Small-angle scattering from fractals

1. Introduction:

A multitude of artificial and natural processes ranging from nano to macro scales generate self-similar structures, which means that they look exactly or approximately similar to a part of themselves under a transformation of scale. These objects are referred to as deterministic fractals (Cantor sets, Koch snowflake, Sierpinski gasket; SG) if the structure is exactly self-similar, or random fractals (polymers, percolation clusters, surfaces, DNA sequences) if the structure is statistically self-similar. At nano and micro scales, the self-similarity plays an important role in the electromagnetic, optical or dynamical properties, and thus one of the main tasks is to understand the correlation between fractal microstructure and its physical properties. Experimentally, structural investigations of fractals at nano and micro-scales using small-angle scattering (SAS; x-ray, neutrons, light) technique is commonly used due to its ability to provide quantities of interest averaged on a macroscopic volume.

During this project student will study fractal geometry, physics of small-angle scattering and learn how to perform computer simulation of the scattering from fractals. This will allow the student to understand structure of matter at nano/micro scales from scattering data.

2. Main topics of the project:

- Introduction to Fractal Geometry
- Fractal construction algorithms
- Derivation of analytical structure factor of fractals
- Simulation of small-angle scattering from fractals
- Interpretation of scattering data

3. Minimal requirements:

Basic knowledge of optics and basic programming skills.

4. Literature:

1. B. B. MANDELBROT, *Fractal Geometry of Nature* (W. H. Freeman, New York, 1982).
2. Hecht, Eugene. *Optics*. Pearson Education, 2016.

5. Number of participants:

Three students limit the number of the participants.

6. Supervisor of the project:

- Eugen Mircea Anitas, head of sector, PhD, Bogolyubov laboratory of theoretical physics, Department of condensed matter theory.
- Azat Mukhiddinuly Slyamov, junior researcher, Bogolyubov laboratory of theoretical physics, Department of condensed matter theory.