclei from the radioactive source in random directions and plotting this state.

By taking the data between the energy and the range of alpha particle in the air (SRIM - The Stopping and Range of Ions in Matter) and by knowing the random direction of the alpha particle between the radioactive source and blood cell during the hitting, the Python program was developed to import the (Energy - Range) text file and determine the absorbed energy of the blood cell. By knowing the mass of the blood cell, the radiation dose of the blood cell has been determined.

The analytical method was compared with the simulation method using the Python program for calculating the probability of alpha particle which hit with blood cell where they were very identical result.

My supervisor helped me to get a license for the Origin software for interactive scientific graphing and data analysis. So, I have watched many videos online to learn how to use the program and how to plot the data and analyze it where I have now ability to do it.

In previous, I prepared many chemical samples are used to medical purposes and published two papers (Eyadeh et al., 2018b, Rabaeh et al., 2018) . Also, in this semester I have contributed to the publication a scientific paper in gel dosimetry (Eyadeh et al., 2018a). This paper includes contain Methylthymol blue-synthetic polymer gel dosimeter with glutaraldehyde cross-linker. Where they were irradiated using a linear accelerator (LINAC) for studying the effect of different dose response, dose rate and energy on these samples also to know the stability

and sensitivity for these samples. Then were analyzed and studied using spectrophotometer, nuclear magnetic resonance (NMR) and CCD camera.

## *Publications*

1- EYADEH, M. M., RABAEH, K. A., **HAILAT, T. F**., AL-SHORMAN, M. Y., ALDWERI, F. M., KANAN, H. M. & AWAD, S. I. 2018a. Investigation of a novel chemically cross-linked fricke-Methylthymol blue-synthetic polymer gel dosimeter with glutaraldehyde cross-linker. *Radiation Measurements,* 118, 77-85.

## *Educational activities in current semester*

In this semester, I registered two courses in the department, I took the statistical physics of biological systems course (6 Credits) and the statistical physics of polymers and membranes course (6 Credits), also I registered for Guided Research Work (18 Credits)

1- **Statistical physics of biological systems course:** which was explained by Dr. Gergely Palla and Dr. Anna Zafeiris

Dr. Gergely Palla explained for us some of very important subjects such as basic properties of scaling phase transitions, critical points and fluctuations and their importance in biology.in addition to fractals: definitions, different fractal types and relations between the dimensions. Then, we touched on the models of self-organized criticality and examples from biology. After that, we move to three types of networks: networks I.: graphs, adjacency matrix, sparse networks, degree, clustering, the small world property and scale-free networks. Also, networks II: models (Erdos–Rényi-model, Watts–Strogatz-model, Barabási–Albert-model, configuration model, deterministic scale-free model, graph ensembles and topological phase transitions. Finally, networks III: applications (robustness of networks, spreading on networks, SIS model and community finding in networks.

While Dr. Anna Zafeiris explained for us also very important subjects such as geometry of bacterial colonies I and II that include micro-biological background, morphology diagram, Fisher equations, the origin of instability and fractal growth models.the we took two lectures about syncronisation in biology and Kuramoto-model for syncronisation. After that we took subjects in collective motion and opinion dynamics

2- **Statistical physics of polymer and membranes course:** The lecturer was Dr. Imre Derényi. We learnt many important subjects in this course about properties of an isolated polymer molecule for the ideal chain. We learnt how to derive many mathematical relationships about the random walk model, the effect of short-range interactions, freely jointed chain (FJC), freely rotating chain (FRC), Kuhn length, end-to-end vector distribution function and Gaussian chain. Then we take the Distribution of segments in the polymer chain subject (pair correlation function, radius of gyration) and non-ideal chains subject (the excluded volume effect, effect of the solvent). Also we touched on the subject concentrated solutions and melts which contain the thermodynamics properties of

polymer solutions (Flory-Huggins theory) and concentration fluctuation in polymer solutions.
After that Dr. Derényi explained to us about molecular motion of polymers in dilute solution that contains specific subjects such as general theory of Brownian motion, the bead-spring model and Hydrodynamic interactions. We also learnt an important part about membranes physics such as shapes, adhesion and Dynamics.

## *Conferences in current semester*

During the semester I attended many seminars and presentations

1-On Thursday, September 27. I attended some events were held by the European Radiation Dosimetry Group (EURADOS) in MTA EK – Budapest. I learnt about

- **PROCORAD – The Association for the Promotion of Quality Control in Radiotoxicological Analysis** which was introduced by C. Guichet (CEA, France)

- **Internal Microdosimetry** which was introduced by W. Hofmann (Univ. Salzburg, Austria) and W.Li (HMGU. Germany).

2-On Thursday, October 11. I attended a lecture about Neutrino Physics that was introduced by Prof. Kai Zuber in the Ortvay Colloquium.

3- On Tuesday, November 20. I attended a lecture about **overview and operation experience of Jordan Research and Training Reactor** that was introduced by Ashraf Albteiha.

4-Next May, I am planning to attend a **XVI Seminar on Software for Nuclear, Sub nuclear and Applied Physics** in Rome, Italy. This seminar will improve my work and it will move me to advanced steps of the work because the lectures also include a full official basic course on the Geant4 Monte Carlo simulation toolkit.

5- I am planning to participate in RAD2019 conference about radiation measurements in Montenegro on June 10-14, 2019.

## *References:*

EYADEH, M. M., RABAEH, K. A., HAILAT, T. F., AL-SHORMAN, M. Y., ALDWERI, F. M., KANAN, H. M. & AWAD, S. I. 2018a. Investigation of a novel chemically cross-linked fricke-Methylthymol blue-synthetic polymer gel dosimeter with glutaraldehyde cross-linker. *Radiation Measurements,* 118**,** 77-85.

EYADEH, M. M., RABAEH, K. A., HAILAT, T. F. & ALDWERI, F. M. 2018b. Evaluation of ferrous Methylthymol blue gelatin gel dosimeters using nuclear magnetic resonance and optical techniques. *Radiation Measurements,* 108**,** 26-33.

RABAEH, K. A., EYADEH, M. M., HAILAT, T. F., ALDWERI, F. M., ALHEET, S. M. & EID, R. M. 2018. Characterization of ferrous-methylthymol blue-polyvinyl alcohol gel dosimeters using nuclear magnetic resonance and optical techniques. *Radiation Physics and Chemistry,* 148**,** 25-32.

ROBERTSON, A., ALLEN, J., LANEY, R. & CURNOW, A. 2013. The cellular and molecular carcinogenic effects of radon exposure: a review. *International journal of molecular sciences,* 14**,** 14024-14063.