



ABCDE



Scientific Report

First name / Family name

Benvenuto

Nationality

Federico

Name of the *Host Organisation*

INRIA

First Name / family name
of the *Scientific Coordinator*

Haddar

Period of the fellowship

01/10/2013 to 30/09/2014

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The main scientific activity during the fellowship has been carried on within the NanolytiX project (joint project between DEFI and Xenocs) in collaboration with the researchers of the Xenocs Company in Grenoble. It was concerned with the development of a fully automatic method for the reconstruction of the particle size distribution of dilute ensembles of non-interacting polydisperse nanoparticles with identical shape, from non destructive SAXS measurements. The developed method solves a maximum likelihood problem with a positivity constraint on the solution by means of an Expectation Maximization iterative scheme coupled with an innovative type of regularization. Such a regularization, together with the positivity constraint results in high fidelity quantitative particle size distributions up to hitherto unavailable accuracy, making the method particularly effective in real applications. The method has been tested on synthetic data in the case of uni- and bi-modal particle size distributions showing an excellent accuracy in reconstruction. Moreover, we applied it to real data provided by a Xenocs device prototype obtaining results of high reliability and performances.

In order to make this method so effective in real applications, the development of a regularization definition based on statistic was needed. The core idea is to select the optimal estimate of the solution of an inverse problem in according with the noise contained into data. For example, in the case of data provided by photon counting devices, regularization is based on Poisson noise. The presentation of the preliminary results of this study was awarded with the “2014 Inverse problems poster prize” at the IPTA conference.

As stated in the research project, we provide an implementation of this method for characterization of the morphology and structure of nanomaterials, in a software package compact and easy to use. In particular this tool, based on the techniques of X-ray scattering at small angles (Small Angle X-ray Scattering (SAXS)) provide access to information on a scale ranging from 0.1 nm to 100 nm, and have the advantage of being able to measure inside the material without (sophisticated) sample preparation.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

A robust stopping rule for Expectation Maximization: an application to particle volume determination in Small Angle X-ray Scattering (submitted)

On asymptotic regularization and its connection with Poisson noise (in preparation)

A two-step strategy for optimal regularization of ill-posed inverse problems (in preparation)

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1) April 2014

Conference : 13 RHESSI MEETING

Presentation title : “An inverse problem approach to the inference of accelerated ion spectra in solar flares”

2) June 2014

Conference : PICO F 2014

Presentation title : “A family of estimators for a non linear inverse problem”

3) July 2014

Conference : SIMAI 2014

Presentation title : “A Small Angle X-ray Scattering Technique for Determining Nano-scale Particle Size Distributions=

4) August 2014.

Conference : IPTA 2014

Presentation title : “Regularization for operators with asymptotically noise-free data” (*)

(*) This work has been awarded by the Scientific Committee with the “2014 Inverse Problems Poster Prize”.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Period: 31/03/2014 5/4/14

REP Organisation : SIRA (ex ERCIM member)

Department : Institute of 4D Technologies FHNW

Country: Switzerland

Local scientific coordinator : André Csillagy

In this short period I collaborated with the researchers of Institute of 4D Technologies FHNW in understanding the data acquisition process from photon counting devices in order to better develop statistical regularization methods. I also participated in the 13 RHESSI meeting.

Period: from 15/02/2014 to 02/03/14 and from 05/09/14 to 30/09/14

REP Organisation : CNR Pisa (ERCIM member)

Department : ISTI - Istituto di Scienza e Tecnologie dell'Informazione

Country: Italy

Local scientific coordinator : Cristina Padovani

In this periods I worked with Dr.Margherita Porcelli in developing a new general regularization method for inverse problems. This collaboration is going on and the aim is to publish the results in a paper “A two-step strategy for optimal regularization of ill-posed inverse problems”.