Title: The Chaotic Life of Mayonnaise

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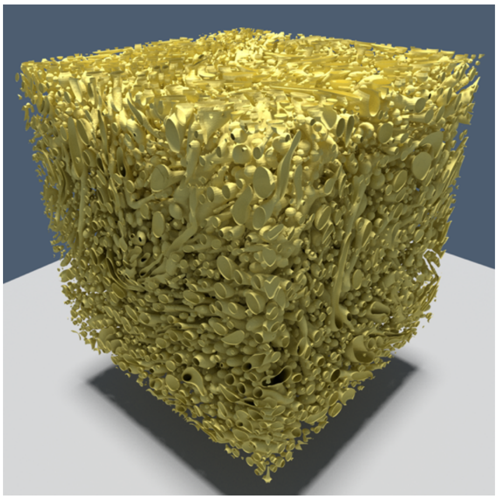
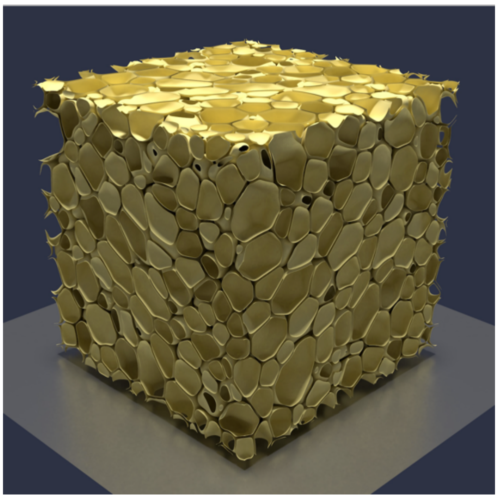
Stabilized multi-component emulsions, commonly found in many foods and cosmetic products, display a fascinating and rich phenomenology. How do such complex fluids flow? Despite considerable attention in the literature, many fundamental questions remain to be answered. For experiments it is very difficult if not impossible to provide full microscopic details for a moving emulsion. Therefore, in order to understand the interplay between small-scale physics and large-scale rheology we employ 3d state-of-the-art numerical simulations. Thanks to two PRACE projects granted in the 17th and in 19th PRACE project call, respectively, we have been able to model a multi-component fluid both under influence of a turbulent stirring (figure left) as well as in his stationary (jammed) phase (figure right).





In this talk we describe our experience in investigating the dynamics of stabilized emulsions via mesoscale 3d numerical simulations (at various resolutions, up to 1024^3) by employing highly optimized numerical codes based on a multicomponent Lattice Boltzmann model (LBM). The first part will describe the initial phase of code optimization of the LBM to achieve high-performance on the KNL processor, including an analysis of the code scalability. In the second part, I will present the steps required to explore the physics of complex fluid emulsions: from their production, via turbulent stirring, to their (statistical) behavior under flowing, as well as under resting (jammed) conditions. I will discuss the emulsion morphology (e.g. droplet size distribution) at varying the stirring intensity, the resolution, as well as the relative volume fraction of the two fluid components. A particular focus will be given on how to achieve large volume fraction of the dispersed droplet phase (i.e. larger than 50%). Indeed, strong forcing, too rapid increase or too large values of the dispersed phase volume fraction will invariably lead to the so-called catastrophic phase inversion (a sudden non-equilibrium process through which the emulsion rapidly destabilize and phases invert). The final part of the presentation will be dedicated to share together with the audience how to make possible those sorts of large-scale simulation on the next generation of supercomputers and to discuss the project insight into the scientific community along with impact on industrial applications.