Structure factor of polydisperse particle suspensions

Background – Light scattering by tissue is a complex phenomenon due to the random nature of the refractive index distribution of tissue constituents. For practical purposes, light scattering is often studied using samples mimicking tissue, e.g. suspensions of spherical particles with fixed size and refractive index and random positions. For individual particles, light scattering can be described using classic theories such as Rayleigh or Mie scattering. The scattering of the suspension as a whole is obtained by incorporating a density dependent function describing the positions statistics of the particles: the structure factor $S(q)$. For the simple case above, the Percus-Yevick structure factor is applicable.

Structure factor – A more realistic ("tissue approaching") sample would contain particles of a broad size distribution. Analytical calculation of $S(q)$ is usually not possible in this case and is usually performed using Monte Carlo simulations. We have implemented a Monte Carlo simulation which accurately determines $S(q)$ for mono-disperse suspensions. Output for polydisperse suspensions has yet to be validated.

Goal – An interesting intermediate case are bi-disperse solutions, i.e. solutions containing particles of 2 discrete diameters. For such samples, (elaborate) analytical descriptions for $S(q)$ are available. You will implement these descriptions in simulation code and compare to Monte Carlo output of the same bi-disperse samples.

Requirements – This assignment has a strong theoretical and numerical component. Affinity with programming, experience with Matlab or LabVIEW, or desire to gain experience in these languages is required.

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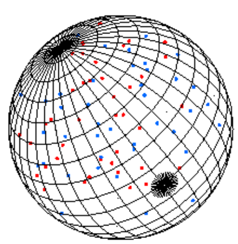

Illustration of Monte Carlo geometry: a large bounding spheres is filled with particles having either diameter D_1 (red) or D_2 (blue). Particle positions are generated randomly. By computing histograms of mutual particle distances over multiple realizations, the structure factor can be derived.