Combining single particle tracking and image correlation spectroscopy techniques to determine local diffusion properties

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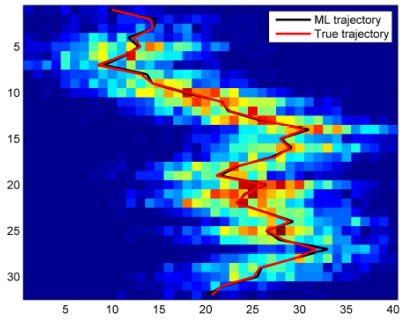
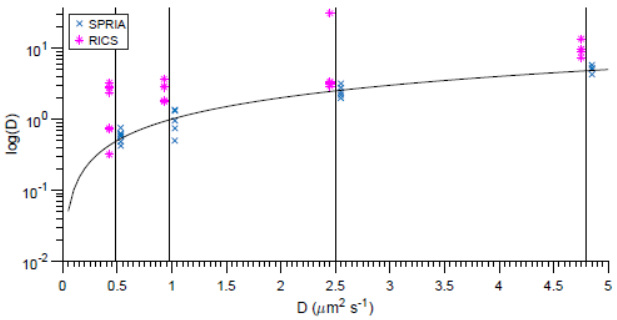
The functionality of many industrial products relies on careful control of mass transport properties. For instance, control of diffusion is vital for water management in pasta and pastry products, chromatography applications and controlled release of drugs. Structures at different length scales to large extent control the mass transport properties. Therefore thorough understanding of structure - mass transport relationships and good measurement techniques for global and local diffusion are essential. In this talk, the coupling between structure and diffusion at different length scales in soft porous heterogeneous materials will be discussed.

Quantitative confocal microscopy allows for simultaneous determination of microstructure at micrometer level and local quantitative information regarding mass transport, electrostatic interactions, rheological properties etc. A brief overview of different confocal microscopy based techniques to characterize local diffusion will be given in this presentation. A new technique that combines single particle tracking (SPT) and raster image correlation spectroscopy (RICS) techniques will be presented[1]. The new analysis method is called Single Particle Raster Image Analysis (SPRIA)[1]. In SPRIA, the start is to identify individual particles and estimate the diffusion coefficient for each particle by a maximum likelihood method, see figure below. Averaging over a number of particles gives a diffusion coefficient estimate for the whole image. The new method gives good estimates of the diffusion coefficient for both simulated and experimental data, see figure below. It should be possible to extend the method to study heterogeneous materials and systems of particles with varying diffusion coefficient. The new SPRIA method and results obtained with RICS and SPRIA will be presented.



Example of a particle trajectory.



Diffusion of fluorescent beads with different sizes.

[1]Longfils, M.; Schuster, E.; Lorén, N.; Särkkä, A.; Rudemo, M. (2016) Single particle raster image analysis of diffusion. J. Microscopy DOI:10.1111/jmi.12511.