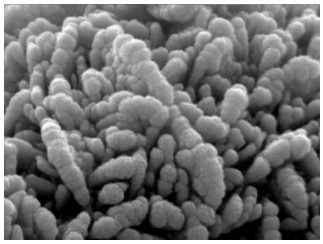
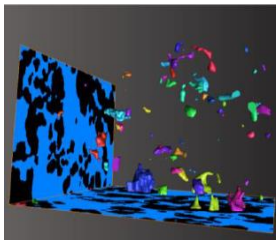
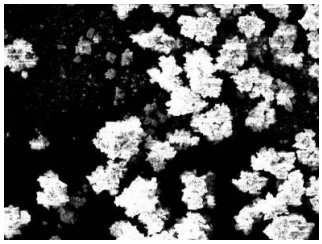
2 INTERNSHIP OPEN POSITIONS

Subject: *Geometrical Characterization, Modeling and Simulation of Images representing Complex Spatial Structures*

Where: École Nationale Supérieure des Mines de Saint-Étienne, France (http://www.mines-stetienne.fr/)
Duration: between 4 and 6 months in 2018
Remuneration: ~500 EUR (~7.900.000 IDR) / month
Student profile: Undergarduate (4th year bachelor) or Master student with a good basic knowledge in mathematics and in image processing; good Matlab skills are required.
Contact: Prof. Johan Debayle (debayle@emse.fr) - http://www.mines-stetienne.fr/~debayle/

Context:
Many natural or artificial environments (fibrous, granular, porous, cellular ...) have complex spatial structures (see figure below) for which many physicists (in the broad sense) of the domains concerned use quantitative descriptors more or less established mathematically, such as: roughness (to quantify the amplitudes of variations of a surface at small spatial scales), tortuosity (to quantify the directional variations of a curve or a surface having many "turns"), the granularity (to quantify the grain size distribution of a population of particles), the porosity (to quantify the size distribution of the cavities in an object), the fractality (to determine a non-fractional behavior invariant by geometric similarity) or texturality (to quantify the relative disposition of a spatial structure).

Geometrical approaches (convex geometry, integral geometry, differential geometry, stochastic geometry) propose tools for global characterization (area, perimeter, Euler number, covariance function) that are insufficient to describe, characterize, discriminate or gather complex spatial structures.

Internship 1: Local geometrical characterization of complex spatial structures
The objective of this first internship is to study and extend these geometrical approaches for local characterization of complex spatial structures. Images of stochastic spatial structures will be firstly investigated (for example, using models coming from the 2nd internship project). The student will study some local measures from an analytical and numerical point of view, and determine their properties according to the type of spatial structures considered. He will then put in place the computer simulations of these models in order to validate the analytic, asymptotic and / or approximate formulas. Finally, he will apply these local measurements on real spatial structures.

Internship 2: Geometrical modelling and simulation of complex spatial structures
The objective of this second internship is to model and simulate images of complex spatial structures. Indeed, a second way to describe and characterize real complex structures is to define a geometrical (random/stochastic) model representing the real data. The student will study different models that can be suitable for representing such complex structures. The models will be characterized (for example, using descriptors coming from the 1st internship) and fitted to the real data. Several numerical simulations will be done to evaluate the performance of the proposed approach.

These 2 internship positions are therefore connected to each other and also related to a PhD thesis started in the same lab in October 2017