Modelling and algorithm development for the analysis of polydisperse droplet and particle dynamics through next generation photon correlation spectroscopy

Description: The characterization of small particle size and motion is an active challenge for researchers examining sprays, emulsions, and nucleation processes in water technology. This project aims to design, model, and develop the data processing algorithms for an advanced photon correlation spectroscopy (PCS) instrument. A set-up for a similar system is shown in Fig. 1 (left); most work of this thesis, however, will be data processing and programming (Fig. 1, right).

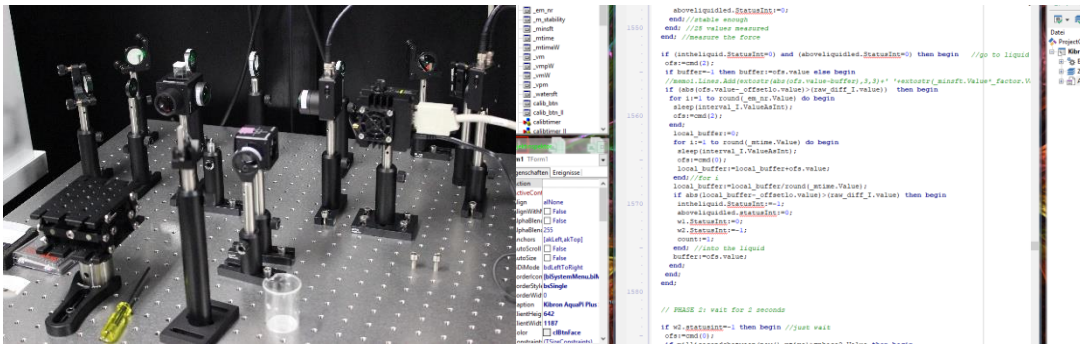

Fig.1: Optical set-up in the Wetsus Laser Lab (left); code sample (right)

This next generation system will have the unique capability to characterize polydispersity, sphericity, and ripening dynamics of particles between 10 - 1000 nm. PCS uses the scattering pattern generated by coherent light interacting with a sample. The instrument uses a hybrid detector scheme to build a cross-correlation matrix from time resolved fluctuations in angular brightness at multiple solid angles to deconvolve the complex scattering signal found in suspensions. These systems can have particles with a range of sizes or exhibit particles that undergo size change due to collision, ripening, or other interaction processes. The instrument consists of beam shaping optics, sample stabilization, collection optics, as well as signal processing algorithms. You will model the expected radiation scattering patterns from simulations of both conductive and dielectric bodies in a dielectric liquid. The output will be used to design and optimize a detector scheme that allows accurate determination of complex mixtures of particles. Finally, you will develop data processing algorithms for deconvolving the measured detector intensities and returning an accurate representation of the sample particle population. The algorithms will use neural networks in conjunction with machine vision to provide a robust analysis of the data.

Candidate requirements: A background in physics, optics, or machine learning is required. Direct experience with computational modelling, image processing, and neural networks is expected. Strong communication and good organizational skills along with a positive attitude are essential. Knowledge of physical chemistry and electromagnetism is also desired.

Application: If you are interested in this project, please contact Dr. Adam D. Wexler (adam.wexler@wetsus.nl) or Gerwin Steen (gerwin.steen@wetsus.nl) for more information or directly apply by sending your CV to the same address. The internship/MSc thesis includes a reimbursement for living expenses of 350 euro per month.

References: Interested candidates are referred to the following papers:

L. Cipelletti and D. A. Weitz, "Ultralow-angle dynamic light scattering with a charge coupled device camera based multispeckle, multitau correlator," Review of Scientific Instruments 70, 3214 (1999)

J. Stetefeld, S.A. McKenna, & T.R. Patel, "Dynamic light scattering: a practical guide and applications in biomedical sciences," Biophysical Reviews, 8(4), 409–427 (2016)

Y. Liu, N. Claes, B. Trepka, S. Bals and P. R. Lang, "A combined 3D and 2D light scattering study on aqueous colloidal model systems with tunable interactions," Soft Matter, 12, 8485-8494 (2016)

L. M. Gugliotta, G. S. Stegmayer, L. a. Clementi, V. D. G. Gonzalez, R. J. Minari, J. R. Leiza, and J. R. Vega, "A Neural Network Model for Estimating the Particle Size Distribution of Dilute Latex from Multiangle Dynamic Light Scattering Measurements," Part. Part. Syst. Charact., vol. 26, pp. 41–52, 2009.

X. Liu, J. Shen, J. C. Thomas, L. A. Clementi, and X. Sun, "Multiangle dynamic light scattering analysis using a modified Chahine method," J. Quant. Spectrosc. Radiat. Transf., vol. 113, no. 6, pp. 489–497, 2012.

S. Rei and D. Chicea, "Using Dynamic Light Scattering Experimental Setup and Neural Networks For Particle Sizing," ACTA Univ. Cibiniensis, vol. 69, no. 1, 2017.